3RD
INTERNATIONAL
CONFERENCE ON

MUSIC & EMOTION

JYVÄSKYLÄ • JUNE 11–15 • 2013

- Programme
- Abstracts
- Proceedings

Edited by
Geoff Luck
Olivier Brabant

MUSIC & EMOTION

Programme · Abstracts · Proceedings

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3rd International Conference on Music & Emotion (ICME3)
Programme and Abstracts

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Department of Music, University of Jyväskylä
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CHAIR'S WELCOME ADDRESS

Dear Colleagues,

It gives me great pleasure to welcome you to the City of Jyväskylä, the Department of Music of the University of Jyväskylä, the Finnish Centre of Excellence in Interdisciplinary Music Research, and the 3rd International Conference on Music & Emotion.

One of the key reasons people engage with music is because of its emotional impact. Music comforts us when we're sad, lifts us up in happier times, bonds us together. We use music to modify our mood, augment current feelings, release tension. Given the ever-growing presence of music in our everyday lives, the investigation of issues related to, and subsequent dissemination of knowledge concerning, music and emotion is becoming increasingly relevant.

The first ICME was held in Durham, UK, in 2009, and the second in Perth, Australia, in 2011. The third in the series, ICME3 features over 200 invited keynote addresses, papers, posters, and symposia presented by leading scientists, pedagogues, practitioners, and performers from 35 countries. The aim of the conference is to promote a dialogue between individuals and groups working in disparate yet related subfields in order to more effectively share concepts, definitions, and methodologies, as well as technical and practical knowledge across disciplinary boundaries.

In addition to the academic programme, ICME3 features an extensive social programme, including a classical concert, a lake cruise, a Finnish sauna experience, and an end-of-conference dinner. In addition, I invite you to attend Sight & Sound, an accompanying three-day club festival featuring live music and visual arts from jazz, pop, and rock artists. Alternatively, simply relax and enjoy the long summer days, beautiful surroundings, and peaceful nature of the region.

However you choose to spend it, I wish you an enjoyable and stimulating week here in Jyväskylä!

Geoff Luck
ICME3 Chair

ICME3 PROGRAMME OVERVIEW

	TUE 11	WED 12	THU 13	FRI 14	SAT 15
08:00	Registration Poster Setup	Registration Poster Setup	Registration Poster Setup		
09:00		Spoken Papers Symposium 2	Spoken Papers	Spoken Papers Symposium 4	Spoken Papers
10:00					
10:30	Opening Ceremony	Coffee	Coffee	Coffee	Coffee
11:00	Keynote 1 Eric CLARKE	Keynote 2 Antonio CAMURRI	Keynote 3 Klaus SCHERER	Keynote 4 Jane DAVIDSON	Keynote 5 Stefan KOELSCH
12:00	Lunch	Lunch	Lunch	Lunch	Lunch
13:00					
13:30	Spoken Papers / Speed Posters 1	Spoken Papers / Speed Posters 2	Spoken Papers / Speed Posters 3	Free Afternoon **City Tours, Free Museum Entry, etc.**	Spoken Papers Symposium 5
14:00					
15:00	Poster Viewing	Poster Viewing	Poster Viewing		
15:30	Coffee	Coffee	Coffee		Coffee
16:00	Spoken Papers Symposium 1	Spoken Papers / RepoVizz Workshop	Spoken Papers Symposium 3		Keynote 6 Daniel VÄSTFJÄLL
17:00				Finnish Sauna Experience **Savutuvan Apaja**	Closing Words
18:00					
19:00	Welcome Reception **City Hall**				Conference Dinner **Savutuvan Apaja**
19:30			Evening Cruise (Dinner Optional) **Lake Päijänne *-s/s Suomi***		
20:00		Classical Concert **Taulumäki Church**			
21:00					
22:00		Sight & Sound	Sight & Sound **Jam with the Stars at 23:00**	Sight & Sound	
23:00					
00:00					
...					

TUESDAY 11 JUNE

	M103	A103	H306	D109	M014
08:00	Registration Poster Setup				
10:30	**OPENING CEREMONY**				
11:00	**KEYNOTE 1** Eric CLARKE *Lost And Found In Music.*				
	Chair: Geoff LUCK				
12:00	Lunch				
	NEUROPHYSIOLOGY	**EXPRESSION**	**THERAPY**	**EXPERIENCE**	**SPEED POSTERS 1** • ***LISTENING & MEMORY*** • ***HEALTH & WELLBEING I*** • ***PERFORMANCE***
	Chair: Elvira BRATTICO	Chair: Jonna VUOSKOSKI	Chair: Esa ALA-RUONA	Chair: Rory ALLEN	Chair: Teruo YAMASAKI
13:30	Rafael RAMIREZ Zacharias VAMVAKOUSIS Sergio GIRALDO *EEG-Based Emotion Detection In Music Listening.*	Kirsten NISULA David HURON Daniel SHANAHAN Matthew DAVIS *Confusing Sadness And Relaxed Musical Expressions: Animal Signaling Versus Speech Prosody Interpretations.*	Neta SPIRO Tommi HIMBERG *Empathy In Musical Interaction.*	Karim WETH Max KICKINGER *Ambivalent Emotions In Music: We Like Sad Music When It Makes Us Happy.*	***LISTENING & MEMORY*** Kelly JAKUBOWSKI Daniel MÜLLENSIEFEN *The Influence Of Music-Elicited Emotions And Relative Pitch Abilities On Absolute Pitch Memory For Familiar Melodies.* Junko MATSUMOTO *Everyday Listening To Music And Emotion Among College Students.* David DITTER Leonid SCHMIDT Nils TESMER Hauke EGERMANN *An Experimental Investigation On Empathy As An Emotion-Induction Mechanism In Music Listening.* Jenny GROARKE Michael HOGAN *The Adaptive Functions Of Music Listening: A Scale Development Project.* Douglas MACCUTCHEON *The Neuroscience Of Musical Expectancy: An FMRI Investigation Into Emotional Responses To Naturalistic Music.*

	M103	A103	H306	D109	M014
14:00	Julian O'KELLY Wendy MAGEE Leon JAMES Ramaswamy PALANIAPPAN *Music Therapy Applications For Promoting Arousal And Emotional Responses In Those With Disorders Of Consciousness: Preliminary Analysis Of A Neurophysiological And Behavioural Study.*	Erica BISESI Marlies BODINGER Richard PARNCUTT *Listeners' Informal Vocabulary For Emotions And Free Associations In Piano Music.*	Monika Malgorzata STANCZYK *Music And Cancer Care.*	Nikki RICKARD Abdulllah ARJMAND Elizabeth WHITE *Depressive Deficits In The Experience, But Not Regulation, Of Music-induced Emotions.*	***HEALTH & WELLBEING I*** Andre SINICO Leonardo WINTER *Music Performance Anxiety: Use Of Strategies By Tertiary Flute Players.* Alexandra LAMONT *Negative Emotions In Performers: Balanced Wellbeing And Music Performance Anxiety.* Alexandra LINNEMANN Beate DITZEN jana STRAHLER Johanna DÖRR Urs M. NATER *Music As A Means Of Stress Reduction In Daily Life - An Ambulatory Assessment Study Among Students.* Malgorzata SIERSZENSKA-LERACZYK *Stage Fright And Participants Of The Wieniawski International Violin Competition.* Tim LOEPTHIEN Bernhard LEIPOLD *How Can Accommodation Be Enhanced? The Role Of Analytical And Emotional Music Reception.* Amelia GOLEMA *How To Prevent Musical Illiteracy Among Children?*
14:30		László STACHÓ Suvi SAARIKALLIO Anemone VAN ZIJL Minna HUOTILAINEN Petri TOIVIAINEN *Perception Of Emotional Content In Musical Performances By 3- To 7-year-old Children.*	Alexis KIRKE Joel EATON Eduardo MIRANDA *Real-time Hallucination Simulation And Sonification Through User-led Development Of An iPad Augmented Reality System.*	Miracle J. LIM PerMagnus LINDBORG *How Much Does Music Quality Matter? Listening Over Earphones On Buses And Trains.*	***PERFORMANCE*** Yuki MITO Hiroshi KAWAKAMI Masanobu MIURA Yukitaka SHINODA *The Relation Between Emotional Valence And Performance Motion Of The Keyboard Instrument.* Sergio GIRALDO Rafael RAMIREZ *Brain-Activity-Driven Real-Time Music Emotive Control.* Carolina LABBÉ Didier GRANDJEAN *The Musical Entrainment Questionnaire.*

	M103	A103	H306	D109	M014
					Birgitta BURGER Juho POLET Geoff LUCK Marc R. THOMPSON Suvi SAARIKALLIO Petri TOIVIAINEN *Investigating Relationships Between Music, Emotions, Personality, And Music-induced Movement.*
15:00	Wiebke TROST Daniele SCHÖN Sascha FRÜHHOLZ Carolina LABBÉ Didier GRANDJEAN Patrik VUILLEUMIER *Rhythmic Entrainment And Musical Emotions.*		Markus RAIVIO *Young Heroes - Music In Mental Health And Functional Peer Support.*	Laila EL-MAHGARY *Live Music In The Tourist Industry In Helsinki And Sharm El Sheikh.*	Poster Viewing **Musica Studio and Basement Corridor**
15:30	Coffee, and Poster Viewing				
	SYMPOSIUM 1 ***MUSICAL EMOTIONS IN THE BRAIN***	**PERFORMANCE I**	**EDUCATION**	**THERAPY: AFFECTIVE DISORDERS I**	
	Discussant: Lauren STEWART	Chair: Ric ASHLEY	Chair: Erja KOSONEN	Chair: Neta SPIRO	
16:00	Mikko SAMS *Processing Emotional Valence In The Brain.* Elvira BRATTICO *Conscious And Spontaneous Music Emotions In The Brain.*	Anemone VAN ZIJL Geoff LUCK *The Sound Of Sadness: The Effect Of Performers' Emotions On Audience Ratings.*	Päivi-Sisko EEROLA Tuomas EEROLA *Does Music In School Increase The Happiness Of The Pupils?*	Denise GROCKE *"Strange Feelings": Songs For Coping With Mental Illness.*	
16:30	Peter VUUST *Prediction Error As The Key To Understanding The Pleasure Of Challenging Rhythms.*	Joana GAMA *The Role Of Inspiration In The Performance Of Programme Music: The Case Of "Viagens Na Minha Terra" By Fernando Lopes-Graça.*	Robert CRISP *Music Technology In The Classroom: A Music Engagement Program Perspective.*	Sergei STANGRIT *Improvisation Musical Adjustment To The Emotional State As The Basis Of Musical Therapy For An Autistic Child.*	
17:00	Petri TOIVIAINEN *Predicting The Neural Substrates Of Perceived Music Emotions During Naturalistic Listening Condition.*	Alexis KIRKE Greg DAVIES Eduardo MIRANDA Joel EATON *Open Outcry: A "reality Opera" In Which Traders Sing To Trade Real Money And The Music Expresses The Emotions Of The Financial Market.*	Sanna KIVIJÄRVI Ari POUTIAINEN *Special Music Education Advancing Inclusion – A Study On Resonaari May 14, 2012 Concert Audience.*		
17:30		Vaiva IMBRASAITE Peter ROBINSON *Absolute Or Relative? A New Approach To Building Feature Vectors For Emotion Tracking In Music.*	Georgia PIKE Susan WEST The Altruistic Teen: The Role Of Altruism In Re-engaging Australian Teenagers In Singing.		
19:00	Welcome Reception (19:00-20:30) **City Hall** All registered delegates are cordially invited to an evening reception hosted by the City of Jyväskylä. Light refreshments will be offered. Music will be provided by **Trio Hei!**				

WEDNESDAY 12 JUNE

	M103	A103	H306	D109	M014
08:00	Registration Poster Setup				
	SYMPOSIUM 2 ***BRAIN-COMPUTER INTERFACES, EMOTION, AND MUSIC***	**CROSS-MODAL EFFECTS**	**EVERYDAY LISTENING**		**THE SINGING VOICE**
	Discussant: Rafael RAMIREZ	Chair: Pasi SAARI	Chair: Suvi SAARIKALLIO		Chair: Jane DAVIDSON
09:00	Rafael RAMIREZ *EEG-based Emotion Detection In Music Listening.* Zacharias VAMVAKOUSIS *Combining Gaze And Brain Control In Music Performance.*				
09:30		Fernando BRAVO *The Influence Of Interval Content On The Emotional Interpretation Of Visual Information.*	Richard VON GEORGI Birce POLAT *Emotion, Personality, Use Of Music In Everyday Life And Musical Preferences.*		Charris EFTHIMIOU *Nightwish: A Finnish Heavy Metal Band With A Female Voice: Use Of A Female Voice In Heavy Metal Music Of The 21st Century And The Reactions Of The Audience And Reviewers.*
10:00		Daniel SHANAHAN Kirsten NISULA *The Size Of Emotion: The Role Of Visual Stimuli On The Perception Of Affect In The Human Voice.*	Alexandra LAMONT *Everyday Life Under The Microscope: Emotions And Engagement With Music.*		Päivi JÄRVIÖ *"La Voix Comme Interprète De Nos Sentiments" – The Voice As Interpreter Of Feelings In 17th- And 18th-Century French Vocal Music.*
10:30	Coffee				
11:00	**KEYNOTE 2** Antonio CAMURRI *Computational Models Of Non Verbal Expressive Gesture And Social Signals In Joint Music Action.*				
	Chair: Petri TOIVIAINEN				
12:00	Lunch				
	REGULATION I	**MODELS**	**NEW TECHNOLOGIES**	**PHYSIOLOGY**	**SPEED POSTERS 2** • ***PREFERENCE*** • ***HEALTH & WELLBEING II*** • ***PERCEPTION***
	Chair: Daniel VÄSTFJÄLL	Chair: Richard PARNCUTT	Chair: Benjamin KNAPP	Chair: Jörg FACHNER	Chair: Ruth HERBERT
13:30	Sylka UHLIG Artur JASCHKE Erik SCHERDER *Effects Of Music On Emotion Regulation: A Systematic Literature Review Describing Music As A Human Instrument For Processing And Regulating Emotions.*	Tomasz SZUBART *Are Musical Emotions Natural Kinds?*	Tom COCHRANE *The Mood Organ.*	R. Michael WINTERS Ian HATTWICK Marcelo M. WANDERLEY *Integrating Emotional Data Into Music Performance: Two Audio Environments For The Emotional Imaging Composer.*	***PREFERENCE*** Ai KAWAKAMI Kiyoshi FURUKAWA Kazuo OKANOYA *The Pleasant Emotion Of Sad Music.* John HOGUE Andrea CRIMMINS Jeffrey KAHN *Determining Predictors And Moderators Of Liking Sad Music.*

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					Rafal LAWENDOWSKI *Temporal Stability Of Music Preferences As An Indicator Of Their Underlying Conditionings.* Stephanie BRAMLEY Nicola DIBBEN Richard ROWE *The Presence, Experience And Influence Of Background Music In Gambling Situations.*
14:00	Suvi SAARIKALLIO Geoff LUCK Marko PUNKANEN *Musical Emotion Perception And Emotion Regulation In Depressed Individuals.*	Pasi SAARI Tuomas EEROLA *Modeling Moods In Social Media Of Music Using Semantic Analysis And Affect Structures From Emotion Research.*	Alexis KIRKE Duncan WILLIAMS Eduardo MIRANDA *Many Worlds: A Live Action Short Film Which Edits Itself In Real-time Based On Audience Emotional Response.*	Finn UPHAM *How And When I Feel: Coordination Of Continuous Emotional Responses From A Single Subject.*	***HEALTH & WELLBEING II*** Anatoly ZHIRKOV Olga ZHIRKOVA Anna GOLUBEVA *The Aestetic-Art Model For The Analysis Of Emotional And Psychosomatic Reactions To Music.* Genevieve DINGLE Hollie SHANNON *Comparison Of A Music Diary With CBT Thought Monitoring For Mood Regulation.* Lara HERMAN Melissa JOURDAIN *Function Of Music Through The Lifespan.*
14:30	William RANDALL *Regulation Strategies And Functions Of Personal Music Listening: The MuPsych Application.*		Steffen LEPA Hans-Joachim MAEMPEL Elena UNGEHEUER Stefan WEINZIERL *Technology Matters: An Experimental Exploration On How The Spatial Cues Afforded By Different Audio Playback Devices Shape The Perceived Emotional Expression Of Mediatized Music.*	PerMagnus LINDBORG *Correlations Between Acoustic Features And Psychophysiological Responses To Urban Soundscapes.*	***PERCEPTION*** Christoph LOUVEN Carolin SCHOLLE *EmoTouch For IPad: A New Multitouch Tool For Real Time Emotion Space Research.* Anat WAX-SHALOM Rony Y. GRANOT *Perception Of Musical Form In Classical And Progressive-rock Pieces: Tension Curves, Open Comments And Memory Measurements.*

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					Teruo YAMASAKI *Perceived Emotion Of Audio-visual Stimuli With Very Short Exposure Time And Their Multi-modal Interaction.*
					Lara PACHECO CUEVAS María EXTREMERA Fernando MOLINA *Recognition Of Em-otions In Novel Music Excerpts In Early Life.*
					Ian STRAEHLEY Jeremy LOEBACH *Conveying Emotion Via Musical Scales: Perceived Emotional Connotations Of The Modes Of The Diatonic Scale In Musicians And Non-musicians.*
					Tuomas EEROLA Henna PELTOLA *Cultural Norms Shape The Structure Of Affects Represented And Induced By Music: Two Surveys In Finland.*
15:00	Genevieve DINGLE Carly FAY *Tuned In: A Brief Music Emotion Regulation Intervention For Young Adults.*	R. Michael WINTERS Marcelo M. WANDERLEY *Strategies For Contin-uous Auditory Display Of Arousal And Valence.*		Roman MLEJNEK *Physically Experienced Reactions And Music: A Questionnaire Study Of Musicians And Non-musicians.*	Poster Viewing **Musica Studio and Basement Corridor**
15:30	Coffee and Poster Viewing				
	EXPECTATION I	**THERAPY: METHODS I**	**PEDAGOGY**	**REGULATION II**	**RepoVizz WORKSHOP**
	Chair: Marc THOMPSON	Chair: Julian O'KELLY	Chair: Pekka TOIVANEN	Chair: Genevieve DINGLE	
16:00	Renee TIMMERS *Mood Congruency Effects On Expectation And Attention In Music Perception.*	Amelia GOLEMA *Emotion ... A Prison - Body, Mind And Music.*	Daniel BERNÁTEK *Emotions And Their Presence During The Study Of Piano Piece Within Musical Perception.*	Sandra GARRIDO Emery SCHUBERT *Listening To Sad Music: Adaptive And Maladaptive Mood Regulation Strategies.*	Oscar MAYOR Panos PAPIOTIS *This Hands-on Tutorial Will Provide Participants With An In-depth Overview Of RepoVizz, An Integrated Solution For Structured Formatting And Storage, Browsing, Sharing, Annotation, And Visualisation Of Synchronous Multi-modal Time-aligned Data.*
16:30	Elizabeth MARGULIS *Musical Topics And The Affective Differentiation Of Surprise.*	Helle NYSTRUP LUND *Songwriting In Adult Psychiatry - Expressive Songwriting As Documentation Of Mental Process.*	Fulya CELIKEL Kim BOWEN COLAKOGLU *Self-taught And Schoo-led: Can They Co-exist On The Same Stage?*	Aida KHORSANDI Suvi SAARIKALLIO *Music-related Nostalgic Experiences Of Young Migrants.*	
17:00	Hauke EGERMANN Marcus PEARCE Geraint WIGGINS Stephen McADAMS *Probabilistic Models Of Expectation Violation Predict Psycho-physiological Emotional Responses To Live Concert Music.*			Antonia ZACHARIOU *Musical Play And Emotional Regulation.*	
17:30	Zuzana CENKEROVA Richard PARNCUTT *Style-Dependency Of Melodic Expectation: Changing The Rules In Real Time.*			TanChyuan CHIN Nikki RICKARD *Using Music To Reduce Stress: The Mediating Role Of Emotion Regulation.*	

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20:00	Classical Concert (20:00-21:30) **Taulumäki Church** Experience a fiery fusion of Vivaldi's classic *Four Seasons* with Nuevo Tango master Astor Piazzolla's *Four Seasons of Buenos Aires*. This is a rare opportunity to hear these two works played in combination, and this concert has been specially arranged to coincide with ICME3. We have arranged a limited number of free tickets for ICME3 delegates, available from the conference info desk on a first come first served basis.				
22:00	Sight & Sound (22:00 -)				

THURSDAY 13 JUNE

	M103	A103	H306	D109	M014
08:00	Registration Poster Setup				
	CONTEXT-DEPENDENCY	**BEHAVIOUR**	**IDENTITY**	**AESTHETICS**	**EXPECTATION II**
	Chair: Stefan KOELSCH	Chair: Tommi HIMBERG	Chair: Anemone VAN ZIJL	Chair: Helle NYSTRUP LUND	Chair: Renee TIMMERS
09:00	Jonna VUOSKOSKI Tuomas EEROLA *Does Extramusical Information Contribute To Emotions Induced By Music?*	Marco ARAÚJO *Development Of A Measure Of Self-regulated Performance Behavior In Skilled Musicians.*			Piotr PODLIPNIAK *Specific Emotional Reactions To Tonal Music – Indication Of The Adaptive Character Of Tonality Recognition.*
09:30	Eduardo COUTINHO Klaus SCHERER *Emotions Induced By Music: The Role Of The Listening Context And Modality Of Presentation.*	Sumi SHIGENO *Effects Of Background Music On The Impression Of Partners In Conversation.*	Jill MORGAN *Active Ageing: The Symbiosis Of Music And Health In Third Age Relationships*	Christoph SEIBERT Thomas A. TROGE *Affective Structural Coupling And Situated Affectivity In Complex Musical Emotions.*	Kari KALLINEN *Music Induced Emotions: Expectancy Vs. Contagion.*
10:00	Sergii TUKAIEV Igor ZIMA *Is Cheerful Music Pleasant? Not Always. Assessment Of The Psychophysiological Effects Of Listening To Cheerful Music.*	Hollie SHANNON Genevieve DINGLE Eric VANMAN *The Effect Of Music Listening On Assignment Anxiety And Urge To Procrastinate.*	Felicity BAKER Raymond MACDONALD *The Effect Of Therapeutic Songwriting On Flow, Identity, Achievement And Ownership In University Students And Retirees.*	Elisabeth KAPPEL *Friedrich Von Hausegger's Aesthetics Of Musical Expression.*	Kathleen AGRES Kathryn CASEY Jeremy GOW Marcus PEARCE *The Effects Of Veridical Repetition And Stylistic Familiarity On Expectations And Preference*
10:30	Coffee				
11:00	**KEYNOTE 3** Klaus SCHERER *Isomorphic Emotion Expression In Music, Song, And Speech.*				
	Chair: Olivier LARTILLOT				
12:00	Lunch				

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	eMOTION	**COMMUNICATION**	**MEMORY**		**SPEED POSTERS 3** ***• NEUROPHYSIOLOGY*** ***• STRUCTURE/ FEATURES*** ***• NEW DIRECTIONS***
	Chair: Hans T. ZEINER-HENRIKSEN	Chair: Jukka LOUHIVUORI	Chair: Alexandra LAMONT		Chair: Duncan WILLIAMS
13:30	Marko PUNKANEN Geoff LUCK Suvi SAARIKALLIO *Emotions In Motion: Dance Movement Therapy In The Treatment Of Depression.*	Vishnu SREEKUMAR David HURON *An Ethological Interpretation Of Affective Displays In Music.*	Carol KRUMHANSL Justin ZUPNIK *Cascading Reminiscence Bumps In Music.*		***NEUROPHYSIOLOGY*** Zacharias VAMVAKOUSIS Rafael RAMIREZ *EEG-Based Emotion Recognition To Enhance Gaze-Controlled Music Performance.* Hauke EGERMANN Nathalie FERNANDO Lorraine CHUEN Stephen McADAMS *Cross-Cultural Emotional Psychophysiological Responses To Music: Comparing Western Listeners To Congolese Pygmies.* Kazuma MORI Makoto IWANAGA *Resting Heart Rate Variability Predicts Music-induced Chills.* Benjamin GOLD Michael FRANK Brigitte BOGERT Elvira BRATTICO *Musical Pleasure And Dopaminergic Learning: Group And Individual Effects.* Heini HEIKKILÄ A. GOTSOPOULOS Iiro P. JÄÄSKELÄINEN Jouko LAMPINEN Patrik VUILLEUMIER Riitta HARI Mikko SAMS Lauri NUMMENMAA *Classification Of Discrete Emotional States From Brain Activity Patterns.*
14:00	Outi LEINONEN Geoff LUCK Suvi SAARIKALLIO Marko PUNKANEN *Movement Analysis Of Depressed And Non-depressed Persons Expressing Emotions Through Spontaneous Movement To Music.*	Dafne MUNTANYOLA-SAURA Simone BELLI *Bodies, Music And Emotions In A Dance Ethnography.*	Richard ASHLEY *Emotion And Memory In Debussy's Piano Works.*		***STRUCTURE/ FEATURES*** PerMagnus LINDBORG *Acoustic And Perceptual Features Of Eating-places In Singapore.*

	M103	A103	H306	D109	M014
					Olivier LARTILLOT Kim ELIARD Donato CEREGHETTI Didier GRANDJEAN *A Simple, High-yield Method For Assessing Structural Novelty.* Nicola DIBBEN Eduardo COUTINHO *The Influence Of Individual Differences On Emotion Perception In Music And Speech Prosody.* Torres-Eliard KIM Donato CEREGHETTI Olivier LARTILLOT Didier GRANDJEAN *Acoustical And Musical Structure As Predictors Of The Emotions Expressed By Music.* Jukka SEPPÄNEN *Sounds And Emotions During Emergency Situations.*
14:30	Birgitta BURGER Marc R. THOMPSON Suvi SAARIKALLIO Geoff LUCK Petri TOIVIAINEN *Oh Happy Dance: Emotion Recognition In Dance Movements.*	Lena QUINTO Bill THOMPSON Felicity KEATING *Melodic And Rhythmic Contrasts In Emotional Speech And Music*			***NEW DIRECTIONS*** Steffen LEPA Marcus BLEISTEINER Alexander FUß Dominik STEGER *Buildup, Breakdown And Drop. An Initial Experimental Approach For Explaining The Emotional Impact Of DJ Performances In Electronic Dance Music (EDM).* Fabia FRANCO *Emotion-related Musical Variables Affect Person Perception: Differential Effects For Men And Women In A Synchronization Task.* Theresa VELTRI Renee TIMMERS Paul OVERTON *The Effect Of Nicotine On Music-induced Emotion.* Marek FRANEK Leon VAN NOORDEN Lukas REZNY *Walking With Music In A Natural Setting.* Yading SONG Simon DIXON Marcus PEARCE *Using Tags To Select Stimuli In A Study Of Music Emotion.* Pasi SAARI Tuomas EEROLA *Modeling Acoustic Qualities Of Moods In Popular Genres Of Music Using Social Media.*

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15:00		Hiroko TERASAWA Reiko HOSHI-SHIBA Takuro SHIBAYAMA Hidefumi OHMURA Kiyoshi FURUKAWA Shoji MAKINO Kazuo OKANOYA *The Structure Of Emotional Communication In Musical Activities.*			Poster Viewing **Musica Studio and Basement Corridor**
15:30	Coffee and Poster Viewing				
	PERFORMANCE II	**TONALITY**	**SYMPOSIUM 3** ***BEYOND EMOTION? MUSIC AND ALTERING STATES OF CONSCIOUSNESS***	**HISTORICAL MUSICOLOGY II**	
	Chair: Jonna VUOSKOSKI	Chair: Carol KRUMHANSL	Discussant: Eric CLARKE	Chair: Sarah ZALFEN	
16:00		Marina KORSAKOVA-KREYN *Emotion And Reorientation In Tonal Space.*	Ruth HERBERT *Music And Dissociation: Experiences Without Valence? 'Observing' Self And 'Absent' Self.*	Georg CORALL *The Eloquent Hautboy.*	
16:30	Esra KARAOL *Misirli Ahmet: The Clay Darbuka Technique And Its Performance Analysis.*	Manuel TIZON Francisco GOMEZ Sergio ORAMAS *Perceived Emotion In Phrygian Mode In Musically Trained Children.*	Thomas SCHÄFER *Changes In The Representation Of Space And Time While Listening To Music.*	Daniele BUCCIO *The Role Of Gefühlsempfindung In Carl Stumpf's Theory Of Musical Emotion.*	
17:00	Anna Maria BORDIN *Study On The Expressiveness In The Performance Of Children.*	Richard PARNCUTT *Schenkerien Prolongation And The Emotional Connotations Of Major-minor Tonality.*	Pekka TOIVANEN *Shamanistic Musical Practices Of The Khanty – An Ethnomusicological Perspective.*		
17:30	Isabel Cecilia MARTINEZ *The Sensed Experience Of The Forms Of Vitality As Elicited In Performance.*	Yuko ARTHURS *Evaluating The Consonance And Pleasantness Of Triads In Different Musical Contexts.*	Jörg FACHNER *Reframing Emotional Intensity – Music In Drug-induced Altered States Of Consciousness.*		
19:30	Evening Cruise (19:30 - 22:30) **Lake Päijänne** Climb aboard the **s/s Suomi** for a three-hour cruise at the northern end of lake Päijänne. A perfect time to relax and enjoy the surroundings and great company! If you wish to have dinner on board, please make a table reservation when booking the cruise upon registration. Payment (EUR 20—30) should be made directly to the restaurant.				
22:00	Sight & Sound (22:00 -). **Jam with the Stars** event at *Poppari* starts at 23:00. The Jam with the Stars House Band will feature *Conrad Isidore* (Manfred Mann, Joe Cocker, Stephen Stills, Jimi Hendrix) on drums, and *Helle Lund* and *Jesper Bang Pedersen* (Helle Lund Trio) on piano and bass.				

FRIDAY 14 JUNE

	M103	A103	H306	D109	M014
	SYMPOSIUM 4 ***MUSIC, EMOTION, AND AUTISM***	**MEASUREMENT**	**PERCEPTION I**	**COMPOSITION**	**THERAPY: AFFECTIVE DISORDERS II**
	Discussant: Rory ALLEN	Chair: PerMagnus LINDBORG	Chair: Antonio CAMURRI	Chair: Rafael RAMIREZ	Chair: Nikki RICKARD
09:00	Rory ALLEN *Are Musical Emotions Chimerical? Lessons From The Paradoxical Potency Of Music Therapy.*	Cian DOHERTY Roddy COWIE *Assessing The Quality Of Experience Of An Audience In A Live Musical Scenario.*	Olivier BRABANT *Different Moment, Different Tune – How Emotional Perception Of Music Changes With The Time Of Day.*	Chih-Fang HUANG En-Ju LIN *An Emotion-based Method To Perform Algorithmic Composition.*	
09:30	Emily CARLSON *Music Therapy, Mood Induction And Autism: Current Practice, Clinical Insights And Future Directions.*	Javier JAIMOVICH Niall COGHLAN Vrennon BORTZ R. Benjamin KNAPP *Music & Emotion Listening Experiments: Design, Implementation & Perspectives.*	Imre LAHDELMA Tuomas EEROLA *Single Chords Convey Distinct Emotional Qualities To Both Naïve And Expert Listeners.*	Chi-Jung LI Chih-Fang HUANG *The Automated Emotional Music Generator With Emotion And Season Features.*	Esa ALA-RUONA Thomas WOSCH *Assessment Of Musical Emotions In The Treatment Of Affective Disorders.*
10:00		Athanasios LYKARTSIS Andreas PYSIEWICZ Henrik VON COLER Steffen LEPA *The Emotionality Of Sonic Events: Testing The Geneva Emotional Music Scale (GEMS) For Popular And Electroacoustic Music.*	Fabio MORREALE Raul MASU Antonella DE ANGELI Patrizio FAVA *The Effect Of Expertise In Evaluating Emotions In Music.*	Duncan WILLIAMS Alexis KIRKE Eduardo MIRANDA Etienne ROESCH Slawomire Jaroslaw NASUTO *Towards Affective Algorithmic Composition.*	Jörg FACHNER *Improvisation And Verbal Reflection On Emotions - Music Therapy Modulates Fronto-temporal Resting EEG Of Depressed Clients.*
10:30	Coffee				
11:00	**KEYNOTE 4** Jane DAVIDSON *Staging Emotions In Vocal Performance.*				
	Chair: Tuomas EEROLA				
12:00	Lunch				
13:30	Free Afternoon **Free Museum Entry** *Museum of Central Finland* – http://www.jyvaskyla.fi/keskisuomenmuseo/english *The Craft Museum of Finland* – http://www.craftmuseum.fi/english/index.htm *Jyväskylä Art Museum* – http://www.jyvaskyla.fi/taidemuseo/english				
17:00	Finnish Sauna Experience (17:00 - 21:00) **Savutuvan Apaja** We're pleased to offer ICME3 delegates the opportunity to enjoy a traditional Finnish lakeside sauna experience. We'll take a short bus ride (transport provided) a few kilometres outside the city to **Savutuvan Apaja** on the shore of Lake Päijänne. There, you'll have the opportunity to take sauna, swim in the lake, and enjoy some traditional Finnish sauna food (and drink!). Space for this event is limited to 30 persons.				
22:00	Sight & Sound (22:00 -)				

SATURDAY 15 JUNE

	M103	A103	H306	D109	M014
	MUSIC ANALYSIS	**PERCEPTION II**	**PREFERENCE**	**THERAPY: METHODS II**	
	Chair: Daniele BUCCIO	Chair: Anders FRIBERG	Chair: Richard VON GEORGI	Chair: Marko PUNKANEN	
09:00	Christoph DENNERLEIN *Emotion Categories And Affective Nuance In Music Reviews Around 1900.*	David ELLISON Suvi SAARIKALLIO Elvira BRATTICO *Personality Shapes Cognitive And Affective Processing Of Musical Pitch In Adults And Adolescents.*			
09:30	Susanna AVANZINI *Emotions And New Formal Principles In Schoenberg's Verklärte Nacht Op. 4.*	Eduardo COUTINHO Nicola DIBBEN *Emotions Perceived In Music And Speech: Relationships Between Psychoacoustic Features, Second-by-second Subjective Feelings Of Emotion And Physiological Responses.*	Gerard MADDEN Roddy COWIE *What Lies Behind Musical Preferences: Putting The Pieces Together*	Hallgjerd AKSNES Svein FUGLESTAD *GEMS-45: A Promising Tool For GIM Therapy Research. A Corpus-Based Study Of Emotion Terms From The Geneva Emotional Music Scale In 58 Transcriptions From GIM Therapy Sessions.*	
10:00	Susan DE GHIZÉ *Isolde's Multiple Orgasms: Sexology And Wagner's Transfiguration.*	Michal ZAGRODZKI *Influence Of Musical Context On The Perception Of Emotional Expression Of Music.*	Stephanie BRAMLEY Nicola DIBBEN Richard ROWE *Music In Gambling Contexts: What Are Individuals' Perceptions Of Music Experienced In Gambling Contexts And Why Do Individuals Self-select Music To Accompany Gambling?*		
10:30	Coffee				
11:00	**KEYNOTE 5** Stefan KOELSCH *Brain Correlates Of Music-Induced Emotions.*				
	Chair: Esa ALA-RUONA				
12:00	Lunch				
	THERAPY: AFFECTIVE DISORDERS III	**EMBODIMENT**	**CLASSIFICATION**	**SYMPOSIUM 5** ***IN SEARCH OF EMOTIONAL ORDERS — MUSIC AND EMOTIONS IN HISTORY***	**PERFORMANCE III**
	Chair: Felicity BAKER	Chair: Birgitta BURGER	Chair: Petri TOIVIAINEN	Discussant: Sarah ZALFEN	Chair: Georg CORALL
13:30	Sanna-Mari KONTONIEMI *A Comparison Of Professional Music Therapists And Music Therapy Students As Listeners Of Clinical Improvisations.*	Marjo SUOMINEN *Embodiment Of Love In Handel´s Opera Giulio Cesare.*	Tuomas EEROLA Petri LAUKKA *A Machine-learning Approach To Acoustic-based Classification Of Musically Expressed Emotions Across Cultures.*	Sven Oliver MÜLLER *Transformation Of Feelings - Richard Wagner And His Audiences.* Henning WELLMANN *Punk – Establishing Orders Of Deviant Emotions.*	Panos PAPIOTIS Perfecto HERRERA Marco MARCHINI Esteban MAESTRE *Aural-based Detection And Assessment Of Real Versus Artificially Synchronized String Quartet Performance.*

	M103	A103	H306	D109	M014
14:00	Stefano NAVONE *Music Therapy As An Effective Intervention In The Treatment Of Depression In A Patient With Korsakoff's Syndrome.*	Henna-Riikka PELTOLA Tuija SARESMA *Embodiment And Verbalisation. Metaphor Analysis In Investigating Experiences Of Listening To Sad Music.*	Olivier LARTILLOT Wiebke J. TROST Kim ELIARD Donato CEREGHETTI Marc-André RAPPAZ Didier GRANDJEAN *Estimating Tempo And Metrical Features By Tracking The Whole Metrical Hierarchy*	Anabelle SPALLEK *The Liszt Concert As An Emotional Space In 19th-century Berlin.* Tim BIERMANN *"All Together Now" - Emotional Styles In Beat Music.*	Anemone VAN ZIJL John SLOBODA *Emotions In Concert: Performers' Experienced Emotions On Stage.*
14:30	Monique VAN BRUGGEN-RUFI *"If I Could Only Hear My Mother Sing Again"; Music Therapy And Huntington's Disease.*	Hans T. ZEINER-HENRIKSEN *Rhythmic Entrainment And Corporeal Tension Building In Communicating Emotions Through Music.*	Judith LIEBETRAU Sebastian SCHNEIDER *Measuring And Classification Of Emotions Using Free-Choice Profiling.*		Marco MARCHINI Rafael RAMIREZ Panos PAPIOTIS Esteban MAESTRE *Inducing Rules Of Ensemble Music Performance: A Machine Learning Approach.*
15:00			Anders FRIBERG *Prediction Of Emotional Expression In Music Using Perceptual Features.*		Florian ECKL Erica BISESI Richard PARNCUTT *What Emotions And Free Associations Characterize Different Musical Styles?*
15:30	Coffee				
16:00	**KEYNOTE 6** Daniel VÄSTFJÄLL *Emoacoustics: How Music And Sound Induce Emotions.*				
	Chair: Suvi SAARIKALLIO				
17:00	**CLOSING WORDS**				
19:00	Conference Dinner **Savutuvan Apaja** The conference dinner will be held at **Savutuvan Apaja** amidst a collection of some thirty historic farm buildings from the Central Finland region. Savutuvan Apaja is situated next to lake Päijänne approximately 12 km from the City centre. Guests will have the opportunity to sample traditional Finnish home-made cuisine, a speciality of Savutuvan Apaja's, and experience a historically authentic lakeside community. Music will be provided by **Dollby**. Not to be missed!				

PERSONNEL

Local Organising Committee

Geoff Luck	Conference Chair
Markku Pöyhönen	Department Conference Coordinator
Taru-Maija Heilala-Rasimov	Faculty Conference Coordinator

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Elske De Jong	
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Sigri Sauna-Aho	
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Safa Solati	
Päivi Väisänen	

GENERAL INFORMATION

Conference Office and Info Desk

The Conference Office and Info Desk is located in the lobby of the Music Department. The Conference office will be open daily 08:00-18:00 for the duration of the conference.

Registration

All participants must register onsite in order to receive their conference pack, including the badge that permits access all scientific sessions.

Badges

All delegates will receive a badge upon onsite registration. This badge permits access to all scientific sessions, and should be worn at all times.

Lunch and Coffee Breaks

Lunches and coffee are included in the conference fee. Lunches will be served at four restaurants and cafeterias located around the University campus: Musica, Lozzi, Ilokivi, and Libri. Restaurant and cafeteria locations are shown on the map on the back cover of this book.

Coffee will be served twice per day, once in the morning and again in the afternoon. Coffee will be served in the Musica (M) building.

Travel and Transportation

The conference site is within walking distance of all official conference hotels. There is no transportation provided from hotels to the conference venue. Information concerning taxis and public transport can be obtained from the Info Desk.

Meeting Rooms

Meeting rooms with A/V equipment, including videoconferencing facilities, are available to ICME3 delegates. Rooms are available for the duration of the conference. For more information, please contact the Conference Office or call Markku Pöyhönen on +358 40 570 7007.

Messages, and Programme Changes

All messages, and any last-minute programme changes, will be posted at the Conference Info Desk.

Internet

All conference delegates will receive wireless network accounts and passwords to the University network in their conference pack.

Technical Assistants' Office

Technical assistants can be found in Musica (M), 3rd floor, room M311, and are available at the times below:

Tuesday 11th 8:00-10:30, 12:00-13:30

Wednesday 12th – Saturday 15th 8:00-9:00, 12:00-13:30.

For out-of-hours enquiries, please call +358 400 247 472.

Foreign Exchange and banking

All banks have offices on the street running through the centre of Jyväskylä (Kauppakatu), and are open 10:00-16:00, Monday-Friday. Most international credit cards (Visa, Eurocard, MasterCard, American Express, Diner's Club, etc.) are accepted in shops, hotels, and restaurants. All banks, travel agencies, and hotels, as well as many shops accept traveller's cheques. ATMs ("Otto" in Finnish) can be found on Kauppakatu, as well as at the railway/bus station.

Health Services

Emergency health care is available at the Central Hospital (Address: Keskussairaalantie 19). For help with first aid, please contact the Conference Info Desk. ***The emergency number in Finland is 112***. Local pharmacies ("Apteekki") sell prescription-free drugs and remedies.

Tourist Information

The City's Tourist Information Office is located at Asemakatu 6 (close to the City centre hotels). Staff there can provide information on events in Jyväskylä and the surrounding region (movies, museums, exhibitions, concerts, etc.). Information about Jyväskylä is also available online at www.jyvaskyla.fi/lang/, or by calling +358 (0)14 266 0113.

Postal Services

The main post office is on Vapaudenkatu 48-50. Stamped mail can be left at your hotel reception, or dropped in general mail boxes, either yellow or blue (the latter for priority mail only). Mail is collected Monday-Friday.

Smoking

In Finland, smoking is generally forbidden in public areas, including restaurants, bars, and coffee shops. It's forbidden to smoke on the University campus except in designated smoking areas. Please obey NO SMOKING signs as a matter of courtesy.

INSTRUCTIONS FOR PRESENTERS

All presentation rooms are equipped with a PC, data projector, and sound system.

In order to avoid a host of formatting, animation, and other associated issues, we recommend that delegates present from their own device (laptop, tablet, etc.) where possible. It is the responsibility of delegates to bring with them any VGA, DVI, or other adaptors necessary to connect their device to the data projector. Please also ensure that your device's battery is sufficiently charged, or connected to a power source if necessary.

Delegates may alternatively choose to upload their presentation to the ICME3 cloud and use room-based PCs. If the latter option is chosen, delegates must visit the Technical Assistants' Office and transfer their presentation in good time before their talk.

Whichever presentation method is chosen, **delegates are responsible for ensuring that their presentation is ready to be presented at their allotted time in the programme**.

All presenters should arrive at their designated room 15 minutes before the session is due to begin. They should introduce themselves to the session Chair, and check that their presentation works as it should.

The official language of the conference is English.

Keynote addresses consist of a five minute introduction, 40 minutes of speaking time, plus 15 minutes for questions/discussion.

Spoken presentations consist of 20 minutes speaking time plus 7 minutes for questions/discussion.

Speed posters consist of a five minute spoken presentation, followed by one hour of question/discussion time at the poster location. Posters will be displayed in Musica Studio complex and corridor in the basement of the Musica (M) building. Posters can be setup from 08:00 each morning, and **must be setup before the speed poster session begins**. The earlier a poster is setup, the more exposure it will get. **Posters must be taken down at the end of each day**.

Symposia consist of 2-4 related papers in a 1-2 hour session. The schedule will be decided by the symposium convenor and discussant.

The overall schedule will be maintained in the event of a cancellation. In such an event, other presenters are not permitted to extend their presentation or to begin the next presentation earlier than scheduled. Should a speaker extend their presentation beyond their allocated time, the session Chair has been instructed to interrupt them. It is essential that presenters stay on time for the duration of the entire programme so as to ensure equity for all presenters, and to allow all delegates to plan the sessions they wish to attend.

SOCIAL PROGRAMME

In addition to the academic programme, we're delighted to offer a comprehensive social programme.

Welcome Reception hosted by the City of Jyväskylä

Tuesday 11

Time: 19:00 - 20:30

Place: Jyväskylä Town Hall

All registered delegates are cordially invited to an evening reception hosted by the City of Jyväskylä. Light refreshments will be offered. Music will be provided by **Trio Hei!**

Classical Concert "Eight Seasons" by Jyväskylä Sinfonia, Featuring Tianwa Yang

Wednesday 12

Time: 20:00

Place: Taulumäki Church

Picture: Taulumäki Church

Picture: Jyväskylä Sinfonia

Picture: Tianwa Yang

Experience a fiery fusion of Vivaldi's classic *Four Seasons* with Nuevo Tango master Astor Piazzolla's *Four Seasons of Buenos Aires*. This is a rare opportunity to hear these two works played in combination, and this concert has been specially arranged to coincide with ICME3. We have arranged a limited number of free tickets for ICME3 delegates, available from the conference info desk on a first come first served basis.

More info about the orchestra: http://www.jyvaskylasinfonia.fi/english
More info about the soloist: http://www.tianwayang.com/en/
More info about the concert (in Finnish only):
http://www.jyvaskylasinfonia.fi/konsertit/kahdeksanvuodenaikaa

Evening Cruise (optional buffet dinner on board)

Thursday 13

Time: 19:30 - 22:30

Place: Jyväskylä Harbour, s/s Suomi

Jyväskylä lies at the heart of the Finnish lake district. On Thursday evening, we'll take a three-hour cruise at the northern end of Päijänne, Finland's second largest lake, with lots of small islands and summer cottages along the shore. A perfect time to relax and enjoy the surroundings and great company! If you've made a dinner reservation, payment (€20-30) should be made at the onboard restaurant.

More information about cruises on lake Päijänne can be found on the cruise company's website: http://www.paijanne-risteilythilden.fi/vessels

Finnish Sauna Experience

Friday 14

Time: 17:00 - 21:00

Place: Savutuvan Apaja

Picture: Areas of Savuntuvan Apaja

We're pleased to offer ICME3 delegates the opportunity to enjoy a traditional Finnish lakeside sauna experience. We'ill take a short bus ride (transport provided) a few kilometres outside the city to Savutuvan Apaja on the shore of Lake Päijänne. There, you will have the opportunity to take sauna, swim in the lake, and enjoy some traditional Finnish sauna food (and drink!). Space for this event is limited to 30 persons.

City Centre museums free of charge *(11:00-18:00)*

Friday 14

Museum of Central Finland
http://www.jyvaskyla.fi/keskisuomenmuseo/english

The Craft Museum of Finland
http://www.craftmuseum.fi/english/index.htm

Jyväskylä Art Museum
http://www.jyvaskyla.fi/taidemuseo/english

Conference Dinner

Saturday 15

Time: 19:00 -

Place: Savutuvan Apaja

The conference dinner will be held at Savutuvan Apaja amidst a collection of some thirty historic farm buildings from the Central Finland region situated next to lake Päijänne approximately 12 km from the City centre. Guests will have the opportunity to sample traditional Finnish home-made cuisine, a speciality of Savutuvan Apaja's, and experience a historically authentic lakeside community. Music will be provided by **Dollby**. Not to be missed!

More information about Savutuvan Apaja can be found on their website:
http://www.savutuvanapaja.fi/

Sight & Sound Music Festival

Wednesday 12 - Friday 14

Time: 22:00 -

Venues: *Freetime*, *Katse*, *Poppari*

Main website: http://sightsound.fi/.

Running alongside ICME3 will be Sight & Sound 2013, a three-day club festival featuring live music and visual arts from jazz, pop, and rock artists. Also included is a special "Jam with the Stars" night at Poppari after the lake cruise. The house band will feature ICME3 delegates plus a very special guest. There will also be a rock jam at Katse. More info about all events is available on the Site & Sound website: http://sightsound.fi/.

Musicians

Jam with the Stars house band:

Conrad Isidore: Drums - *Manfred Mann*, *Joe Cocker*, *Stephen Stills*, *Jimi Hendrix*, and more (http://www.discogs.com/artist/Conrad+Isidore, and http://musiciansolympus.blogspot.fi/2011/02/conradisidore-drums.html)

Helle Lund: Piano - *Helle Lund Trio* (http://www.hellelundtrio.dk/)

Jesper Bang Pedersen: Bass - *Helle Lund Trio*

Trio Hei!

Heidi Luck: Vocals

Esko Turpeinen: Guitar, Vocals

Ilona Rimpilä: Bass

Dollby

Heidi Luck: Vocals, Percussion, Glitter

Esko Turpeinen: Guitars, Vocals

Mikko Pellinen: Keyboards, Vocals

Ilona Rimpilä: Bass

Jani Lahtinen: Drums

KEYNOTE SPEAKERS

Eric Clarke *University of Oxford, UK*

Eric Clarke is Heather Professor of Music at the University of Oxford, and a Professorial Fellow of Wadham College. He has published widely on various issues in the psychology of music, musical meaning, and the analysis of pop music, including Empirical Musicology (OUP 2004, co-edited with Nicholas Cook), Ways of Listening (OUP 2005), The Cambridge Companion to Recorded Music (CUP 2009, co-edited with Nicholas Cook, Daniel Leech-Wilkinson and John Rink), Music and Mind in Everyday Life (OUP 2010, co-authored with Nicola Dibben and Stephanie Pitts), and Music and Consciousness (OUP 2011, co-edited with David Clarke). He was an Associate Director of the AHRC Research Centre for the History and Analysis of Recorded Music (CHARM) and is an Associate Director of the successor AHRC Research Centre for Musical Performance as Creative Practice (CMPCP; 2009-14). He is on a number of editorial boards including Music Perception, Musicae Scientiae, Empirical Musicology Review, and Radical Musicology, and was elected a member of Academia Europaea in 2009 and a Fellow of the British Academy in 2010.

Antonio Camurri *University of Genova, Italy*

Antonio Camurri, PhD in Computer Engineering, is Associate Professor at the University of Genova where he teaches "Human Computer Interaction" and "Multimedia Systems". His research interests include multimodal intelligent interfaces, sound and music computing, kansei information processing, computational models of non-verbal expressive and social signals, interactive multimodal systems for theatre, music, dance, and museums, as well as interactive multimodal systems for therapy, rehabilitation, and independent living. He is founder and scientific director of InfoMus Lab and of Casa Paganini - InfoMus Research Centre at University of Genoa, and coordinator and local project manager of a number of European projects, contracts with industry, and cultural institutions. He is a member of the Editorial Board of the Journal of New Music Research, and author of more than 180 scientific papers.

Klaus Scherer *Swiss Centre of Affective Sciences, Switzerland*

Klaus Scherer is Director of the Swiss Center for Affective Sciences at the University of Geneva. Apart from extensive theoretical work (Component Process Model), his research activities focus on different aspects of emotion and other affective states, in particular emotional expression and induction of emotion by music. He has reported this work in numerous publications in the form of monographs, contributed chapters, and papers in international journals. He was the founding co-editor of the journal Emotion, has edited several collected volumes and handbooks, and co-edits the "Affective Science Series" for Oxford University Press. He is a member of several international scientific societies, and a fellow of both the American Psychological Association and the Acoustical Society of America. He has been an invited professor at Stanford, Berkeley, the University of Zurich, and EHESS Paris, an elected member of the Academia Europea and honorary foreign member of the American Academy of Arts and Sciences, and has received a Dr. honoris causa from the University of Bologna.

Jane Davidson *University of Western Australia, Australia*

Winthrop Professor Jane Davidson is Deputy Director of the Australian Research Council's (ARC) Centre of Excellence for the History of Emotions and Callaway/Tunley Chair of Music at The University of Western Australia (UWA). Her research is broadly in the area of performance studies, with five core areas of interest: emotion and expression in performance, vocal studies, historically informed performance practices, musical development, and music and health. She has published extensively and secured a range of research grants in both Australia and overseas. As a practitioner, she has worked as an opera singer and a music theatre director, collaborating with groups such as Andrew Lawrence-King's Harp Consort, Opera North, and the West Australian Opera Company. She continues this work in the co-ordination of vocal studies at UWA. She was Editor of Psychology of Music (1997-2001); former Vice-President of the European Society for the Cognitive Sciences of Music (2003-2006); and President of the Musicological Society of Australia (2010 and 2011). She has just completed service working as a member of the Research Evaluation Committee of the Excellence in Research in Australia (ERA) for both the trial evaluation in 2009 and main assessment in 2012.

Stefan Koelsch *Freie Universität Berlin, Germany*

Stefan Koelsch is Professor of Biological Psychology and Music Psychology at the Freie Universität Berlin, Germany, and the "Cluster of Excellence: Languages of Emotion". He holds Masters degrees in music, psychology, and sociology, and received his PhD and habilitation at the Max Planck Institute for Cognitive Neuroscience, where he also led the Independent Junior Research Group "Neurocognition of Music". His PhD thesis was entitled "Brain & Music", the second edition of which appeared in 2012. He has published well-known articles on neural correlates of music-syntactic and music-semantic processing, music-evoked emotions, and music therapy.

Daniel Västfjäll *Linköping University, Sweden*

Daniel Västfjäll is a Senior Research Scientist at Decision Research (Eugene, OR) and Full Professor of Cognitive Psychology at Linköping University in Sweden. His research focuses on the role of affect, and especially mood, in judgment and decision-making, perception and psychophysics. A common theme for his research is how affective feelings serve as information for various judgments including judgments about consumer products, health, the self, auditory characteristics of objects and music. He has conducted research and lead several national and international projects on how sound and music induce emotions, emotional sound design, music and health, and auditory affective computing. His research in this area has been published in some of the top journals in the field (Behavioral and Brain Sciences, Psychological Science, JEP: General, JEP: Applied, PLoS One, JASA, POM). Currently he is director of the LiU Center for Behavioural and NeuroEconomics where he uses a multi-method approach (self-report, behaviour, physiology) to study how sound and music induce emotions.

Abstracts

Tuesday

Keynote 1

M103

11:00

Lost and found in music

Eric CLARKE

University of Oxford, United Kingdom

After decades of neglect, the last twenty years have witnessed a dramatic increase of scholarly interest in music and the emotions – as the series of international conferences on Music and Emotion, and the Oxford Handbook on Music and Emotion demonstrate. There is no doubt that this has been a very positive development, and one that has rehabilitated a powerful and conspicuous component of musical experience. But there is a danger that the term 'emotion' is both too narrow, and too blunt, to do justice to the wide range of phenomena to which it is applied. Emotions are a powerful component of 'strong experiences of music' – to use Gabrielsson's term – but they certainly do not exhaust them. In this paper I argue for a more heterogeneous approach, framed within the perspectives of musical consciousness and musical subjectivity, that attempts to bring together perceptual, emotional and embodied components of musical experience, embedded in the ecology of everyday listening. In doing so, I also argue for the importance of paying proper attention to phenomenological qualities of musical experience as a counterbalance to the predominantly behavioural and neuroscientific perspectives that currently prevail; and also for a more dynamic and animated understanding of musical engagement than the term 'emotion' seems sometimes to afford.

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EEG-based emotion detection in music listening

Rafael RAMIREZ, Zacharias VAMVAKOUSIS, Sergio GIRALDO
Universitat Pompeu Fabra, Spain

Tuesday

Paper session

M103

13:30

NEUROPHY.

The study of emotions induced by multimedia stimuli has increased in recent years. This is due to the growing need for computer applications capable of detecting the emotional state of users and adapt to them accordingly. On the other hand, current affordable technology allows the recording of brain activity in real-time and the discovery of patterns related to emotional states. This paper describes an approach to detecting music-induced emotion from electroencephalogram (EEG) signals measured with a low-cost EEG headset. First, we present to subjects 30-seconds music fragments with different emotional content and record their response EEG activity. Then, we filter and process the signal in order to extract emotion-related features and apply machine learning techniques (linear discriminant analysis and support vector machines) to classify emotional states into high/low arousal and positive/negative valence. The obtained results indicate that EEG data obtained with the lowcost EEG device contains sufficient information to distinguish among the emotional states induced by the music stimuli, and that machine learning techniques are capable of learning the patterns that distinguish these states. Furthermore, we proved that it is possible to train successful classifiers with no to self-assessment of information about the emotional states by the subjects.

rafael.ramirez@upf.edu

Music Therapy applications for promoting arousal and emotional responses in those with Disorders of Consciousness: preliminary analysis of a neurophysiological and behavioural study

Julian O'KELLY[1], Wendy MAGEE[2], Leon JAMES[3], Ramaswamy PALANIAPPAN[4]
[1]Aalborg University in association with The Royal Hospital for Neuro-disability, United Kingdom; [2]Temple University, USA; [3]Royal Hospital for Neurodisability, United Kingdom; [4]Wolverhampton University, United Kingdom

Paper session

M103

14:00

NEUROPHY.

In work with minimally responsive populations, music therapists use a range of receptive techniques, which until recently have received little scrutiny from an neurophysiological perspective. With disorders of consciousness (DOC), the use of salient music and simple improvised music entrained to respiration are advocated, based on the expectancy of arousal and emotional responses to assist in assessment focused on the detection of awareness. To underpin this work with objective scientific data a multiple base line within subjects study comparing EEG, heart rate variability, respiration and behavioural responses of 20 healthy controls with 10 DOC patients diagnosed as in vegetative states and 10 as minimally conscious has been undertaken. Controls and patients were presented with live salient music, improvised entrainment, recordings of disliked music, white noise and silence. Neurophysiologic and behavioural measures were recorded using a 32 channel XLTEK c video EEG system, with a piezoelectric respiratory belt, and analysed using MATLAB and EEGLAB. Significant findings within EEG power spectra and topographic measures, behavioural and respiration data suggest music therapy techniques are appropriate for promoting arousal in the DOC cohorts. Preliminary analysis of data also indicate a range of neurophysiological responses corresponding to both positive and negative affect across subjects. These findings will be discussed in relation to the extant literature and relevance to the development of evidence based music therapy in this field.

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Tuesday

Music, reason and/or emotion

Horácio MARQUES

FEUP – Faculty of Engineering of University of Porto / ESMAE – School of Music, Image and Performative Arts, IPP, Portugal

Paper session

M103

14:30

NEUROPHY.

The practice of music is based on an orchestrated dynamic rational, motor, visual and emotional behavior where various mechanisms interact in multiple and complex decision-making in real-time, to adequately control the muscular, auditory and visual systems. It also triggers emotional states often as spontaneous feedback energy, complementary to the aware cognitive system. A factor that may influence the rational decisions and affect the practice of music itself. Some studies suggests that: 1) brain waves synchronization and entrainment could be achieved by acoustic stimuli; 2) long-range synchrony in gamma waves are of the most importance in understanding higher cognition; 3) evidence of possible relationships between gamma and theta waves, and related phases and synchronization, that could provide an efficient system to encode and retrieve memories; and 4) emotional processes rely on brain-signals interdependencies (e.g., phase synchronization). Throughout real-time recording of brain electric potentials in the context of music practice (guitar playing, classic and jazz performers, structured pieces), we are correlating the music oscillations with the brain oscillations, specifically the processes that explicitly constrain the ratio between music, reason and emotion, i.e., the a) dynamic, b) dialectic, d) tension, e) relevancy, f) hierarchy, and g) prevalence of the processes. We are working on an exploratory experiment that expects to get significant correlations namely 1) between the power of the neuro frequencies and the power of the sound frequencies — generated by music pieces — and 2) between the phases of neuro frequencies and the phases sound frequencies — generated by music pieces.

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Rhythmic entrainment and musical emotions

Wiebke TROST[1], Daniele SCHÖN[2], Sascha FRÜHHOLZ[1], Carolina LABBÉ[1], Didier GRANDJEAN[1], Patrik VUILLEUMIER[3]

[1]Neuroscience of Emotions and Affective Dynamics Lab, University of Geneva, Switzerland; [2]Institut de neurosciences des systèmes Centre MEG, Service de Neurophysiologie Clinique CHU Timone, France; [3]Laboratory for Behavioral Neurology and Imaging of Cognition, Switzerland

Paper session

A103

15:00

NEUROPHY.

Rhythmic entrainment is the process that different rhythms in the brain and the body resonate to the music and eventually tune these internal rhythms into the external rhythms presented in the musical structure. It has been suggested that this process might also serve as an emotion induction mechanism in response to music. The here presented study investigated the brain processes of rhythmic entrainment to the musical meter and its modulation by aesthetic appreciation with the use of functional magnetic resonance imaging (fMRI). We designed an fMRI study where participants listened to consonant and dissonant versions of piano pieces while performing a visual speeded response task. The task consisted of detecting visual cues that appeared time locked to either a strong or a weak beat of the musical meter. Behavioral results showed that consonant music and presentation of cues in synchrony with the musical beat facilitate motor reactions. fMRI results show that the caudate nucleus as part of the basal ganglia is sensitive to subtle differences of rhythmic expectancies induced by the musical meter, an effect which is primarily present during dissonant music. Behavioral and fMRI results together suggest that consonant music leads to a global broadening of attentional resources, whereas dissonant music seems to narrow them down requiring a more effortful bottom-up approach of music listening. We speculate that this is why in dissonant music the temporal structure of the music becomes more salient.

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Confusing sadness and relaxed musical expressions: Animal signaling versus speech prosody interpretations

Tuesday

Kirsten NISULA, David HURON, Daniel SHANAHAN, Matthew DAVIS
The Ohio State University, USA

Paper session

A103

13:30

EXPRESSION

It has been common to regard speech prosody as a template for affective expression in music. For example, a number of features characteristic of sad speech prosody have been identified: slow speaking rate, low overall pitch, quiet dynamic, monotone pitch movement, mumbled articulation, and dark timbre. These same features have been observed in nominally sad music. However, all of these features are plausible artifacts of low physiological arousal. Moreover, other states, such as sleepiness and relaxation involve the same low physiological state, and so may be expected to associated with the same prosodic features. Indeed, the acoustical features characteristic of sleepiness and relaxation are remarkably similar to features of sadness. In this study, we use the method of adjustment to test whether participants are able to create music-like sequences that distinguish sadness from sleepiness or relaxation. (The experiment is currently in progress with final results anticipated.) If it is important for individuals to infer the affective states of others, why would there be such potential for confusion between sadness and sleepiness? It is suggested that ethological signaling theory provides a parsimonious account for this possible confusion.

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Listeners' informal vocabulary for emotions and free associations in piano music

Erica BISESI, Marlies BODINGER, Richard PARNCUTT
University of Graz, Austria

Paper session

A103

14:00

EXPRESSION

We previously explored listeners' informal vocabularies for describing expression in piano music. Most words fell into three categories: musical structure, emotion, and free association. Subcategories included immanent/performed attributes of the sound (tempo, dynamics, pitch and timbre), accentuation, character and meaning, basic/complex emotions and static/dynamic or living/nonliving associations. In this study, we investigate the relationship between emotions and free associations in more detail. 21 participants (7 musicians, 7 amateurs and 7 non-musicians) listened to 7 piano pieces in different "classical" styles. They were then asked to describe their experience of the music (open question). After that we asked them to focus on emotions and free associations (or abstract images). Results are currently being processed. We are exploring qualitative relationships and quantitative correlations between subcategories of emotions and images by grounded theory, multidimensional scaling, and correspondence analysis. Results will influence the design of a quantitative study to map music expression into multidimensional spaces of emotions and free associations in pDM – a system for real-time expressive control of music performance. This research is supported by the FWF project P 24336-G21 "Expression, emotion and imagery in music performance".

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Paper session

A103

14:30

EXPRESSION

Perception of emotional content in musical performances by 3- to 7-year-old children

László STACHÓ[1], Suvi SAARIKALLIO[2], Anemone VAN ZIJL[2], Minna HUOTILAINEN[3], Petri TOIVIAINEN[2]

[1]Kodály Institute – Music Pedagogy Department, The Liszt Academy of Music, Budapest, Hungary; [2]Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland; [3]Cognitive Brain Research Unit, University of Helsinki, Finland

The emotional content expressed through musical performance has become a widely discussed topic in music psychology during the last two decades. However, empirical evidence regarding children's abilities in interpreting the emotional content of a musical performance is sparse. We investigated 3- to 7-year-old children's abilities to interpret the emotional content expressed through performance features in music. Short musical pieces previously rated as inexpressive of emotion were recorded by three musicians with five emotional expressions (happy, sad, fearful, angry, and neutral) and played to 3- to 7-year-old children (N = 94), adult non-musicians (N = 83), and adult musicians (N = 118) who made a forced-choice judgment about the emotion that each excerpt conveyed. We observed significant differences between children, adult non-musicians and musicians in their ability to interpret the emotional content of a performance. Especially for children, the easiest emotions to identify proved to be happiness and sadness, while anger, fear and emotional neutrality appeared to be more difficult to identify. The most salient confusion patterns of the emotions (categorizing angry performance as happy and neutral performance as sad or mixing up fear with sadness) are analyzed in the context of general theories of emotion and suggest that children are not able as subtly as adults to discriminate emotions relying on the information provided by the valence dimension.

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Paper session

H306

13:30

THERAPY

Empathy in musical interaction

Neta SPIRO[1], Marianne SCHOFIELD[2], Tommi HIMBERG[3]

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Entrainment has been linked to positive affect and pro-sociality, e.g. empathy. Empathy and entrainment are facets of the "shared manifold", mirroring and mental simulation system allowing us to automatically share emotions and intentions, and to understand others. They are foregrounded in music, which is very efficacious in communicating emotions and intentions. We perceive the intentional, expressive motor acts behind the sounds of music. Music therapists take advantage of this and use musical interaction to work with their clients. Therapists use techniques such as mirroring, matching and reflecting to establish musical communication. The cognitive foundations of synchronisation have been studied extensively, but its emotional aspects only rarely. Also, the methods of entrainment research have only rarely been used in music therapy (MT) research, which has mainly focussed on qualitative case studies. Our aims are to study the associations between empathy, entrainment and musical communication, using dyadic tapping studies and video from MT improvisations. In dyadic tapping tasks, participants started in different tempi and later on started to hear each other's tapping. We also did a case study analysing the timing characteristics of a client and therapist in MT improvisation sessions. In both cases we analysed whether and how the players entrained and the contributing factors. The link between entrainment and empathy is not linear; we discuss e.g. the effects of pair constitution and task difficulty. Quantitative analysis of MT improvisations provided objective view of mutuality and patterns of interaction. We discuss the theoretical and practical consequences of our ongoing research project.

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Music and cancer care

Monika Malgorzata STANCZYK

Greater Poland Cancer Centre in Poznan, Poland

Paper session

H306

14:00

THERAPY

The purpose of this presentation is to show the effectiveness of music therapy techniques in the context of cancer care and to present the integration of music therapy program into continuum supportive cancer care for inpatients and out-patients at a leading oncology hospital in Poland – the Greater Poland Cancer Centre in Poznan. Music therapy as a part of the complementary medicine program in supportive cancer care can accompany medical treatment. There are many benefits of music therapy for cancer patients. Interactive- as well as receptive music therapy techniques can be used to improve mood, decreasing stress, pain, anxiety level and enhance relaxation. Music therapy is an effective form in supporting cancer patients during the treatment process. It may be also basic for planning effective program of rehabilitation to promote wellness, improve physical and emotional well-being, to improve a quality of life.

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Real-time hallucination simulation and sonification through user-led development of an ipad augmented reality system

Alexis KIRKE, Joel EATON, Eduardo MIRANDA

ICCMR, Plymouth University, United Kingdom

Paper session

H306

14:30

THERAPY

The simulation of visual hallucinations has multiple applications. For example in helping diagnosis, in helping patients to express themselves and reduce their sense of isolation, for medical education, and in legal proceedings for damages due to eye / brain injuries. We present a new approach to hallucination simulation, which allows real-time expression, using an iPad. An individual can overlay their hallucinations in real-time on the iPad screen over the iPad's video camera image. The system has been developed focusing on the visual symptoms of Palinopsia, experienced by the first author, and hence is a case of user-led research. However such an approach can be utilized for other conditions and visual hallucination types. The system also enables the hallucinations to be converted into sound through visual sonification, thus providing another avenue for expression for the hallucinating individual. The sonification attempts to express a mood related to the visual effect. As well as describing the system in this paper, a musical performance is described which used the system, and which has helped to raise awareness and comfort some people who have Palinopsia symptoms.

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Tuesday

Paper session

H306

15:00

THERAPY

Young heroes – Music in mental health and functional peer support

Markus RAIVIO

SOSPED Foundation, Finland

The GFP (Guided Functional Peer Support) -model is combining guided peer support and creative activities. The main objective is to support young adult mental health clients in finding natural means of life management and social skills development, both at work and during disability rehabilitation. Resource centrally GFP-model aims for a new type of peer-guided functional development. Instead of the traditional disease-centered dialogue of peer support, GFP focuses on human resources and functionality through interaction. Activities and the rehabilitation clients are supported by professional staff that trained peer tutor to support the operations carried out jointly. The contents of functional groups are versatile, for example music, recording technology, drama and visual arts. The GFP-model is relying on a strong co-operation with a local Youth Services Center and uses their space and equipment. The first GFP-house ELVIS was founded in Helsinki in May 2009. The evaluation of effectiveness was carried out by the Rehabilitation Foundation in 2011. The results of the evaluation indicate that there is a genuine demand for ELVIS and there are no equivalent services available in mental health rehabilitation in Finland. ELVIS has over 25 functional groups running every week. The professional staff consists of two music therapists and occupational therapist. ELVIS has 72 young mental health clients with various diagnoses. After the first year, 21 of them applied for school and work. The SOSPED-foundation is building new GFP-houses in 4 different cities within the next 3 years.

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Paper session

D109

13:30

EXPERIENCE

Ambivalent emotions in music: We like sad music when it makes us happy

Karim WETH[1], Max KICKINGER[2]

[1]Centre for Systematic Musicology, University of Graz, Austria; [2]Independent Scholar, Austria

We often react ambivalently to a piece of music, simultaneously experiencing both sadness and happiness, and attributing both emotions to the musical content. Two experiments were conducted (1) to empirically test for ambivalent emotions and (2) to investigate the amount of musical information necessary to elicit such emotions. In experiment 1, synthesized musical excerpts were manipulated in tempo (fast/slow) and mode (major/minor). By using unipolar scales, listeners could independently rate how (1) happy and (2) sad the music made them feel, as well as the (3) happiness and (4) sadness perceived in the music. Regarding perceived emotion, happiness was higher in major-fast excerpts, sadness was higher in minor-slow excerpts, and mixed emotions were reported (raised happiness and sadness ratings) for ambivalent music (major-slow and minor-fast). Ratings of felt emotions were similar, except that sad music (minor-slow) was experienced as ambivalent, happiness often nearly equalling the amount of sadness. Furthermore, the liking of sad excerpts positively correlated (r=.59) with the experienced happiness in the same excerpts. The results help to understand the enjoyment of sad music by suggesting that feelings of happiness are a desired emotional outcome. In experiment 2, the main results of experiment 1 were replicated with shorter musical excerpts (0.5-1.5s), suggesting that ambivalence is an immediate and effortless emotional response.

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Depressive deficits in the experience, but not regulation, of music-induced emotions

Nikki RICKARD, Abdullah ARJMAND, Elizabeth WHITE
Monash University, Australia

Tuesday

Paper session

D109

14:00

EXPERIENCE

Depression is characterized by dysfunction in experience of both positive (anhedonia) and negative (low mood) emotions. Depressed individuals also demonstrate less adaptive, and a restricted repertoire of, emotion regulation strategies. Experimental studies into emotion processing deficits in depression have, however, been limited by ecological validity of emotion manipulation (e.g., by static pictures). In two studies, we obtained insight into emotion processing by using music as a powerful and dynamic means of eliciting both positive and negative emotions. Emotion induction was verified by synchronised changes in both subjective and physiological indices, consistent with the multi-component model of emotion. In Study 1 (N=18; mean age 22.2), individuals with depressive symptoms rated positive music less intensely than did controls, but rated negative music in a similar way as did non-depressed controls. They also exhibited fronto-temporal asymmetry shifts to the right (reflective of negative affect) in response to both positive and negative subjective peaks during the music. In Study 2 (N=32; mean age 20.2), no significant difference in regulation of music-induced emotions was observed across individuals with varying depression levels. These findings suggest that the most pronounced emotional deficits observed in depressed individuals in response to music may be with the experience of positive emotions. An enhanced focus on treatments which emphasize training of positive experience may therefore be warranted, to complement more traditional programs which challenge negative symptoms and maladaptive emotion regulation strategies.

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How much does music quality matter? Listening over earphones on buses and trains

Miracle J. LIM, PerMagnus LINDBORG
Nanyang Technological University, Singapore

Paper session

D109

14.30

EXPERIENCE

The article aims to investigate the perception of sound and relationship between price and perceived earphone quality. People tend to rate music listening experiences in terms of sonic clarity and envelopment. Today, many listen to music while commuting, however such environments are not ideal due to generally high ambient noise levels. In terms of price, people use a wide range of earphones, with large variation in measurable audio quality/performance. Hypothesizing that price of earphones, satisfaction and listening quality are linearly related, we also investigate whether the price-quality relationship is moderated by different levels of ecologically valid ambient noise. A survey of listener habits on buses and trains in Singapore (N=100) was conducted and 5 typical earphone models were selected for the perceptual experiment (N=20). Volunteers listened to different kinds of music under 3 sound environment conditions: silent (studio), reproduced low-noise commuter environments (LeqA = 65 dB), and high-noise (LeqA = 80 dB). The volunteers then evaluated the 5 models for which we measured acoustic performance in terms of harmonic distortion, frequency response, and sensitivity. Survey results showed a significant correlation between satisfaction and priciness of respondents' earphones ($t(92)=1.81$, $r=0.18$, $p=0.074$), but not with physical comfort levels ($p=0.17$). Further results will be presented at the conference with a discussion of implications. We believe that our results will inform the development of ecologically valid simulations of how noisy environments affect people's music listening quality. This will inform consumers and audio equipment manufacturers.

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Tuesday

Paper session

D109

15:00

EXPERIENCE

Live music in the tourist industry in Helsinki and Sharm El Sheikh

Laila EL-MAHGARY

Turku University, Finland

The primary aim of this study is to focus on the tourists, singers-musicians and hotel managers experiences with live music in Helsinki's and Sharm El Sheikh's hotels-resorts. The tourist, singer-musician and hotel manager relations although an integral part of the tourist experience, have received little attention in past tourism and music studies. Thus, the purpose of this research will be to show that by observing these different informants performances, interactions, and attitudes towards different genres of live music in the tourist industry, we could offer insightful guidelines to better understand the cultural significance of live music in the tourist experience. Unlike previous tourism and music studies, this research will shed more light on the similarities in the host-guest experiences with live music. Furthermore, it will try to encompass new grounds by focusing on the socio, cultural and aesthetic meanings of live (popular, folk and world) music performances, from both tourist and popular music perspectives. Themes such as the "flow", "liminality" and "memory", will be crucial in assessing the socio- culturally or aesthetically different or similar performer-audience meanings and experiences with live music in Helsinki's and Sharm El Sheikh's hotels-resorts. While the use of a multi-sited ethnographic framework will be handy, as it will explore the future impacts of world systems on changes in local music production and vice versa, the Performance, Symbolic Interactionism, Distinction, Cultural Imperialism and World System theories, should be seen as tool kits for other performance, tourism, popular and world music studies.

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Posters 1

M104

13:30

LISTENING & MEMORY

The influence of music-elicited emotions and relative pitch abilities on absolute pitch memory for familiar melodies

Kelly JAKUBOWSKI, Daniel MÜLLENSIEFEN

Goldsmiths, University of London, United Kingdom

Research has demonstrated that emotional stimuli are remembered better over time than nonemotional stimuli in the linguistic and visual domains, and that emotional music is retained better in long-term memory than less emotional music. It has also been found that emotional events may be recalled with greater accuracy and vividness than non-emotional events. There remain, however, many unanswered questions about whether music-elicited emotion might facilitate veridicality of the music's representation in memory. The present study stems from a project investigating the finding that non-musicians could produce from memory the absolute pitches of self-selected pop songs. Our study aimed to investigate factors that might influence latent absolute pitch (AP) memory for familiar songs in non-AP possessors – specifically, musical background, pitch memory abilities, and music-elicited emotions – using Levitin's sung production paradigm. Results of 50 participants' sung pop song productions were compared to their ratings of music-elicited emotions for songs chosen for the production task, measured using the GEMS-25, as well as to performance on a pitch labeling task and a relative pitch memory test. The findings suggest that the quality and degree of music-elicited emotions and relative pitch memory influence latent AP memory for selfselected pop songs. It was found that music-elicited nostalgia was positively associated with accurate AP memory, while music-elicited peacefulness was negatively associated. Results are discussed in relation to previous research and the valence-arousal model of emotions.

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Everyday listening to music and emotion among college students

Junko MATSUMOTO
Nagano College of Nursing, Japan

Posters 1

M104

13:30

LISTENING & MEMORY

This study attempted to reveal the relationship between everyday listening to music and emotion among college students. Participants were 13 female and 2 male college students who were given booklets to record the following over an 8-day period: dates and times of their everyday experiences of listening to music, duration of listening, locations and contexts of listening, active or passive listening, emotions before and after listening, and tiles and artists to which they listened. Results indicated that the participants listened to music for 5 to 30 minutes while driving or riding in a car. Emotions reported both before and after listening to music were mainly 'happy', 'calm', and 'dull'. When participants listened to music actively, their emotions before and after listening to music were essentially the same as the above. With respect to the relation between emotions before listening to music and characteristics of the music they chose to listen to, when feeling 'sad', 'anxious', or 'lonely' before listening, they actively chose music having positive as well as negative affective characteristics. These results suggest that their music use in part reflects the iso-principle.

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An experimental investigation on empathy as an emotion-induction mechanism in music listening

David DITTER, Leonid SCHMIDT, Nils TESMER, Hauke EGERMANN
Audio Communication Group, Technische Universität Berlin, Germany

Posters 1

M104

13:30

LISTENING & MEMORY

Previous findings indicate that empathy influences emotional responses while listening to music. These findings are based on experiments which used audiovisual stimuli of musical performances. It remains unclear if this influence would continue, if a person is only exposed to the audio content. Therefore this web-based experiment investigated the influence of induced empathy on emotions by listening to pure audio content. All 83 participants (45 female, 51 male, age M = 31 years) listened to four different contemporary music excerpts (instrumental-happy content / instrumental-sad content / vocal-happy content / vocal-sad content) with one out of two different and randomly assigned instructions. Subjects were either instructed to empathize with the emotional expression in the music or to evaluate audio quality (low empathy control condition). Both groups rated felt intensity of 5 basic emotions (5 point-scale) after listening to each of the four stimuli. Results show that the two treatment groups differed significantly in the rating of their felt emotions: Confirming our hypothesis, different pieces with different emotional expressions were rated differently on different emotions comparing empathy and control groups. In that, emotions expressed in the songs were rated higher by the empathy group than emotions not expressed. Hence, induced empathy modulated emotional responses to the stimuli presented. To our knowledge this study offers the first results on this topic while using audio-only stimuli.

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Tuesday

Posters 1

M104

13:30

LISTENING & MEMORY

The adaptive functions of music listening: a scale development project

Jenny GROARKE, Michael HOGAN

National University of Ireland, Galway, Ireland

The aim of the current study is to develop a model of the Adaptive Functions of Music Listening, and to design and validate a new scale based upon this model. A review of the literature reveals a wide range of affective, cognitive and social functions of music listening. Affective functions dominate, with emotion regulation being reported as the most important function of music listening. Analysis of music listening motivations and the impact of listening strategies on the well-being of younger and older adults are poorly developed as a consequence of limited theory and scale development in this particular area. This study sought to identify and structure the functions of music listening as argued for by a group of younger adults (N = 20) and older adults (N = 20), utilizing a collective intelligence methodology, Interactive Management (IM). IM allows for a system of functions to be organized into an enhancement structure. The current study represents a novel application of IM to understand the complexity of individual and developmental differences in music listening. Thematic analysis of the IM deliberation will also be used to clarify the nature of music listening functions in both younger and older adults, and will inform item generation for the Adaptive Functions of Music Listening scale. These systems design sessions are ongoing and findings will be presented in June.

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Posters 1

M104

13:30

LISTENING & MEMORY

The neuroscience of musical expectancy: An fMRI investigation into emotional responses to naturalistic music

Douglas MACCUTCHEON

University of Jyväskylä, Finland

This poster presents investigative research into the neurological correlates of musical expectancy and emotion in the context of naturalistic music stimuli. Musical expectancy refers to a range of emotionproducing responses causally related to specific structural and musical features. The dynamics of musical expectancy are also dependent on certain cultural and psychological factors, stylistic enculturation and musical preference respectively, which are fundamental to interpreting the results of this investigation. Research into the area of musical expectancy and relationship with musical structure goes back to the work of Leonard Meyer in the 1950s, and recent literature draws attention to the need for in-depth research into the subject of musical expectancy. This investigation hopes to address this need. The methodology is to create a create a musical analysis of the Dream Theater song under investigation (aptly titled ”Stream of Consciousness”) using a variety of traditional music analytic methods as well as continuous ratings of expectancy and computational extraction using MIR Toolbox. This model will then be used to predict expectancy and emotion-related brain responses to the naturalistic music stimuli. The overall aim of this research is to provide greater insight into the way in which music elicits emotion in listeners and the neural underpinnings of that response. Detailed results will be presented at the conference.

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Music Performance Anxiety: Use of coping strategies by tertiary flute players

Andre SINICO, Leonardo WINTER

Federal University of Rio Grande do Sul, Brazil

Posters 1

M104

14:00

HEALTH & WELLBEING I

This article presents part of a master´s degree research, which focused on investigating causes, symptoms, and strategies used by tertiary flute players to cope with music performance anxiety in the performance of an unaccompanied flute work in recital of evaluative character. However, it will present only the results on strategies of twelve flute students from three music colleges in Brazil to cope with music performance anxiety. Seven of participants were male, and five were female. The procedures of collection and analyses of data occurred through the behavioral observation of the participants in the recital, and verbal reports by semi-structured interview. Both procedures were recorded in audio and video. The data were analyzed in four steps, the first and fourth quantitatively, and the others qualitatively. The first step aimed to determine the profile of the participants of this research, and at the ending of crossing of the data the total number of causes, symptoms, and coping strategies. The other steps sought to identify causes, symptoms, and coping strategies through the behavioral observation, and verbal reports analyses. Finally, we performed the crossing of the data for comparison between the two data analyses, and arrived at conclusions about some coping strategies. Thus, the positive self-talk was reported as the main strategy used by tertiary flute players to cope with music performance anxiety in this study.

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Negative emotions in performers: Balanced wellbeing and Music Performance Anxiety

Alexandra LAMONT

Keele University, United Kingdom

Posters 1

M104

14:00

HEALTH & WELLBEING I

Music Performance Anxiety (MPA) is a particularly prevalent instance of negative emotion experienced by many performers, even professionals. Current treatments include a range of conventional ”problem-focused” approaches such as medication, mental rehearsal, and biofeedback. The positive psychology framework provides an alternative way of conceptualising MPA and helping tackle it by focusing on performers’ strengths. This paper explores the relevance of this approach by assessing the prevalence, role, and importance of negative emotions in performers at different levels, considering whether negative emotions are important and necessary. The paper draws on data from an online survey and follow-up interviews, both being conducted at present (data available at the conference). Student, amateur and professional musicians engaged in classical music performance scenarios will be asked to complete the Kenny MPA Inventory, measures of general strengths (items such as resilience and self-awareness) and measures of psychological wellbeing. Interviews will explore performance situations in more depth and the ways in which performers currently attempt to tackle MPA and deal with negative emotions in performance. I also explore the relative balance of the components of wellbeing that performers place in the context of performances in different settings. This research will shed light on the role of negative emotions experienced by performers at different times and stages of life in relation to performance situations and how performers manage these emotionally charged situations. The results may highlight alternative means of treating MPA at different levels of performance by focusing on existing strengths rather than weaknesses.

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Posters 1

M104

14:00

HEALTH & WELLBEING I

Music as a means of stress reduction in daily life – An ambulatory assessment study among students

Alexandra LINNEMANN[1], Beate DITZEN[2], Jana STRAHLER[1], Johanna DÖRR[1], Urs M. NATER[1]

[1]University of Marburg, Germany; [2]University of Zurich, Switzerland

Music can be considered as a means of emotion regulation and stress reduction in daily life. Ambulatory assessment (AA) allows investigating behavior in daily life with high ecological validity. However, studies on the relationship between music listening and stress in daily life are extremely scarce. An AA study was conducted to investigate the relationship between daily music listening and perceived stress in healthy students. Fifty-five students were investigated during a) five days of a regular term week and b) during five days of an examination period. Students rated their perceived stress and current music listening behavior six times per day. Additionally, they indicated intentions for listening to music and valence/arousal of the selected music at each time point. Hierarchical linear modeling revealed that the examination period was perceived as more stressful than the regular week. Increased music listening was associated with lower stress ratings, but only during the regular term week. During the examination period, students listened to music less often. Furthermore, listening to music with the intention to relax predicted lower stress ratings during both periods. Neither valence nor arousal of the selected music were associated with stress ratings. Listening to music is an effective stress reduction strategy in daily life, particularly when used for relaxation purposes. Consequently, intentions for music listening need special consideration when selecting music for stress reduction purposes. However, the stress reducing effect was not found under highly stressful conditions. During severe stress, additional strategies might be useful in order to cope with the situation.

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Posters 1

M104

14:00

HEALTH & WELLBEING I

Stage fright and participants of the wieniawski international violin competition

Malgorzata SIERSZENSKA-LERACZYK

Academy of Music (University of Music), Poland

The author of the presentation is both a psychologist and a musician. She is a lecturer at Academy of Music in Poznan, and she has worked in specialist music schools in Poznan as a teacher and a psychologist for 25 years. The poster presented during 3rd International Conference on Music and Emotion includes information about nature of stage fright among all participants during the the Competitions in 2006 and 2011 (n=90). The Wieniawski International Violin Competition is preceded by rigorous preliminaries, the very fact of taking part in the Competition can be considered an achievement, which means that we deal with a group of individuals whose high quality of music attainment is unquestionable. The group’s quality of music attainment is also confirmed by their previous achievements – most of them were winners of various performance competitions, students of prestigious music academies, and tutees of famous violin teachers.

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How can accommodation be enhanced? The role of analytical and emotional music reception

Tim LOEPTHIEN, Bernhard LEIPOLD

University of Hildesheim, Germany

Posters 1

M104

14:00

HEALTH & WELLBEING I

The Dual-Process Model of Development Regulation proposes that accommodation (flexible goal adjustment) is an essential mechanism in coping with a threat to personal goals and thereby leading to well-being. A cognitive mindset characterized by a divergent thinking mode should facilitate accommodative processes. Two studies were conducted to examine the relationship between music reception and accommodative mechanisms. Study 1 (training-study; N = 79) investigates whether a comparable mindset can be induced by attentive-analytical music reception (simultaneously focusing various musical parameters). Two groups of students were trained in listening to music or regarding art in a complex way. Results showed group differences in the preference for the presented stimuli. The preference for the objects was correlated with accommodation. The findings from Study 2 (cross-sectional; N = 470) show a significant relationship between attentiveanalytical music reception and accommodation. Both studies showed a connection between affective variables (e.g., emotional listening, preference for the objects) and accommodation. Furthermore, the interplay between analytical and affective music reception seems to play an important role in this process. Further studies are needed to examine the preconditions influencing the effects of the various trainings and the interaction between analytical and affective music reception more closely and it would be worthwhile to examine how the training could be implemented into fields of practice where developmental regulation processes are relevant (e.g., support groups, psychotherapy, adult education settings and lifelong learning).

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How to prevent musical illiteracy among children?

Amelia GOLEMA

The Karol Lipinski Academy of Music, Poland

Posters 1

M104

14:00

HEALTH & WELLBEING I

Why are children unwilling to listen to classical music ? There are many reasons why we choose pop but it appears that the phrase ”I don’t like classical music” means ”I don’t understand it” or ”I don’t know it”. To understand music we need to be familiar with its language. Letter code consists of 24 graphics characters. Digital code includes 10 numbers whereas music code is built of 7 notes. All of them are keystones in an international and intercultural communication. Lidia Bajkowska’s method is highly effective way of introducing children in a musical world. The core of this method is hidden in a game and paly. Taking part in any games allows children to enter the Kingdom of Music where they imperceptibly absorb the most basic music knowledge. What’s more, even if children don’t know letters and digitals, they are able to understand music thanks to fairytales characters. So, in other words children, who can’t count, read and write, are able to understand the music language. Firstly, children, who learn the language of music, begin to consciously receive music and than they learn how to play the instrument. Finally, they start composing a simple musical piece. All these activities do not take much time. This is a great opportunity to ”discover” children who have musical gift.

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Tuesday

Posters 1

M104

14:30

PERFORM.

The relation between emotional valence and performance motion of the keyboard instrument

Yuki MITO[1], Hiroshi KAWAKAMI[1], Masanobu MIURA[2], Yukitaka SHINODA[3]

[1]College of Art, Nihon University, Japan; [2]Faculty of Science and Technology, Ryukoku University, Japan; [3]College of Science and Technology, Nihon University, Japan

The emotion in music performance was firstly figured out by Juslin in 2001, which revealed an association between acoustical cues and emotions. The motion on musical performance has been thought to have an important role since it is conducted for the production of musical sound. Our former study revealed the association between motion and emotion based on the basic six emotions (tenderness, happiness, sadness, fear, anger and non-emotion), on which the motion data are averaged among the six emotions, by our "Motion Averaging Method (MAM)". The motions are differentiated using averaged motion so the description of emotional motion was realized. Here tries to clarify the association on performance motion of the keyboard instrument by motion capture. Keyboard performances are recorded by a motion capture system. Employed players are one professional pianist. We ask all the players to play it under each of six emotions such as tenderness, happiness, sadness, fear, anger, or non-emotion. Employed motion capture system is the MAC 3D System of Motion Analysis Corp.., which is an optical motion capture system. The total markers are 35 points. We analyzed the shifting of center of gravity of motion capture data. As a result, we understood the difference in emotional valence by the center of gravity of the head, an arm, the body, and the hand. Particularly, the non-emotion was move less than other five emotions. Then we were able to express an association between five emotions of Juslin and motion as a figure.

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Posters 1

M104

14:30

PERFORM.

Brain-activity-driven real-time music emotive control

Sergio GIRALDO, Rafael RAMIREZ

Music Technology Group, Pompeu Fabra University, Spain

The quality and availability of brain computer interfaces has increased in recent years making easier to study emotion in human computer interaction. On the other hand, the study of music performance investigates the deviations introduced to the score by a skilled musician in order to add expression and convey emotions. In this study our aim is to fulfill the gap between music and listener by merging the previous two approaches in order to control the expression of a given music piece by means of the perceived emotional state of the user as detected by his/her brain activity. We obtain brain activity information using an EEG device and then map this information into the arousal-valence plane. The resulting coordinate in the arousal-valence plane serves as the input to transform a musical piece in real time. The nature of this transformation is based in the KTH expressive performance rule system (Director Musices – pDM player), where different performance parameters are tuned to generate a performance with the intended emotion. Initial results show that this technique makes possible to control the performance of a given musical piece just by the emotion detected in brain activity.

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The Musical Entrainment Questionnaire

Carolina LABBÉ, Didier GRANDJEAN

University of Geneva, Switzerland

Posters 1

M104

14:30

PERFORM.

Entrainment is the process through which two independent but interacting systems become synchronized with each other. In the music domain, rhythmic entrainment has been proposed as a potential emotion induction mechanism caused by listeners' internal rhythms, including physiological and cognitive, becoming entrained to the rhythm in the music. In our study, two groups of participants (n=61 and n=61) listened to nine pieces for solo violin and rated how they felt along an "affect" dimension and the nine Geneva Emotional Music Scale (GEMS; Zentner, Grandjean, & Scherer, 2008) dimensions. After each peace they also filled our 12 item questionnaire corresponding to subjective feelings of entrainment. A factorial analysis of the "Musical Entrainment Questionnaire" revealed a two-factor solution with the first factor (Visceral Entrainment) corresponding to sensations of internal bodily entrainment while the second factor (Motor Entrainment) corresponded to the inclination to move body segments to the beat of the music. Moreover, these factors predicted different GEMS dimensions in distinctive ways, suggesting that different kinds of entrainment can indeed act as unique mechanisms of emotion induction.

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Investigating relationships between music, emotions, personality, and music-induced movement

Birgitta BURGER[1], Juho POLET[2], Geoff LUCK[1], Marc R. THOMPSON[1], Suvi SAARIKALLIO[1], Petri TOIVIAINEN[1]

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Posters 1

M104

14:30

PERFORM.

Listening to music makes us to move in various ways. The characteristics of these movements can be affected by several aspects, such as individual factors, musical features, or the emotional content of the music. In a study in which we presented 60 individuals with 30 musical stimuli representing different genres of popular music and recorded their movement with an optical motion capture system, we found significant correlations 1) between musical characteristics and the exhibited movement, 2) between the perceived emotional content of the music and the movement, and 3) between personality traits of the dancers and the movement. However, such separate analyses are incapable of investigating possible relationships between the different aspects. We describe two multivariate analysis approaches – mediation and moderation – that enable the simultaneous analysis of relationships between more than two variables. The results of these analyses suggest mediation effects of the perceived emotional content of music on the relationships between different features of music and movement. It can therefore be assumed that musical emotions can (partly) account for the effect of music on movements. However, using personality as moderator between music and movement failed to show a moderation effect in most cases, suggesting that personality does not generally affect existing relationships between music and movement. Hence it can be assumed that musical characteristics and personality are independent factors in relation to music-induced movement.

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Symposium 1

M103

16:00

MUSICAL EMO. IN THE BRAIN

Processing emotional valence in the brain

Mikko SAMS

Aalto Univerrsity, Finland

Perceived emotional valence of sensory stimuli influences their processing in various cortical and subcortical structures. We recently examined how brain was activated when subjects were listening to auditory stimuli varying parametrically in perceived valence. We found a quadratic U-shaped relationship between valence and blood oxygen level dependent (BOLD) signal strength in the medial prefrontal cortex, auditory cortex, and amygdala, signals were the weakest for neutral stimuli and increased progressively for more unpleasant or pleasant stimuli. Interestingly, we have found similar U -shaped relationships between valence and brain activity also for complex visual stimuli and emotional experiences. In our recent study, we calculated synchrony between subjects' brains when they were watching short movie clips. We showed that networks of brain areas "tick together" in participants who are viewing similar emotional events in a movie. Negative valence was associated with increased synchrony in the emotion-processing network and in the default-mode network. High arousal was associated with increased synchrony in the somatosensory cortices and visual and dorsal attention networks. We propose that negative valence synchronizes individuals' brain areas supporting emotional sensations and understanding of another's actions, whereas high arousal directs individuals' attention to similar features of the environment. We are now extending this approach to naturalistic narrative as well as music. In addition, we are decoding emotional states from brain activity using multivariate pattern analysis techniques.

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Symposium 1

M103

16:30

MUSICAL EMO. IN THE BRAIN

Conscious and spontaneous music emotions in the brain

Elvira BRATTICO, Brigitte BOGERT

Cognitive Brain Research Unit, University of Helsinki & Center of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland

Different cognitive strategies may be involved in the perception and induction of emotions by music. One may engage explicit, or conscious and effortful processing, thus attending directly to the emotive qualities of the music. However, often music is only played in the background and has the power to unconsciously affect our mood. In this case, processing of emotions in music occurs implicitly, or unconsciously and automatically. In the visual domain, these explicit and implicit emotional processes rely on separate neural circuits, with implicit emotional responses depending on subcortical structures and explicit circuitry relying on networks of cortical regions, but virtually nothing is known about the auditory domain. Subjects listened to 4-sec clips from film soundtracks, rated as fearful, happy, or sad in a previous behavioral experiment. To study the implicit processing of music emotions, we utilized functional magnetic resonance imaging (fMRI) while subjects focused on the number of musical instruments, thereby unconsciously processing the emotional content of the stimuli. To study the explicit processing of music emotions, subjects were asked to classify the emotion perceived in the same musical stimuli, hence explicitly drawing attention on the affective content. Implicit emotion processing recruited a network of core, subcortical structures, including the amygdala and parahippocampal gyrus, typically involved in the fast, spontaneous affective reactions in other modalities. Explicit processing instead predominantly activated cortical areas associated with the cognitive processing and emotional recognition and regulation. We also will discuss the role of personality, mood, and musical expertise in modulating limbic and cortical activity.

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Prediction error as the key to understanding the pleasure of challenging rhythms

Symposium 1

M103

17:00

MUSICAL EMO. IN THE BRAIN

Peter VUUST[1,2], Maria WITEK[2]

[1]Royal Academy of Music, Aarhus, Denmark; [2]Centre of Functionally Integrative Neuroscience (CFIN), Aarhus University Hospital, Denmark

Meyer was first to formulate the idea that musical anticipation and incongruity, i.e., elements that do not fit with schematic, veridical or short-term memory based predictions, may be a fundamental source of music emotion and pleasure. A strong source of musical pleasure in contemporary music is the tension created between musical rhythm and the underlying pulse or metric framework. Leaving familiarity and other extra-musical explanations aside, three main mechanisms have been suggested as the source of this tension: micro-timing variations, repetition, and syncopation. This presentation report the results of recent investigations, using behavioral measures and functional magnetic resonance imaging (fMRI) of brain activity to syncopated rhythms in which the degree of syncopation (prediction error) is systematically varied. In an internet rating study, we found evidence suggesting that ratings of musical pleasure and wanting to move in relation to short drum breaks form an inverted U-shaped relationship with degree of syncopation echoing Berlyne's theories of an inverted U-shaped relationship between complexity and aesthetic appreciation in art. Using fMRI, we found this shape in the activation of the auditory cortex, whereas brain structures in the basal ganglia and the anterior inferior insula responded in linear ways. This indicates that the perceived pleasure of rhythm depends on the balance of tension between musical anticipatory structures and predictive brain mechanisms in higher-level areas for music processing. This will be discussed in the light of emerging theories of brain function such as Friston's predictive coding theory.

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Predicting the neural substrates of perceived music emotions during naturalistic listening condition

Symposium 1

M103

17:30

MUSICAL EMO. IN THE BRAIN

Petri TOIVIAINEN[1], Elvira BRATTICO[2]

[1]Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland; [2]Finnish Centre of Excellence in Interdisciplinary Music Research, University of Helsinki, Finland

Neural processing of perceived musical emotion can be investigated using two main approaches: encoding, referring to prediction of neural activity from emotion ratings; or decoding, referring to prediction of emotion ratings from neural activity. Significant encoding performance in a given brain region does not alone prove that emotion is processed in that region. Decoding models can be used to assess if the activity in a region is related to emotion ratings. We used a decoding approach to investigate neural correlates of perceived emotion during continuous listening to music. To this end, participants were measured with functional magnetic resonance imaging (fMRI) while they were listening to musical pieces. Subsequently, they continuously rated the activity and valence of the same musical stimuli. The fMRI data were subjected to dimensionality reduction via voxel selection and spatial subspace projection. The obtained projections were subsequently regressed against the behavioral ratings. To avoid overfitting, cross-validation was utilized. Different voxel selection criteria and subspace projection dimensionalities were used to find optimal prediction accuracy. The results will be presented at the conference.

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Tuesday

Paper session

A103

16:00

PERFORM. I

Open Outcry: a "reality opera" in which traders sing to trade real money and the music expresses the emotions of the financial market

Alexis KIRKE[1], Greg DAVIES[2], Eduardo MIRANDA[1], Joel EATON[1]

[1]ICCMR, Plymouth University, United Kingdom; [2]Barclays, United Kingdom

The opera Open Outcry, by Alexis Kirke and Greg B. Davies, involves 12 operatic performers trading real money and competing for profits in an artificial market by singing to each other and thus creating music which acoustically expresses the behaviour of the market in real time. The opera was performed on 15th November 2012 at The Mansion House in the City of London, sponsored by Barclays, directed by Alessandro Talevi. The musical trading phrases were composed by Alexis using genetic algorithm computer music techniques so as to emotionally express through music whether the market was broadly positive or negative in its movements. The market was designed by Greg, Global Head of Behavioural Finance at Barclays. This paper explains the background of the project as well as some of the techniques used, and what actually occurred in the "reality opera" on the night.

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Paper session

A103

16:30

PERFORM. I

The role of inspiration in the performance of programme music: The case of "Viagens na Minha Terra" by Fernando Lopes-Graça

Joana GAMA

Évora University / UnIMeM – Research Unit in Music and Musicology, Portugal

"Viagens na minha Terra" (Travels in my Homeland) is a piano cycle in nineteen movements by Portuguese composer Fernando Lopes-Graça (1906-1994). The work relates to portuguese culture in many ways: the title of the work is from a novel by Almeida Garrett and each movement is based on a traditional folk song. The music also refers to traditional dances, musical instruments and religious festivities, all of which are associated with small villages or regional traditions. By tracing the composer's original sources of inspiration, this paper examines how these extra-musical ideas can influence the way the piece is performed. It gives examples of how these ideas are incorporated into the piece and transcribed into the score. It also shows how analysing sound recordings of the traditional folk songs used in "Viagens na minha Terra" can determine the performer's approach to the work in terms of tempo, rhythm, dynamics and sound.

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The sound of sadness: The effect of performers' emotions on audience ratings

Anemone VAN ZIJL, Geoff LUCK

Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland

Tuesday

Paper session

A103

17:00

PERFORM. I

Very few studies have investigated the effect of performers' felt emotions on the audience perception of their performances. Does it matter what a performer feels or thinks about when performing? To investigate this, we asked four violinists to play the same musical phrase in response to three different instructions. The first instruction was to focus on the technical aspects of their playing. The second instruction was to give an expressive performance. Following a sadness-inducing mood induction task, the third instruction was to play while focusing on their felt emotions. High quality audio and motion-capture recordings were made of all performances. Subsequently, motion-capture animations, audio recordings, and motion-capture animations combined with audio recordings of the performances were presented to an audience. Thirty audience members rated how much they liked each performance, how skilled they thought each performer was, and to what extent each performance was expressive of sadness. Statistical analysis revealed that, overall, audience members preferred the Expressive performances to the Technical and Emotional ones. In addition, the Expressive performances were rated as played by the most skilled performers. The Emotional performances, however, were rated as being most expressive of sadness. Our results suggest that what performers feel or think about when performing does affect the perception of their performances by an audience.

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Absolute or relative? A new approach to building feature vectors for emotion tracking in music

Vaiva IMBRASAITE, Peter ROBINSON

University of Cambridge, United Kingdom

Paper session

A103

17:30

PERFORM. I

It is believed that violation of or conformity to expectancy when listening to music is one of the main sources of musical emotion. To address this, we test a new way of building feature vectors and representing features within the vector for the machine learning approach to continuous emotion tracking systems. Instead of looking at the absolute values for specific features, we concentrate on the average value of that feature across the whole song and the difference between that and the absolute value for a particular sample. To test this "rela-tive" representation, we used a corpus of popular music with continuous labels on the arousal-valence space. The model consists of a Support Vector Regression classifier for each axis, with one feature vector for each second of a song. The relative representation, when compared to the standard way of building feature vectors, gives a 10% improvement on average (and up to 25% improvement for some models) on the explained variance for both the valence and arousal axes. We also show that this result is not due to having the average of a feature in the feature vector, but due to the actual relative representation.

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Tuesday

Paper session

H306

16:00

EDUCATION

Does music in school increase the happiness of the pupils?

Päivi-Sisko EEROLA, Tuomas EEROLA

University of Jyvaskyla, Finland

Music is known to be an effective mood regulator, and assumed to generate well-being through social interaction. The affective aspects of these benefits can be conceptualized in terms of positive psychology, particularly by pleasure, engagement, and meaning. It is precisely these aspects that large-scale studies of school performance (e.g., PISA) have identified as problematic areas of the school in general. The aim was to explore whether music in school can increase the general happiness of the pupils. Are those who receive extended music education getting higher scores in the measures of pleasure, engagement and meaning in comparison to those with standard music education? A quasi-experimental design consisting of extended and standard music education was carried out. A sample of schools (10), which had both standard and extended music education in their curriculum, participated in the study (grades 3 and 6, N=735). Happiness and satisfaction in school was measured with Quality of School Life –instrument. A comparison between pupils with and without extended music education revealed that the pupils with extended music had significantly higher scores in factors related to pleasure ($p<.001$) and engagement ($p<.05$) than those having standard music education. The school and other background variables (e.g., gender) did not have major impact on the main findings. We conclude that extended music education is able to generate measurable happiness within school context, and this effect may be related to music activities or the special status or formation of these classes.

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Paper session

H306

16:30

EDUCATION

Music technology in the classroom: A music engagement program perspective

Robert CRISP

Kingsford Smith School, Australia

The aim of this paper is to study available technologically driven approaches and innovations to music education in terms of philosophy and practical methodology. The recent advent of tablet computers has led to a plethora of applications that have the potential to be effectively utilized in the music classroom. The inherent danger of this innovation is that technology could end up driving the lesson rather than assist in music creation. The upside is that technology could enhance the engagement of students that would otherwise be disinterested as well as broadening the experience of all students. This paper will assess a sample of available applications using students ranging from kindergarten through to year 5. The paper will consider the philosophical and practical implications of the ANU's alternative Music Education Program in terms of IT provision. The main thrust of this research is to find ways in which mainstream classroom teachers can access material that is used to deliver the MEP philosophy. Therefore the technology not only needs to be present but also be in a form that is easy to use without adding to the burden of everyday teaching.

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Special Music Education Advancing Inclusion – A Study on Resonaari May 14, 2012 Concert Audience

Sanna KIVIJÄRVI, Ari POUTIAINEN
University of Helsinki, Finland

Paper session

H306

17:00

EDUCATION

There is a growing interest in music education that focuses on students with special educational needs (SEN). This is partly due to the various concerts, video clips, and documentaries that have popularized the development in the field. Among the best-known Finnish achievements in this respect is the work of the Special Music Centre Resonaari (Helsinki). Its results have been successfully presented, for example, in the annual Savoy Theatre concerts. In this presentation, we report on our study of the audience that attended Resonaari's May 14, 2012 concert. For the study purposes we conducted a survey (a digital questionnaire) in Finnish and English. In addition to the survey, supplementary material was collected employing interviews and delphi method. The study suggests that Resonaari's concert format effectively promotes equality and that concerts performed by students having SEN can be rewarding both musically and emotionally. It seems that Resonaari's concerts can be an effective way to pass information concerning diverse learners. The results also imply that the particular concert event conveyed important messages on musical values and stimulated interaction between different audiences. In sum, especially the emotional experiences attained during Resonaari's concert accelerated the audience to assess the definitions of and attitudes towards disability. Utilizing the case context, we emphasize the importance of music and music education for stable and inclusive society. Moreover, we discuss educational participation and the potential for social change that Resonaari's concert activities conceive. This study is a part of a larger research on the marginalized groups within music education.

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The Altruistic Teen: The role of altruism in re-engaging Australian teenagers in singing.

Georgia PIKE, Susan WEST
Australian National University, Australia

Paper session

H306

17:30

EDUCATION

This paper reports on the work of the Music Engagement Program (MEP) at the Australian National University. The level of engagement in music making in Australia, particularly in singing, declines steeply during the school years. There are concurrently a range of assumptions about the types of music and music making with which adolescents are willing to engage. The MEP has developed ways to re-engage high school students in making music, in particular through altruistic singing, community outreach, singing workshops, student-led assembly presentations, and student-led teacher training. This paper tracks the program's engagement with teenage students from 2006, and discusses its most recent outcomes. The project has been documented in a range of media, and provides the evidential basis for one of a number of multi-media ethnographic case-studies that form part of a doctoral thesis. The thesis focuses on developing definitions of excellence in music that will encourage and support ongoing engagement in music.

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Tuesday

Paper session

D109

16:00

THERAPY: AFFEC. DIS. I

"Strange Feelings": Songs for coping with mental illness

Denise GROCKE

University of Melbourne, Australia

People who have a long-standing mental illness must cope with severe symptoms including intrusive hallucinations and delusions, difficulty relating to others, apathy lack of volition, and blunted affect. Music therapy improves global symptoms of people who have mental illness, and group song writing enhances quality of life. When composing original songs within a group context, participants express the full gamut of emotions from elation to despair and vulnerability. The paper will present results of a controlled study measuring quality of life, self-esteem, social enhancement, spirituality and symptom status. The study design utilised a wait-list control, with groups of 5-6 people meeting weekly over 12 weeks to compose original songs, including original lyrics and making decisions about the genre, style, shape and form of the music. Significant results were found on quality of life and self-esteem, the latter sustained at followup. Focus group themes, and lyric analysis will be presented to demonstrate themes of pleasure and challenge experienced by the participants. Examples of songs that express diverse emotions will be played.

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Paper session

D109

16:30

THERAPY: AFFEC. DIS. I

Improvisation musical adjustment to the emotional state as the basis of musical therapy for an autistic child

Sergei STANGRIT

Stangrit-centre, Russia

The diverse folk musical culture of Karelia and Finland has given the basis to the ”kantele-therapy” – authors methods of musical therapy by Sergei Stangrit. According to the Health Ministry classification of Russia, ”kantele-therapy” is a method of musical pedagogical medical work. Instrumental and/or vocal improvisation is its main technological manoeuvre. The creative game begins with posing the question: "Where did Väinämöinen (the main character of ”Kalevala" epos, the kantele creator) take music from? He didn't study either at conservatory or musical academy" answer variants: from man – his or her feelings, thoughts, physical conditions could be expressed by musical sounds; from people's communication; sounds of nature, nature processes dynamics also have rhythm-intonation characteristics. The author has working experience with autistic children of 3 -9 years of age. Communication with such a child is known to be very difficult, as the child lives in his own world. But the child has his or her own emotional inner life. Emotions are showed by the sound made by the child, by gestures and movements. Such "grains" should be grown into musical composition. Musical improvisation can express any emotional state the autistic child has "here and now". All possible means of musical expression are used. Tempo-rhythm, Intonation, Dynamics, Harmony (texture), Morphogenesis (development principles, culminations, cadences). Improvisation music becomes the mediator between an autistic child and an adult.

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EEG-based emotion detection in music listening

Rafael RAMIREZ, Sergio GIRALDO, Zacharias VAMVAKOUSIS
Universitat Pompeu Fabra, Spain

Symposium 2

M103

09:00

BRAIN-COMPU. INTERFACES, EMO. & MUSIC

The study of emotions induced by multimedia stimuli has increased in recent years. This is due to the growing need for computer applications capable of detecting the emotional state of users and adapt to them accordingly. On the other hand, current affordable technology allows the recording of brain activity in real-time and the discovery of patterns related to emotional states. This paper describes an approach to detecting music-induced emotion from electroencephalogram (EEG) signals measured with a low-cost EEG headset. First, we present to subjects 30-seconds music fragments with different emotional content and record their response EEG activity. Then, we filter and process the signal in order to extract emotion-related features and apply machine learning techniques (linear discriminant analysis and support vector machines) to classify emotional states into high/low arousal and positive/negative valence. The obtained results indicate that EEG data obtained with the lowcost EEG device contains sufficient information to distinguish among the emotional states induced by the music stimuli, and that machine learning techniques are capable of learning the patterns that distinguish these states. Furthermore, we proved that it is possible to train successful classifiers with no to self-assessment of information about the emotional states by the subjects.

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Combining gaze and brain control in music performance

Zacharias VAMVAKOUSIS, Rafael RAMIREZ
Music Technology Group, Spain

Symposium 2

M103

09:30

BRAIN-COMPU. INTERFACES, EMO. & MUSIC

There has been little research in creating musical instruments for people with severe motor paralysis, e.g. locked in syndrome. In this paper we describe a new musical interface, the EyeHarp, combining gaze-control and brain activity input to produce emotion driven expressive performances. Using the Emotiv Epoch EEG device we estimate the performer's emotional state. Based on left and right hemisphere's alpha and beta power we assign a value in the Thayer's arousal-valence plane in real time. In our musical interface melody is gaze-controlled while the estimated arousal is mapped to arpeggio intensity and the estimated valence to sad/happy chord progressions. This system was tested in a concert setting with satisfactory results. Combining EEG information about the emotional state of the performer might enrich the expressiveness of instrument designed for people with motor disabilities.

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Wednesday

The influence of interval content on the emotional interpretation of visual information

Fernando BRAVO
University of Cambridge, United Kingdom

Paper session

A103

09:30

CROSS-MOD. EFFECTS

From the perspective of experimental psychology, the ability of music to influence the emotional interpretation of visual contexts has been supported in several studies. However, we still lack a significant body of empirical studies examining the ways in which specific structural characteristics of music may alter the affective processing of visual information. The present study suggests a way to use algorithmically generated music to assess the effect of sensory dissonance on the emotional judgment of a visual scene. This was examined by presenting participants with the same abstract animated film paired with consonant, dissonant and no music. The level of sensory dissonance was controlled in this experiment by employing different intervals sets for the two contrasting background music conditions. Immediately after viewing the clip, participants were asked to complete a series of bipolar adjective ratings representing the three connotative dimensions (valence, activity and potency). Results revealed that relative to the control group of no music, consonant background music significantly biased the affective impact by guiding participants toward positive valence ratings. This finding is discussed in terms of interval content theory within the general perspective of post-tonal music theory and David Temperley's probabilistic framework.

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The size of emotion: The role of visual stimuli on the perception of affect in the human voice

Daniel SHANAHAN, Kirsten NISULA
Ohio State University, USA

Paper session

A103

10:00

CROSS-MOD. EFFECTS

A number of correlates between the perception of emotion in both speech and music have already been discussed. For example, both raised F0 and raised musical pitch are associated with happiness, while lowered F0 and lowered musical pitch are more likely to be associated with sadness. Additionally, the theory of "sound-size symbolism" explores the relationship between pitch height and the perceived size of an object. Recent work by Shanahan and Nisula (in preparation) has used both a reaction time experiment and an implicit association task to quantify the correlations between the perception of pitch height and visual stimuli. The current study examines the effect of visual stimulus size on the perception of emotion in the spoken voice. Participants were presented with recordings of speakers reading emotionally-neutral sentences in a specified affect: sad, sleepy, aggressive, friendly, or neutral. The recordings were accompanied by a visual stimulus of a random size. Although this study is currently collecting data, it is hypothesized that participants would be more likely to judge emotionally neutral sentences as aggressive when presented with a larger visual stimulus. Conversely, they would be more likely to perceive a neutral sentence as friendly when given a smaller visual stimulus. This paper then discusses how further research might be used to examine the role of visual stimuli on the perception of emotion in melodies.

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Wednesday

Emotion, personality, use of music in everyday life and musical preferences

Paper session

H306

09:30

EVERYDAY LISTENING

Richard VON GEORGI[1], Birce POLAT[2]

[1]Institut für Musikwissenschaft und Musikpädagogik der Justus-Liebig-Universität Gießen, Germany; [2]Musikhochschule Lübeck, Germany

The use of music in everyday life (UofM) is an area with growing interest. Scales for the measurement can be criticized despite their reliability and validity. Additionally, the association of UofM with personality theories has not been carried out thoroughly. Within an ongoing project, the IAAM (Inventory-for-the-measurement-of-Activation-and-Arousal-modulation-by-Music) has been constructed. The IAAM measures UofM within five dimensions which were integrated into the neurophysiological model of Gray & McNaughton. Within the existing study the reliability and validity of the IAAM-scales are to be examined. The assignment of the scales to the BIS-BAS-model should be proven by different BIS-BAS-scales. Further hypotheses derived from the IAAM-model are to be tested. Method: 180 students completed the IAAM, EPP-D, PANAS, BIS/BAS-Questionnaire and the GWPQ-S. Musical preferences were also recorded. Beside item and scale analyses, the derived hypotheses were tested by correlation analyses. Using stepwise hierarchical regression analyses, the assignments of the IAAM-scales to the BIS-BAS-model were tested. Alpha of all IAAM-scales lies above 0,84. The correlation analyses show a dependence between the IAAM-scales, personality and music preferences (p<=0,05). The three way interaction of these variables indicate a strong role of personality. Regression analyses support the validity of the scales (p<=0,05). Conclusions: The IAAM-scales seem to be reliable and valid. The study indicates that UofM has strong personality dependencies. This means that learned strategies of UofM serve as an action theoretical approach to link the effects of music on the brain in terms of emotions, personality based feelings, behaviors and additional variables.

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Everyday life under the microscope: Emotions and engagement with music

Paper session

H306

10:00

EVERYDAY LISTENING

Alexandra LAMONT

Keele University, United Kingdom

Music psychology research has begun to establish a canon of accepted and effective techniques to investigate everyday emotions and experiences with music, including in-depth phenomenological interviews, retrospective surveys and Experience Sampling Methodology. These studies highlight the importance of context and the fluid nature of engagement with music over time. The current project explores everyday listening amongst a small sample of participants over an extended period of time using a novel in-depth diary method. Seven student participants (six female, one male, aged 20-22, from the UK and Africa) completed a daily music diary over a period of four months, writing about all the music experiences of the day and their emotions in relation to these. Diary entries were freely structured around general prompts of choice, attention, emotion, engagement with new music, liked versus disliked music, and music making as appropriate. Based on one month of data collection, emerging themes relate to the interconnection between choice and attention in music listening, and the increased awareness of how music affects mood which taking part in the study has brought. Data collection is ongoing and results will be available at the conference. By mapping music listening over a very extended time period and exploring how music can be used to influence mood in a fine grained manner, this innovative technique will challenge existing paradigms in music psychology and provide inspiration for novel research directions, as well as contributing to the body of knowledge on music listening in everyday life.

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Nightwish, a Finnish Heavy Metal band with a female voice: Use of a female voice in Heavy Metal music of the 21st century and the reactions of the audience and reviewers

Paper session

M014

09:30

THE SINGING VOICE

Charris EFTHIMIOU

University of Music and Performing Arts Graz, Austria

The timbre of a male voice is an important aspect of Heavy Metal music. Very often the roaring vocals of male singer are decisive in order to find criteria that allow a classification of a Heavy Metal song into one of its subgenres. Nightwish, one of the most famous Heavy Metal bands of the 21st century, uses a female voice in the performance of the vocal parts. The voices of Tarja Turunen (until 2005) and Anette Olzon (since 2007) significantly characterize the sound of this band. Several reviews indicate that the successful integration of the female voice in this male-dominated genre was judged extremely positive by most of the fans. However, some artists, fans and reviewers are still highly sceptical about Heavy Metal bands with female singers and discussions about that are lively in various conferences (incl. Interdisciplinary Congress on Heavy Metal and Gender Research: Cologne 2010). This paper deals with musical characteristics of Nightwish in regard to the use of a female voice and the emotional resonance of the audiences and the reviewers. Furthermore, there will be given a brief overview of Heavy Metal bands (with female singers) of the 21st century.

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“La voix comme interprète de nos sentiments” – The voice as interpreter of feelings in 17th- and 18th-century French vocal music

Paper session

M014

10:00

THE SINGING VOICE

Päivi JÄRVIÖ

Sibelius Academy, Finland

According to Jukka Sarjala, affects and passions have formed the silent history of music; something that musicology has avoided. As Sarjala notes, however, “in the seventeenth and eighteenth centuries the doctrine of affects was not just a theory among others; it was the theory of music and its characteristics”. In this paper I will concentrate not on the theory of les passions de l'âme but on the practice of them from the point of being of a present-day musician performing French 17th- and 18th-century music. My focus will be on the living declamation of the singer and on the potential of the human voice in the passionate recitation of music. As an example I will discuss Armide's famous recitative “Enfin il est en ma puissance” from Jean-Baptiste Lully's Armide. Drawing on contemporary sources I will consider the concept of passion in relation to the repertoire in question. Further I will analyse the example recitative in terms of the passions that, according to Jean-Jacques Rousseau, the performer herself should experience in order to move others. Thirdly, I will discuss and demonstrate some of the means of expression available for the present-day singer, such as tempo, phrasing, articulation, and timbre of the voice. By emphasizing the aspect of embodied, living declamation, I aim to expand the working space of the present-day classical singer and pedagogue. With this paper I join the budding discussion on the embodiment of Early Music performance.

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Computational models of non-verbal expressive gesture and social signals in joint music action

Wednesday

Keynote 2

M103

11:00

Antonio CAMURRI

Casa Paganini, Italy

This keynote briefly presents some recent projects at Casa Paganini – InfoMus characterized by the intersection of research in ICT (Information and Communication Technology) with artistic research and humanistic theories. Cross-fertilization with artistic productions and cultural projects can be a source of inspiration of paramount importance for scientific and technological research. As examples of such cross-fertilization process the following projects are presented: SIEMPRE (EU FP7 ICT FET Project on computational models and automated analysis of non-verbal expressive, emotional, and social signals), I-SEARCH (EU FP7 ICT Project on multimodal search engines for the retrieval of audiovisual content), and MIROR (EU FP7 ICT Project on interactive serious games for music education). Music is adopted in SIEMPRE as a main research testbed to study computational models of non-verbal social behaviour, including synchronization, entrainment, leadership: experimental scenarios face the subtle and complex social interactions taking place between string quartet musicians during live musical performance, within orchestra strings sections and conductor, and in listening to this music by non-expert audiences. The EyesWeb XMI software platform (freely available at www.infomus.org) supports the development of experiments and applications in SIEMPRE, I-SEARCH and MIROR. Short video excerpts on some research results are finally discussed.

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Effects of music on emotion regulation: A systematic literature review

Sylka UHLIG[1,2], Artur JASCHKE[1,3], Erik SCHERDER[1]

[1]Vrije Universiteit Amsterdam, dept. of clinical Neuropsychology, Netherlands; [2]HAN University, Netherlands; [3]Cognitive Science Centre Amsterdam, Netherlands

Paper session

M103

13:30

REGULATION I

Music and its use for emotion regulation processes, to this day remains an unresolved question. Multiple experimental layouts encompassing its daily life use and clinical applications across different cultures and continents have preserved music as a self-regulative tool. Therefore it is seen as a very individual but cross-culturally accepted therapeutic tool. Large amounts of recent studies demonstrate the effects of music on emotion and emotionally evoked processes. A thorough literature search was conducted across the data bases for the timeframe from January 2001 to July 2012; CINAHL, EMBASE, PubMED, PsychINFO, The Cochrane Library, Eric, Psychology and behavioral science collection, SpringerLink, google scholar, picarta, Web of Science, Science Direct, DARE,Worldcat, and handsearch. Inclusion criteria encompassed youth/adolescents from 10 to 29, including healthy aswell- as clinical populations. Music intervention and emotion regulation measures were viewed and included only when at least forms of music participation (singing, playing, listening, engagement) were noted in the study and effects on emotion regulation were directly measured. The interrelations between the effects of music on emotion regulation and the use of it as a purposeful instrument, e.g. music interventions for specific educational or therapeutic functions, yielded limited results. Music has a 'self-regulative capacity', but is restricted as valuable instrument for specific emotion regulation interventions. This review presents the effects of music on emotion regulation for youth population, detecting 1) insufficient adequate (clinical) studies about the purposeful use of music for emotion regulation, and 2) insufficient actively used music interventions, like listening, singing, playing in academically studies.

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Wednesday

Musical emotion perception and emotion regulation in depressed individuals

Suvi SAARIKALLIO, Geoff LUCK, Marko PUNKANEN
University of Jyväskylä, Finland

Paper session

M103

14:00

REGULATION I

People efficiently identify basic emotions expressed by music and actively use music for regulating their moods and emotions. However, little is still known about individual differences in this behavior. In the current study we investigated how clinical depression relates to both emotion perception and emotion regulation through music. 21 depressed and 21 non-depressed adults (35 women, mean age 34.38) participated in the study. Depression was assessed through the Beck Depression Inventory (BDI). Musical emotion regulation was measured through the Brief Music in Mood Regulation (BMMR) questionnaire with additional questions about the typicality and effectiveness of engaging in music for regulating basic emotions (happiness, sadness, anger, fear, tenderness). As regards emotion perception, a listening task was conducted in order to measure the congruency of recognizing basic emotions (happiness, sadness, anger, fear, tenderness) from 15 music excerpts (1min each), chosen to be characteristically representative of these emotions. Results showed clear differences between depressed and non-depressed individuals in musical emotion regulation: the non-depressed participants engaged significantly more often than the depressed participants in music for regulating happiness and distracting away from stress and worries towards mood improvement. They also found music more efficient in regulating positive emotions (happiness and tenderness). As regards emotion perception, the data analysis is currently under way and the results will be presented at the conference. Overall, the results will provide new information about the health-relevant aspects of musical emotion perception and emotion regulation. In particular, they will be discussed in relation to the symptomatology of depression.

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Regulation strategies and functions of personal music listening: The MuPsych application

William RANDALL
Monash University, Australia

Paper session

M103

14:30

REGULATION I

Theories of how personal music listening is utilised for self-regulation of affective state have been limited by a lack of empirical and ecologically valid data. To provide such data, a mobile application named MuPsych was developed, with the ability to gather real-time and ecologically valid measurements of personal music listening. The data collected by MuPsych were used for two studies, to provide empirical support for two theoretical aspects of the listening experience. The first of these investigated the frequency and regulation outcomes of specific reasons for listening to music. This provided support for previous theories in the music psychology literature, relating to reasons for listening, and the various functions music plays in everyday life. The second study investigated the frequency and efficacy of antecedent and response-based emotion regulation strategies, in relation to the Process Model of Emotion Regulation. Specific reference to this established model allowed for the comparison of music as a self-regulation device to other non-musical forms of regulation. Together, these two studies provide supporting evidence for previous theories, and help reveal how personal music listening is used for self-regulation in everyday life.

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Tuned In: A brief music emotion regulation intervention for young adults

Wednesday

Genevieve DINGLE[1], Carly FAY[2]

[1]University of Queensland, Australia; [2]Cancer Council QLD, Australia

Paper session

M103

15:00

REGULATION I

Emotion dysregulation underpins around half of all psychological disorders and is particularly evident in adolescents and young adults. Treatments for emotion dysregulation such as dialectical behavior therapy are intensive and there is a need for brief interventions that are engaging to young people. This study is a description and pilot evaluation of Tuned In, a brief music based emotion regulation intervention for young people. The four session program was piloted with a sample of 58 university students (67% female, mean age = 18 years) randomly assigned to Tuned In or wait-list control. Results of Mixed Analyses of Variance showed significant group by time interactions for emotional clarity and emotion regulation strategies. Repeated measures analyses showed significant improvements in emotional awareness, ability to name emotions, and ability to regulate emotions across the four weeks. Attendance rates and ratings of engagement were high. Tuned In shows promise as a brief emotion regulation intervention for young people.

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Are musical emotions natural kinds?

Tomasz SZUBART

Jagiellonian University, Institute of Philosophy, Department fo Cognitive Science, Poland

Paper session

A103

13:30

MODELS

The problem of definition of emotion has been recently widely discussed on the fields of psychology and philosophy of psychology. It seems inevitable, however, at least from the philosophy of science perspective, to specify whether emotions are natural kinds. Furthermore, as we are concerned with musical emotions, clarification whether musical emotions are natural kinds is necessary. Positive answer for the latter question may lead to further definitions of musical emotions; negative, however, cause several methodological problems in emotive aspects of music research. The aim of my paper is to refer basic philosophical approaches to the mentioned problem, and to critically analyze models, according to which musical emotions might be understood as natural kinds.

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Wednesday

Modeling moods in social media of music using semantic analysis and affect structures from emotion research

Paper session

A103

14:00

MODELS

Pasi SAARI, Tuomas EEROLA

Department of Music, University of Jyväskylä, Finland

Digital music consumption environments provide inimitable ways to explore links between music listening habits, semantic and acoustic contents of music, and ways these are expressed and used in social media. Past accounts of emotion modeling in music psychology research have relied on expert opinions and researcher-chosen musical examples limited to handful of examples. On the other hand, the field of Music Information Retrieval has utilized large-scale social media data for semantic computation of moods. Yet, past research on the modeling of emotion has not been appreciated appropriately in these approaches. This study aims at showing the advantage of applying the existing emotion models to semantic computation of moods, enabling utilization of large music collections. We first form low-dimensional spaces representing the similarity of several hundreds of mood terms based on tags collected from Lastfm social music service related to 1.3 million tracks. We then transform these spaces to optimize their resemblance to dimensional and categorical models of emotion. We validate our model with listener ratings of moods in 600 music tracks in several genres. Spearman's Rank Correlation is high ($r \approx 0.60$, $N = 600$) between the optimal mood space and listener ratings. As a contrast, modeling moods with our baseline method gives unreliable and significantly lower results ($0 \leq r \leq 0.60$). Results suggest that large social media data can be utilized to infer explicitly mood-related qualities of music tracks. As millions of tracks are available through these constantly expanding services, this study gives good prospects for future utilization of these data in mood and emotion research.

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Prediction of emotional expression in music using perceptual features

Paper session

A103

14:30

MODELS

Anders FRIBERG

KTH Royal Institute of Technology, Sweden

One of the primary research questions in music and emotions has been to estimate how different musical features contribute to the emotional expression. These features are either intuitively derived e.g. by composing different examples or by computer algorithms. In this study we are instead using features that are determined perceptually functioning as an intermediate step between the audio and the perceived emotional expression. The overall aim is to investigate if this is in a general sense a better model for describing musical features. Nine perceptual features (Speed, Rhythmic complexity, Harmonic complexity, Dynamics) were rated in two experiments containing either a set 100 polyphonic ringtones or 110 film music clips. The emotional expression in Exp.1 was rated using Energy and Valence and in Exp.2 eight different emotions were derived in a previous experiment. Each emotion rating was predicted using multiple correlation with all rated features as independent variables. The results indicate a rather high degree of overall explained variation. In Exp.1 the adj R2 = 0.93 and 0.87 for the two rated emotions. In Exp.2 the overall explained variation was somewhat lower. Overall the significant features corresponded well with previous studies. Furthermore, there was a difference in how the features were used in the two data sets. For the ring tones, the Speed was relatively more important while in the film music clips timbre and harmonic complexity were more salient. In conclusion, the results indicate that perceptually derived features provide an interesting method for describing and quantifying emotion communication in music.

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Strategies for continuous auditory display of arousal and valence

R. Michael WINTERS, Marcelo M. WANDERLEY
IDMIL, CIRMMT, McGill University, Canada

Wednesday

Paper session

A103

15:00

MODELS

Sonification is an interdisciplinary field of research broadly interested in the use of sound to convey information. A fundamental attribute of sound is its ability to evoke emotion, but for sonification, there has yet to be a dedicated investigation into the special case of conveying affective information. Affective computing, which has arisen in recent years to address the challenge of bestowing computers with “emotional intelligence,” requires affect display paradigms that are objective, meaningful, and ultimately successful in diverse contexts. Sonification finds application here, where it can be used when visual or verbal attention is already occupied, or provide a multimodal experience which can strengthen the desired percept. Although distinguishing itself from affective music generation systems, we argue that sonification needs to utilize its shared emotional ground with music if it seeks to create the most compelling models for affect display. This “shared emotional ground,” is properly defined as the mechanisms and elicitors of musical emotion, a rich field of contemporary music research. Recently, a compiled three-quarters of a century’s worth of empirical studies on musical emotion has identified tempo, loudness, timbre, sensory dissonance, and mode as among the strongest acoustic cues for emotion elicitation, leading to computational approaches to emotion recognition using these cues. We present a formalized system for continuous auditory display of arousal and valence relying exclusively upon these cues, and present evidence supporting our claim that a strategies based upon these cues will be the most useful in realworld contexts of affective computing.

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The mood organ

Tom COCHRANE
Department of Philosophy, University of Sheffield, United Kingdom

Paper session

H306

13:30

NEW TECH.

I will introduce a system that I have developed called ’the mood organ’. The system takes peripheral signals of emotion, and uses these signals to automatically generate music that is expressive of the emotional state of the user. Sensors are attached to the body measuring heart rate, skin conductance and muscle tension. A webcam is also used to track facial expression. These signals are then fed into the music programme MAX/MSP and translated into 3 overarching emotion dimensions: Valence, Power and Expectation. The translations between the physiological measures and the emotion dimensions have been inferred from the scientific literature. For example, raised heart rate variability has been correlated with positive emotions and so this measure contributes to the dimension of valence. The 3 emotion dimensions are then the locus of control over the musical variables of the system. For example, the dimension of valence is responsible for controlling the harmonic consonance of the music. Overall, there are several aims to this device: First it provides an intuitive way to combine the various patterns of activity that characterize our emotional states, allowing us to verify how these patterns are correlated with emotional states. Second it provides further confirmation of how musical variables combine in the expression of certain emotions. Third it provides a novel means of expressive communication and musical performance. Finally, I will discuss ways in which receiving feedback in musical form upon one’s current emotional state has a reciprocal impact on that emotion.

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Wednesday

Paper session

H303

14:00

NEW TECH.

ManyWorlds: A live action short film which edits itself in real-time based on audience emotional response

Alexis KIRKE, Duncan WILLIAMS, Eduardo MIRANDA

ICCMR, Plymouth University, United Kingdom

Many Worlds is a short live-action film about a physics experiment that should never have been performed, directed by Alexis Kirke, whose soundtrack and story arc are generated subconsciously by the cinema audience. Selected audience members have biological signals monitored by a computer that digitally splices together a coherent movie in real-time based on detected emotions and pre-filmed segments. It is not the first algorithmic film, recent examples include 'whiteonwhite: algorithmicnoir' at Sundance 2012. Nor is it the first interactive film. However unlike many previous algorithmic films 'Many Worlds' is a linear plotted live-action movie, not a surreal cut-up, or computer-generated abstract shapes. Also unlike previous interactive films, the audience will interact with the storyline in an unconscious way, and thus remain immersed in the film.

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Paper session

H306

14:30

NEW TECH.

Technology matters: An experimental exploration on how the spatial cues afforded by different audio playback devices shape the perceived emotional expression of mediatized music

Steffen LEPA[1], Hans-Joachim MAEMPEL[2], Elena UNGEHEUER[3], Stefan WEINZIERL[1]

[1]Audio Communication Group, Technische Universität Berlin, Germany; [2]Department III for Acoustics, Music Technology & IT, Staatliches Institut für Musikforschung Preußischer Kulturbesitz (SIMPK) Berlin, Germany; [3]Institute for Music Research, Julius-Maximilians-Universität Würzburg, Germany

Every single "playback" of a piece of music is a unique "performance", insofar as the media technology employed and the listening room conditions alter the morphology of the resulting ambient sound field at our ears. As demonstrated in numerous experiments by technical acoustics, these differences are at least noticeable. But do they really matter for the experience and enjoyment of music? And how do quality expectations towards certain technologies come into play? We initially focused on "spatiality" as a distinguishing technical parameter of audio technologies that might lead to a modified affective physiognomy of music. 306 subjects listened to the same four pieces of different genres. The original audio material had been manipulated by means of dynamic binaural synthesis technology into three differently spatialized versions: "headphones", "loudspeakers", and "concert hall". Each subject experienced only one of them and had to rate the perceived emotional expression after each piece and the overall audio quality at the end of the experiment. Additionally, half of the subjects were instructed to pay attention to "peculiarities in audio quality due to the special audio technology used". While this manipulation substantially increased perceived audio quality (regardless of spatialization type administered) it did not affect perceived emotions at all. Contrariwise, loudspeaker and concert hall simulations led to significant increases in intensity on all dimensions of perceived affective musical expression. Results are discussed in terms of limitations in possible interpretations and with regard to future prospects of virtual acoustics as a tool in music and media psychology.

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Wednesday

Integrating emotional data into music performance: Two audio environments for the emotional imaging composer

R. Michael WINTERS, Ian HATTWICK, Marcelo M. WANDERLEY
IDMIL, CIRMMT, McGill University, Canada

Paper session
D109
13:30
PHYSIOLOGY

Technologies capable of automatically sensing and recognizing emotion are becoming increasingly prevalent in music performance and compositional practice. When using these technologies, the primary questions are 1) How should the emotional data influence musical performance? and 2) What is the best technology for the performance context? This paper presents two implementations for performance using the Emotional Imaging Composer (EIC), a commercial product for emotion recognition being developed by Emotional Imaging Incorporated. Using a collection of physiological measures reflecting autonomic nervous system (ANS) function, the EIC identifies human affective states and creates continuous realtime arousal and valence measurements. By using signals from the ANS, the EIC becomes relatively difficult to consciously control or fake, adding unique constraints for performance. For this specific technology, two audio environments were created which reflect different approaches to the integration of emotional data into performance. In the first, a spectral delay processor for live vocal performance was created in Max/MSP. Using this processor, virtual acoustic environments occupy subspaces of the underlying arousal and valence space. Changes in the performer's emotional states continuously interpolates between these spaces. For the second, a SuperCollider patch was created to accurately communicate continuous arousal and valence measurements using tempo, loudness, decay, mode, and roughness. These choices were informed by empirical research on musical emotion, and created an intuitive, simple mapping that can be quickly understood by an audience and used as an emotionally salient sonic background.

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How and when I feel: Coordination of continuous emotional responses from a single subject

Finn UPHAM
New York University, USA

Paper session
D109
14:00
PHYSIOLOGY

Empirical research on emotional responses to music has traditionally gathered responses from many subjects with the goal of finding some predictable effects of the stimulus in the patterns of response common across listeners. But inferences from experiments using continuous responses, physiological or self-report, have been limited by great inter-response variability. An alternative is to look for consistency in responses from a single subject to repeated presentations of the same music. The author undertook a case study of her own emotional responses to music, recording simultaneously seven physiological measures and reporting 2D felt emotions during more than thirty hours of music listening. Twenty-five stimuli selected to range widely in musical genre, emotional expression, and familiarity, were heard in random order in each of the twenty-four sessions. Using activity analysis and summary statistics, the continuous ratings of felt emotion show high coordination, higher than usually measured in responses from different subjects to a piece of music, though there is still considerable variation to explain. Notes taken during the sessions and post experiment introspection point to specific causes for variation in the rating responses, from changes in interpretation of the performance to variation in empathy. The physiological responses also show notable consistency, capturing repeated extreme responses, such as crying, and more subtle behaviours such as synchronised breathing. Though generalizing from these results is limited by the particularities of the subject, this experimental paradigm offers a promising window onto music's ability to coordinates human responses, both cognitive and physiological.

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Wednesday

Correlations between acoustic features and psychophysiological responses to urban soundscapes

Paper session

D109

14:30

PHYSIOLOGY

PerMagnus LINDBORG

Nanyang Technological University, Singapore

That soundscape quality influences societal and individual health has been investigated in large projects, partly using physiological methods. An important aim of urban planning is to facilitate core affect regulation. The present paper reports correlations between acoustic features and psychophysiological responses. 17 healthy subjects, blindfolded and free to move in a large surround sound installation, were presented with a randomised sequence of 12 soundscapes, whose features in two dimensions, Sound Mass and Variability Focus, had been determined. Psychophysiological responses on 10 channels were recorded, together with birds-eye movement tracking. Detrended Fluctuation Analysis was applied to each response time series before extracting median and slope, then averaged across subjects for each stimulus. Preliminary results show significant regressions of Sound Mass with Skin Conductance (positive, p=0.064), with Temperature (negative, p=0.072), and with Heart Rate Variability (positive, p=0.072). Variability Focus weakly regressed onto Heart Rate (positive, p=0.096). Further results from ongoing analyses, pertaining to Respiration Rate and Blood Volume, as well as personality traits, will be reported at the conference. The results lend support to the assumption that stress markers are associated with soundscape quality. We argue that it is cost-beneficial for architects and city planners to increase access to green spaces, reduce residential area traffic, and ambient noise in schools and workplaces.

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Physically experienced reactions and music: A questionnaire study of musicians and non-musicians

Paper session

D109

15:00

PHYSIOLOGY

Roman MLEJNEK

Institute of Musicology, Faculty of Arts, Charles University Prague; Prague Conservatory, Czech Republic

Studying physically experienced reactions such as chills, tears and racing heart (sometimes generally referred to as thrills) represents an important approach to music and emotion. A questionnaire study methodologically based on Sloboda's influential article of 1991 partly confirms the results but disagrees with them in some findings. More frequent physical reactions during music listening in women reported by previous studies were confirmed only for respondents older than 30 in this study. In partial accordance with some of previous studies, more frequent physical reactions in professional musicians than in amateur musicians and non-musicians were found and goose-pimples and chills appeared to be the two most frequent reactions. Another study based on modified questionnaire was focused on musicians only and aimed at the difference between thrills experienced during listening to music and during music-making. The results show that for some musicians these two situations represent similar experiences (with regard to the reactions), while for most musicians the two situations are quite diverse. These results suggest that musicians' reports about chills and similar reactions may be influenced by their experience during performance. This contamination of questionnaire responses can be to a certain extent based on reactions connected to stage fright. The highly consistent frequency of occurrence of different examined reactions, and language nuances are discussed.

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The pleasant emotion of sad music

Ai KAWAKAMI[1], Kiyoshi FURUKAWA[1], Kazuo OKANOYA[2]

[1]Tokyo University of the Arts, Japan; [2]JST ERATO OKANOYA Emotional Information Project, Japan

Wednesday

Posters 2

M014

13:30

PREFERENCE

In general, sad music is thought to cause us to experience sadness, which is considered an unpleasant emotion. As a result, the question arises as to why we listen to sad music if it evokes sadness. We hypothesized that felt and perceived emotion may not actually coincide in this respect: sad music would be perceived as sad, but the experience of listening to sad music would evoke positive emotions. A total of 44 participants listened to musical excerpts and provided data on perceived and felt emotions by rating 62 descriptive words or phrases related to emotions on a scale that ranged from 0 (not at all) to 4 (very much). The results revealed that the sad music was perceived to be more tragic, whereas the actual experiences of the participants listening to the sad music induced them to feel more romantic, more blithe, and less tragic emotions than they actually perceived with respect to the same music. Thus, the participants experienced ambivalent emotions when they listened to the sad music. After considering the possible reasons that listeners were induced to experience emotional ambivalence by the sad music, we concluded that the formulation of a new model would be essential for examining the emotions induced by music and that this new model must entertain the possibility that what we experience when listening to music is vicarious emotion.

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Determining predictors and moderators of liking sad music

John HOGUE, Andrea CRIMMINS, Jeffrey KAHN

Illinois State University, USA

Posters 2

M014

13:30

PREFERENCE

Music therapy typically uses happy, preferred music during treatment, but Self-Verification Theory for depressed individuals states that they like stimuli that verify their negative self-views. It has been proposed that people with a negative affect and anxiety would like sad music. We extended this research by seeing if absorption, gender, depression, lassitude, and social anxiety predict liking sad music and if absorption and gender moderated depression, lassitude, and social anxiety's effects on liking. We hypothesized that everything would positively predict liking, and that absorption and gender would moderate depression, lassitude, and social anxiety's effect on liking. There were 488 people who took the complete Inventory of Depression and Anxiety Symptoms and the Absorption in Music Scale. We created a 3-item scale of liking sad music. Controlling for Absorption and gender, General Depression, Social Anxiety, and Lassitude positively predicted liking. Absorption also positively predicted liking, but gender did not. Absorption, General Depression, and gender significantly explained 48% of the variance. Only gender moderated the predictive effects of General Depression and Lassitude, but it did not moderate Social Anxiety. The depression-liking slope was near zero for women but was significant and positive for men. The 3- way interaction between gender, Absorption, and General Depression was nonsignificant. The results have implications for Self-Verification Theory and for using sad music in music therapy.

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Temporal stability of music preferences as an indicator of their underlying conditionings

Rafal LAWENDOWSKI
Institute of Psychology, University of Gdansk, Poland

Posters 2

M014

13:30

PREFERENCE

To emphasize the substantial impact of both cognitive and emotional processes on the development of music preferences, such definitions are formed which define preferences as a set of emotionalrational attitudes, which in turn affect the perception of a piece of music. It can be assumed that music preferences are dependent on the current situational and emotional aspects. Accepting this assumption, the absolute stability of the preferences of particular musical genres will be relatively low. As an alternative to the above reasoning, it can be assumed that the high temporal stability of the musical genres preferences may indicate deeper than, for instance, related to the current mood determinants of music preferences. The current study analyzed the temporal stability of musical preferences as measured with the Short Test of Music Preferences, which was tested within five months in a group of 88 people aged 20 to 58 years. Studies have shown that STOMP allows for a relatively stable measurement of music preferences in a period of 5 months. The analyzes revealed that the stability of the results of music preferences is high and constant. With the awareness of the limitations of the method to research the stability of results over time, you can assume with some caution that the high temporal stability of the music factors preferences may indicate deeper conditionings of music preferences than, for example, those connected to the current mood or situation.

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The presence, experience and influence of background music in gambling situations

Stephanie BRAMLEY, Nicola DIBBEN, Richard ROWE
The University of Sheffield, United Kingdom

Posters 2

M014

13:30

PREFERENCE

Background music influences risk-taking behaviours such as driving, drug-taking and gambling. However, research investigating music's effects on gambling behaviour has been limited to examining the influence of gambling-operator or experimenter-selected music on certain gambling activities (e.g. fruit machine and laboratory gambling behaviour). Potentially self-selected music may influence gambling behaviour however this has not yet been explored. Furthermore, the theorisation of which psychological mechanisms underlie music's influence on gambling remains speculative. This research examines the presence, experience and influence of both gambling-operator and self-selected music in a range of gambling situations. A mixed-methods approach was adopted and our poster presents the preliminary findings of three studies. In Study One we conducted semi-structured interviews with gambling-operators to obtain an insight into music's utilisation within casinos. A questionnaire was administered to gamblers for Study Two which revealed music's functions and the perceived influences of music on gambling behaviour. Study Three comprised a laboratory experiment designed to test whether arousal was responsible for music tempo's effect on betting speed in laboratory virtual roulette. This body of work furthers the knowledge of music's roles, functions, gamblers' responses to music and the psychological mechanisms which may underlie music's effects on gambling behaviour. To conclude we consider the implications of our research for gamblers, healthcare professionals and the gambling industry.

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The Aestetic-Art Model for the analysis of emotional and psychosomatic reactions to music

Anatoly ZHIRKOV[1], Olga ZHIRKOVA[2], Anna GOLUBEVA[3]

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Posters 2

M014

14:00

HEALTH & WELLBEING II

We used the original aesthetic-art model based on minimal energy consumption principle for the analysis of music perceptions among women with high and low blood pressure. 68 women aged from 19 to 58 years were investigated. Study design included psychological and psycho-physiological measurements before and after listening to music. After necessary ethic procedure including writing agreements, all women were examined by a physician and tested for emotion and beauty psychometrics by a psychologist. Every patient was exposed to music of classical and techno styles for 30 minutes. Blood pressure (BP) measurement and EEG were conducted during music listening. Second psychometric examination and discussion with a psychologist were organized after listening to music. The results revealed no relationship between music style preference and age. Older patients preferred techno music as often as younger ones. However, we found differences in music preferences related to the BP levels. Patients with low BP preferred techno music, while hypertensive patients preferred classic music. Distinction between low and high BP groups was made according to the ZhGS formulas for the determination of optimal BP. We found time coincidence in BP change, skin reaction, and realization of music beauty. After listening to music correlations between psychometric data, BP parameters, and simplification of EEG fractal dimension were found. We suggest that energy consumption principle and beauty understanding can be used to explain relationship between emotional and cognitive signs in the process music perception on the one hand and psychosomatic reactions on the other hand.

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Comparison of a music diary with CBT thought monitoring for mood regulation

Genevieve DINGLE, Hollie SHANNON

University of Queensland, Australia

Posters 2

M014

14:00

HEALTH & WELLBEING II

The aim of this study was to compare the effectiveness of a standard cognitive behaviour therapy thought monitoring homework task with a music diary homework task for mood regulation in young adults. Fifty-nine university students (Mage = 18.91 years) in the non-clinical range on mood symptoms were randomly assigned to complete weekly self-monitoring in the form of either a music diary or thought record for a one-month period. Participants were assessed at pre- and post-treatment on the Difficulties in Emotion Regulation Scale (DERS), Depression Anxiety Stress Scale (DASS-21) and Music Affective Response Scale (MARS), as well as weekly ratings on five key emotion variables (e.g., ability to name emotional states; confidence in managing strong emotions). Further, the effectiveness of the music diary and thought record in regulating the emotional states of participants was assessed via self-reported ratings of valence and arousal. Results showed that the music diary and thought record produced comparable improvements in the emotion regulation skills of participants and were equally effective in regulating emotional states. Repeated measures analyses showed that both groups improved on all five weekly ratings of emotion, with no differences observed between the two groups. Furthermore, participants rated the music diary as a more effective and engaging emotion regulation strategy than the thought record. In conclusion, the music diary is an effective and engaging alternative to CBT thought monitoring for mood regulation in young people that is ready for use in clinical settings.

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Wednesday

Posters 2

M014

14:00

HEALTH & WELLBEING II

Music Therapy Education at the IMC University of Applied Sciences Krems/Austria

Gerhard TUCEK, Patrick SIMON, Marlies SOBOTKA

IMC University of Applied Sciences, Austria

This presentation gives an insight into the clinical training approach and research focus at the IMC University of Applied Sciences Krems/Austria. The therapeutic concept follows the idea of biological and emotional regulation and it will be shown how this approach is integrated into the concept of the “Lower Austria Health and Social Fund”. This presentation follows music-therapy perspectives as well as social and cultural-anthropological views. The first part of the presentation gives a short report about the basic concepts of music therapy at the IMC – University of Applied Sciences in Krems with its Bachelor- and Master-program. Part two deals with the concept of action research and the stepwise integration of music therapy into the concept of the “Lower Austria Health and Social Fund” and its 27 associated clinics. In part three, video examples of clinical music therapy will be shown. The focus will lay on the psychosocial needs of the patients and how music therapy may respond to their individual needs, hopes and suffering. Examples of music therapy in an hematologic department and in neurologic rehabilitation after stroke will be shown.

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Posters 2

M014

14:00

HEALTH & WELLBEING II

The efficacy of music as therapy in effecting changes in persons with Cerebral Palsy

Gitashree MAJUMDAR[1], Sumanta THAKUR[1], Surangama DASGUPTA[2]

[1]Thakur’s Music And Movement Therapy Research Centre, India; [2]Bengal Music College, India

The present study was to create a communication medium through music with the cerebral palsy patients. An empirical evaluation revealed statistically significant changes in group behavior following the introduction of the programme. Five individuals (four males and one female) whose ages ranged from 15 to 20 years participated. All had received a clinical diagnosis of Cerebral Palsy (CP) by medical personal; the consequent degree of disability varied across the individuals. Indian music based on Ragas and Indian instrumentalism was used. In a 45 min session the problems of the individual was dealt, by using instruments like Tabla, Pakhwaj, Guitar, Tanpura, manjira and bells to restrict some motor movement which were abnormal. More specifically, there was a significant increase in observed target behaviors from pre- to post-intervention, with means of 0.75 and 7.72 respectively. This suggests a significant increase in the frequency of target behaviors for the group following the introduction of music as a therapy. The results of this research provide support for the efficacy of music therapy in bringing about significant changes in specific behaviors of persons with Cerebral Palsy. The therapist in the present study carefully matched the target behavior(s) of each individual with a central program theme (emotions, with an emphasis on happiness) and to specialized musical instruments to increase the likelihood of specific outcomes (i.e., behavior change) being achieved. That this approach was effective in changing a range of target behaviors (e.g., hand eye coordination, head movements, and torso position).

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How music and emotion affect the discourse in music therapy practice and supervision

Dora PSALTOPOULOU-KAMINI

Aristotle University of Thessaloniki, Greece

Posters 2

M014

14:00

HEALTH & WELLBEING II

Science has proven that positive emotions affect the neural, immune and endocrinal systems of the human being in positive ways, and negative emotions in negative ways. In music therapy clinical practice, evidence shows that when negative emotions are expressed, shared and sublimated, positive effects emerge in all areas for the individual. Thus in music therapy every emotion is of value and significance whereas, lack of emotions, positive or negative hinders the therapeutic process. The topic is analyzed based on Lacanian psychoanalytic thoughts about the four kinds of discourse concerning neurosis. The discourse of the hysteric, of the master, of the university, as well as of the analyst are illustrated through excerpts from case studies of music therapy clinical work and supervision. Music has taken its name from ancient Greek muses, goddesses of beauty and truth, and it is born from Medusa's cry. When the music therapist listens and responds appropriately to the phonic/aphonic cry of the human being in an interactive music therapy lingual relationship a fifth kind of discourse emerges for psychosis and/or autism, and it is called the FA-fonie (FA-voice). Thus music and emotion play an essential role in the music therapy process enabling the human being to come closer to his/her inner truth.

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Function of music through the lifespan

Lara HERMAN, Melissa JOURDAIN

Nova Southeastern University, USA

Posters 2

M014

14:00

HEALTH & WELLBEING II

According to Plato, "music is a moral law, it gives soul to the universe, wings to the mind, flight to the imagination, and charm and gaiety to life and to everything." As far back as history reaches, music has played an innumerable amount of roles in every individual's life. This analysis aims to look at the different functions that music takes throughout life. Starting in infancy and childhood, being active in music shows to enhance development. Those exposed at a young age tend to develop a more sophisticated level of communicating and social behavior. When progressing into adolescence and adulthood, music choices act as a revelation of personality functions. It serves as an expression of identity and plays a role of relating to others and fitting in or deviating from society. Music is used for self-regulation of mood and arousal, along with artistic and intellectual stimulation. Music choices can also highly correlate with other lifestyle choices. When it comes to older adulthood, music is still found to be a very important part of life. Older adults tend to be more social with others when music is present and report an increased satisfaction with life. Research has also shown it is beneficial with those experiencing cognitive decline as musical recognition and ability seems to hold steady. Music finds a way to touch people every day of their lives. Music is the reflection of the unique, individual qualities that makes up the core of who people are.

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Wednesday

Posters 2

M014

14:30

PERCEPTION

emoTouch for iPad: A new multitouch tool for real time emotion space research

Christoph LOUVEN, Carolin SCHOLLE
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Since Russel's 'Circumplex Model of Affect' multi- and especially two-dimensional models of emotion space have become the theoretical framework for many studies. So far, tools for real time investigation of the emotional reactions while listening to music had to use specific hardware-based interfaces, e.g. rotary controls or sliders (CRDI), computer mice (ESL, RTCRR) or joysticks (EMu-JOY). But the use of these interfaces had to be learned by unexperienced subjects before they could be applied, and the additional hardware always stood between the user and an intuitive expression of reactions in the emotion space. When Apple introduced the iPad in 2010 it's solely touch based user interface created a totally new, intuitive computer experience. It made additional tools like mice completely disappear and created the illusion of having direct access to the content without any barrier. Therefore the iPad also provides a perfect framework for research on music and emotion. We created a widely configurable touch based emotion space lab where the "invisible" interface gives the illusion of directly touching the emotion space itself. The tool records user reactions to music in one or two dimensions and provides adjustable dimensional scaling, graphical presentation, chill markers, and user feedback options. Multiple sessions on the same music may be replayed simultaneously along with a configurable average-session visualisation. Data may be exported in different sample rates and formats. The app for iPad and iPad mini will be available on Apple's App Store for free until mid-2013.

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Posters 2

M014

14:30

PERCEPTION

Perception of musical form in classical and progressive-rock pieces: Tension curves, open comments and memory measurements

Anat WAX-SHALOM, Rony Y. GRANOT
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Previous studies have shown that global structure has limited influence on subjects' ratings of coherence, emotional profile and musical flow. The current research examined the perception of musical global structure, while manipulating the influence of subjects' acquaintance with musical style. We used two musical pieces, one in an unfamiliar musical style (classic) and one in a more familiar musical style (progressive-rock). Both pieces are composed in a very different style, but share a similar musical form. We used the original pieces, and two new versions, which were created by reordering the musical segments of the original pieces into a global form inconsistent with tonal and tensional principles of the sonata form. Each of these 4 versions was presented to a different group of subjects, all with no or little musical training. Perception of structure was measured by analyzing open comments on the musical piece, continuous real-time measurements of tension, and by testing the subjects' memory for the piece. As opposed to previous research, tension test and open question results indicate that the structural intervention does affect subjects' perception: reordered pieces elicited longer and more contrastive descriptions, lower inter-subject correlations in tension ratings, and somewhat different tension curves as compared to the originals. In addition memory was better in the progressive-rock piece for the original as compared to the reordered piece. In contrast, explicit ratings such as ratings of coherence and flow as well as subjects' ability to categorize the pieces as original vs. recomposed did not reveal any significant effects.

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Perceived emotion of audio-visual stimuli with very short exposure time and their multi-modal interaction

Teruo YAMASAKI
Osaka Shoin Women's University, Japan

Posters 2

M014

14:30

PERCEPTION

This author's previous study on the perceived emotion of audio-visual stimuli showed that the effect of musical excerpts on the perceived emotion of paintings was larger than the effect of paintings on the perceived emotion of musical excerpts. This study investigated this asymmetry between musical effect and visual effect. The hypothesis is as follows. Music excerpts and paintings can be processed intentionally and non-intentionally. However, while music excerpts are processed more non-intentionally than intentionally, paintings are processed vice versa. Because the perceived emotion elicited by non-intentional process tends to be misattributed to other objects more easily, musical effect is larger than visual effect. In order to examine this hypothesis, experiment on the perceived emotion of audio-visual stimuli was conducted. In this experiment, participants were presented combination stimuli of music excerpts and paintings with very short exposure time (0.9s) and asked to evaluate musical excerpts or paintings individually. Because such a short exposure is not enough for intentional process, non-intentional process becomes to dominate instead of intentional process and consequently visual effect might be larger. To the contrary, size of musical effect will not change, because non-intentional process dominates originally over intentional process. As the result of this study, visual effect became larger and the asymmetry between musical effect and visual effect disappeared. The hypothesis is discussed on the basis of this result.

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Recognition of emotions in novel music excerpts in the early life

Lara PACHECO CUEVAS, María RUEDA EXTREMERA, Fernando CARVAJAL MOLINA
Universidad Autónoma de Madrid, Spain

Posters 2

M014

14:30

PERCEPTION

Research of emotion in music has endeavored to include a developmental perspective. However, cognitive development has been not always considered like a possible factor explicative or related in the development of the capacity of identifying and recognizing basic emotions in the music. The aim of the present study is to test if young children could recognize different emotions more than happysad in music. We explored the possible relationship between cognitive functions and recognition of emotional expressions in music. In 3 to 6 years old children (n = 25), we have assessed cognitive development, measured with MSCA (McCarthy Scales of Children's Abilities) and PPVT-III (Peabody Picture Vocabulary Test), and the accuracy in forced choice task of the recognition of emotional expressions and neutral category in 31 novelty musical pieces (9 happiness, 8 sadness, 6 fear, 3 anger, 5 neutral). Accuracy above chance was found in all different emotions, except anger. The emotion best recognized was happiness and sadness, followed for fear, and finally neutral category and anger. About association between cognitive variables and emotion recognition, PPVT score was related with the recognition of sadness, and general score in MSCA related with anger. These findings tell us that the children from 3 to 6 years old could label different emotions more than happy-sad dichotomical choice. The neuropsychological findings in this pilot study could point to regard in future research the cognitive development in the field of recognition of emotions in music.

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Wednesday

Posters 2

M014

14:30

PERCEPTION

Conveying emotion via musical scales: Perceived emotional connotations of the modes of the diatonic scale in musicians and non-musicians

Ian STRAEHLEY[1], Jeremy LOEBACH[2]

[1]Goldsmiths, University of London, United Kingdom; [2]St. Olaf College, USA

The present study examined the relationship between melodic structure and perceived emotion in the seven modes of the diatonic scale and the major-minor scale. Participants selected best fitting emotions from Plutchik's circumplex model of 24 emotions after hearing randomized and intervalically balanced melodies. Major melodies were most commonly associated with joy and serenity showing a significant correlation with mixolydian melodies. Phyrgian melodies were strongly associated with fear and apprehension. The remaining scales had distinct emotional profiles which were more variable. Emotional perception was strongly correlated between musicians and non-musicians for major, minor, locrian, and major-minor scales, while other scales showed strong non-significant correlations, suggesting that musical training does not influence perceived melodic emotion. In general, the emotions chosen most frequently for each scale were in line with historical accounts of emotional connotations of the diatonic modes. Implications for music composition are discussed as well as the possible effects of enculturation on emotional perception in music.

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Posters 2

M014

14:30

PERCEPTION

Cultural norms shape the structure of affects represented and induced by music: Two surveys in Finland

Tuomas EEROLA, Henna-Riikka PELTOLA

University of Jyväskylä, Finland

Recent studies have established the structure of affects induced by music. Since the structure of affects show differences in these studies, perhaps cultural norms or method of collection influence such structures. To explore the possibility that affect structure is influenced by cultural norms, two surveys of emotion terms were carried out in Finland, a country similar to Sweden yet distant to Switzerland in terms of individualism and affect balance. In Survey 1 (N=373), the appropriateness of 109 emotion terms was rated separately for emotions represented and induced by music. Survey 2 replicated Survey 1 with a shortened list of terms (68 terms) to a nationally representative sample (N=386). Relevant terms from the both datasets were subjected to factor analyses. In Survey 1, the emotions represented by music produced 8 factors, out of which three represented negative states (sorrow, anxiety, and rage) and the rest were variants of GEMS factors (tenderness, peacefulness, power, joy, and energy). For emotions induced by music, only one factor represented negative affects (sadness). In Survey 2, similar – albeit not identical – affect structures to Survey 1 were obtained, suggesting that the negative valuation of the perceived emotions in comparison to felt emotions is consistent in Finland. The results are discussed in terms of cultural affect valuation and affect balance, which may bring systematic and predictable differences to reported structures of affects in music.

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Mood congruency effects on expectation and attention in music perception

Renee TIMMERS

University of Sheffield, United Kingdom

Wednesday

Paper session

M103

16:00

EXPECT. I

From psychological literature, it is well known that mood and emotions may influence the way in which we attend to and process information. Facilitation of processing of mood congruent information is one type of influence. Given the prominence of affective responses to music, it is likely that similar influences of emotions on music processing can be observed. In this paper, the results of two studies will be presented that investigated mood congruency effects on expectation and attention in music perception. Depending on whether an association with happiness or sadness was evoked, participants expected the melodic sequences to continue upwards or downwards, with wide or narrow intervals, and participants attended more to the high pitched or low pitched stream of sequences consisting of alternating high and low notes. The presentation of results is followed by the discussion of a model of affect infusion in music perception, which is used to generate predictions and raise questions for further research. It is hoped that this will lead to a growing number of studies investigating interactions between emotion and cognition in music listening.

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Musical topics and the affective differentiation of surprise

Elizabeth Hellmuth MARGULIS

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Paper session

M103

16:30

EXPECT. I

Expectation has been held to be a primary generator of musical affect, yet the exact mechanics of this relationship remain unclear. The experience of listening to music does not seem merely like a series of smaller and larger surprises; quite the contrary – music can seem intense, expansive, gloomy, arousing, and any of a number of other adjectives. Surprise may lurk behind all of these diverse percepts, but how does it get registered phenomenologically in such various ways? This study looks to the theory of musical topics for a possible explanation. Listeners without formal musical training heard 8 excerpts of 18th century music, each of which represented one of 4 musical topics – siciliano, tempesta, singing style, or brilliant style. Each excerpt was heard in two versions – one normative, and one with a surprising general pause inserted before the cadence. Listeners used a dial to continuously rate a single expressive aspect of each excerpt as it progressed. On separate trials, they continuously rated each excerpt's tension, its playfulness, its ominousness, and its sublimity. Results demonstrate that the expressive inflection of the surprising event (the pause) depends on the topical context; the added pause elevates perceptions of tension, playfulness, ominousness, and sublimity only when placed in the appropriate context. Musical topics, in other words, can form a lens through which surprise is differentiated into distinct phenomenological experiences.

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Wednesday

Paper session

M103

17:00

EXPECT. I

Probabilistic models of expectation violation predict psycho-physiological emotional responses to live concert music

Hauke EGERMANN[1], Marcus PEARCE[2], Geraint WIGGINS[3], Stephen MCADAMS[4]

[1]Audio Communication Group; Technische Universität Berlin, Germany; [2]Centre for Digital Music & Research Centre in Psychology, Queen Mary, University of London, United Kingdom; [3]Centre for Digital Music, Queen Mary, University of London, United Kingdom; [4]CIRMMT, Schulich School of Music, McGill University, Canada

We present the results of a study testing the often-theorized role of musical expectations in inducing listeners' emotions in a live flute concert experiment with 50 participants. Using an audience response system developed for this purpose, we measured subjective experience and peripheral psychophysiological changes continuously. To confirm the existence of the link between expectation and emotion, we used a three-fold approach. (1) Based on an information-theoretic cognitive model, melodic pitch expectations are predicted by analyzing the musical stimuli used (six pieces of solo flute music). (2) A continuous rating scale was used by half of the audience to measure their experience of unexpectedness towards the music heard. (3) Emotional reactions were measured using a multi-component approach: subjective feeling (valence and arousal rated continuously by the other half of the audience members), expressive behavior (facial EMG) and peripheral arousal (the latter two being measured on all 50 participants). Results confirmed the predicted relationship between high-information-content musical events, the violation of musical expectations (in corresponding ratings) and emotional reactions (psychologically and physiologically). Musical structures leading to expectation reactions were manifested in emotional reactions at different emotion component levels (subjective experience and autonomic nervous system activations). These results emphasize the role of musical structure in emotion induction, leading to a further understanding of the frequently experienced emotional effects of music.

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Paper session

M103

17:30

EXPECT. I

Style-dependency of melodic expectation: Changing the rules in real time

Zuzana CENKEROVA[1], Richard PARNCUTT[2]

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Melodic expectation can be divided into two subsystems: bottom-up, which is learned and schema-based; and top-down, which is innate and operates on Gestalt principles, such as proximity, similarity and common fate. Similarly, a distinction can be made between innate and learned constraints governing the process of auditory stream analysis. It has been suggested that melodic expectations (including Gestalt principles) may be entirely learned by exposure to music and environmental sound patterns. For example, small melodic intervals tend to descend, while large intervals tend to ascend – an asymmetry that is also present in speech declination. If principles of melodic expectation are acquired, it should be possible to manipulate them – to condition listeners to alter their expectations. In Experiment 1, listeners heard short melodies (mainly diatonic, western classical, unfamiliar to listeners) in which the intervals between successive tones were either mainly large (>= 6 semitones) or mainly small (<6). The penultimate tone of the melody lay midway between the highest and lowest tones. The interval between that and the last tone was manipulated. Listeners rated the surprisingness of the last tone on a 7-point Likert scale. Listeners were more tolerant of large final intervals if the preceding melody had been dominated by large intervals. In Experiment 2, melodies were either consistent with the risingfalling step-leap asymmetry or consistently contradicted it. We hypothesize that listeners will be more tolerant of contradictions to this principle if the preceding melody contains such contradictions.

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Emotion ... a prison – Body, mind and music

Amelia GOLEMA

The Karol Lipinski Academy of Music in Wroclaw, Poland

Paper session

A103

16:00

THERAPY: METHODS I

This abstract is about the project directed to men just after prison (3 month max. after prison). Special project program is divided by three parts: 1. Selection of breath, voice and articulatory exercises. 2. Body relaxation based on Jacobson's training. 3. Making tasks – guided by music and the conversation about different emotion: from the past to the present. The main goals of this project are: – aggression decrease (the effect of body exercises and relaxation), – voice and breath exercises as a main help in case of looking for a new job (first contact with a potential employer), – making an attempt to "understand and accept myself" (conversation in a group or individually). Participants of this project are men with different sentences: murder, drugs, burglary. A part of them is after few or even 15 – 20 years in a prison, some of them have suspended sentence. Almost all of them have an alcohol or drug problems. This project accompanies a kind of re-socialization called "A social decompression method".

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Songwriting in adult psychiatry – Expressive songwriting as documentation of mental process

Helle Nystrup LUND

Aalborg University Hospital, Denmark

Paper session

A103

16:30

THERAPY: METHODS I

The development of an eclectic music therapy practise using songwriting methods as well as methods from CBT (Cognitive Behavioural Therapy) will be described. A short case presentation demonstrates how song writing in the style of rap is used in music therapy. The case example illustrates that explorative song writing processes and methods from cognitive therapy can be integrated in music therapy based on a psychodynamic orientation.

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Wednesday

Evaluation and anonymisation of video- and psycho-physiological data in music therapy

Gerhard TUCEK, Claudia WENZEL, Iris ZODERER

IMC University of Applied Sciences, Austria

Paper session

M103

17:00

THERAPY: METHODS I

Videography is an important tool not only for research but also for education in music therapy. An inherent problem with this evaluation method is the anonymisation of (clinical) data keeping in mind the demands for a policy of data privacy protection. This presentation gives an insight into methodological research challenges in videography and introduces an innovative computer based software tool which allows to anonymise video-data and combine it with psycho-physiological data which is relevant for music therapy research and education. The computer based software allows to analyse videos in such a way, that video data is not (only) translated into text-data (e.g. through coding), but can also be evaluated in a time course (”process evaluation”). This software can be used within different phases of the research process as well as for different purposes: As an instrument of analysis (working with terms, conceptualization), as an instrument of presentation (e.g. for presenting a critical incident within a therapy session) or as a transcript or matrix for (quantitative or qualitative) data. Also for education this software can be used for analysis of group processes or group analysis for certain video material. Furthermore the software allows to combine video-data with psycho-physiological data for evaluation. For purposes of presentation the video data can be omitted, so that there is no conflict with privacy of participants. This innovative software sets a new standard for evaluating and anonymising video-data and other relevant psycho-physiological data and opens up new prospects for music therapy research and education.

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Emotions and their presence during the study of piano piece within musical perception

Daniel BERNÁTEK

Palacký University Olomouc, Pedagogical Faculty, Department of Music Education, Czech Republic

Paper session

H306

16:00

PEDAGOGY

The paper deals with mental training in the area of piano playing. Special interest was given to the presence of emotions during the study of a piano composition, as well as the influence of emotions on the on-going mental representations during perception. Pupils and students in the age of 11 to 21 who had been studying playing the piano for 5 – 12 years participated in the qualitative survey. The methods used included observation and pedagogical experiment using substitution of variables. We assume that work away from the instrument is not merely a means of better stabilisation of memory, but also a means of deeper understanding of the works studied. The necessary prerequisites include developed internal hearing and mental representations, which lead the person to overcome the acoustic properties of the piano sound. The mental work on the studied composition leads to a number of deviations. These manifest themselves during the performance to create concepts impracticable on the piano that project into the auditory illusions. These effects comprise mainly of mental representations derived from singing and acoustic properties of the orchestra etc. The return to the sound of the piano becomes an effort of manipulating the sound in such a manner that it resembles the concept, which is necessarily reflected also by the emotional tension. This tension is based on the ”will for sound” also in connection to the temporal lag or delay between the active concept in its organisation and then finding an adequate way of expression through sound.

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Wednesday

Self-taught and schooled: Can they co-exist on the same stage?

Fulya CELIKEL[1], Kim BOWEN COLAKOGLU[2]

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Paper session

H306

16:30

PEDAGOGY

When the “classical”, “art” music traditions of the world are considered, it is unlikely to encounter a professional performer who has not undergone a lengthy, institutional training. For some of these traditions, it is considered impossible for the autodidact, no matter how talented, to prove himself/herself as an adequate performer. The stakes to attain concert artist level are ever higher and the performer must increasingly become a multifaceted, multitalented “world citizen”. However, in the domain of Western influenced popular music, the self-taught musician, sometimes even music-illiterate, still has a chance. These individuals have very different concepts of musical fundamentals and are often unable to communicate with schooled musicians who have assimilated the universal musical vocabulary during their training. This communication difficulty shows itself most clearly when advanced musicianship is required. This paper will focus on progressive metal, a genre that emphasizes virtuosity, complex structural, temporal and harmonic parameters. The genre is often considered the pinnacle of popular music, bordering art music. The significance from the research’s viewpoint is that it is possible to encounter performers of this genre, either thoroughly schooled or self-taught to boot. The paper presents a case study based on existing interviews of Dream Theater: the most representative band of progressive metal. The findings will be reinforced by an exclusive interview with Jordan Rudess, the band’s keyboardist who is an institutionally trained classical pianist. The main concern is to find out how much two opposing emotions, frustration and satisfaction become part of the band’s music making.

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The effects of utilizing a computer-based visual model to improve musical expression in piano performance

Priyeshni PEIRIS-PERERA[1], Amal Shehan PERERA[2]

[1]The University of Visual & Performing Arts, Sri Lanka; [2]University of Moratuwa, Sri Lanka, Sri Lanka

Paper session

H306

17:00

PEDAGOGY

Performance studies have shown that music teachers and students are often unaware of specific tools they could utilize to develop musical expression. To find concrete solutions to this problem, this paper based its groundwork on Patrick Juslin’s GERMS model. We developed a computer-based visual model, with the objective of testing its effectiveness as a tool to develop expression. The purpose of this study is to examine the effects of utilizing this “visual model” to develop expression in piano performance. Subjects are undergraduates enrolled in piano study in the Department of Western Music at the University of Visual and Performing Arts, Sri Lanka. Subjects briefly reviewed a piece, previously studied. After recording a play-through of the piece on digital pianos they rated the level of musical expression on selected sections that were likely to be played without expression on a scale of 1 to 5 (with 1 indicative of ”no expression” and 5 of ”Highest level of expression”) when performing each section. Approximately one week following, one group received instruction on the ”visual” to apply musical expression to the piece and recorded while the control group did not; instead they practiced and recorded a play-through of piece. Following this process, audio recordings are extracted, compiled, and randomly ordered on a CD. Five independent judges listened to the recordings of the piece and adjudicated each performance, taking into account performers’ musicality. Data collection is on-going and detailed results will be presented and discussed in light of current practices in music education.

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Wednesday

Listening to sad music: Adaptive and maladaptive mood regulation strategies

Sandra GARRIDO[1], Emery SCHUBERT[2]
[1]University of Western Australia; [2]University of New South Wales, Australia

Paper session

D109

16:00

REGUL. II

Despite the paradox inherent in the idea that sad music could make people happier, research indicates that an improved mood is amongst the primary motivations that people give for listening to sad music. However, it is not clear whether listeners are always able to achieve such aims. This presentation reports the results of three studies including two surveys and a series of in-depth interviews which indicate that not all listeners have rational motivations for choosing to listen to sad music. Results reveal that the majority of participants feel sadder after listening to sad music, at least in the short term. In addition, listeners with adaptive mood regulation habits such as 'Reflectiveness' may ultimately benefit from listening to sad music, while others with maladaptive mood regulation strategies such as 'Rumination' may find their mood worsening as a result of their listening choices. These findings have important implications for the individualisation of music therapy programs and for our understanding of the function of music in human society.

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Music-related nostalgic experiences of young migrants

Aida KHORSANDI, Suvi SAARIKALLIO
University of Jyväskylä, Finland

Paper session

D109

16:30

REGUL. II

Music is a powerful means for constructing identity – both formulating and remembering who one is – and migration can be seen as a particular situation creating challenges for this sense of identity. This qualitative study focused on investigating music-related nostalgic experiences of young migrants. The aim of the study was to identify features characteristic to music-related nostalgia particularly in relation to the experience of migration. Ten university students (Iranians currently living in migration) participated in the study. Data was collected through spoken interviews with an additional short questionnaire and a task to listen to self-selected nostalgic music. The interviews focused on the participants' current situation in the foreign country, their nostalgic experiences and the role of music in their nostalgic experiences. The data was analyzed qualitatively through the grounded theory approach. The results showed that the participants' nostalgic memories focused on their home country. The inclusion of music to nostalgic episodes appeared to intensify and stimulate the experience. The participants employed different strategic methods in utilization of music-related nostalgia: for counteracting loneliness, for bringing new perspectives into one's sense of self, finding meaning in life, and sympathy for one's feelings. Accordingly music seemed to play a triple role in nostalgic reverie; as a trigger, as a mean to recall and simulate the memory-related emotional state, and finally as a mood regulator tool. Furthermore, individual participants showed differences in their encounter style (avoidance or acceptance) towards nostalgic experiences. Preference for these encounter styles was influenced by the personal experiences and mood (including depression) of the participants.

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Wednesday

Musical play and emotional regulation

Antonia ZACHARIOU

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Paper session

D109

17:00

REGUL. II

This paper presents an innovative attempt to investigate self-regulatory behaviours in young children's musical play, and focuses on results in the area of emotional and motivational regulation. Musical play is one of the first manifestations of musicality, a fundamental aspect of human functioning, and is significantly related to emotional development. Different types of play appear to encourage self-regulatory development in children. Nevertheless, the relationship between musical play and self-regulation has been under-researched. The nature of this relationship was explored by the present study. A case study of one class was conducted, observing ten 6-year-old children engrossed in musical play sessions in a Cypriot elementary classroom. A mixed-methods approach was adopted and both qualitative and quantitative data were collected. Children's musical play was video-recorded and the self-regulatory behaviours apparent during it were identified and coded on the basis of a validated coding framework. Data on the children's general self-regulation were also collected, through an observational checklist completed by the music teacher. The results indicated that in musical play 20% of the total self-regulatory behaviours involved emotional/motivational regulation (of which 72% involved emotional/motivational monitoring and 28% emotional/motivational control). The subsequent analysis showed that even though all other aspects of children's self-regulatory behaviour during musical play were highly and significantly correlated with children's general self-regulation, the children's emotional/motivational regulation behaviours during musical play were not. This suggests that musical play might have a particular role to play in emotional regulation. Further qualitative investigation, providing useful insights into this finding, will also be discussed.

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Using music to reduce stress: The mediating role of emotion regulation

TanChyuan CHIN[1], Nikki RICKARD[2]

[1]University of Melbourne; Monash University, Australia; [2]Monash University, Australia

Paper session

D109

17:30

REGUL. II

The mediating effects of emotion regulation (reappraisal and suppression) were examined in the relationship between music use and stress. Emotion regulation strategies (Emotion Regulation Questionnaire), styles of music engagement (Music Use questionnaire) and stress (Depression Anxiety Stress Scale 21) were assessed in a large diverse sample of 637 (144 male, 493 female) participants, between the ages of 20 and 58 (M = 23.93, SD = 5.82). Results demonstrated that the path of mediation was dependent on the type of emotion regulation strategy utilized, as well as the way in which one engages with music. Findings provide initial evidence that engaging with music for the purposes of cognitive and emotion regulation may lower stress levels primarily through the habitual use of cognitive reappraisal. Dance also reduced stress, through indirect-only mediation by expressive suppression. In contrast, two styles of music engagement (engaged production and social connection) if coupled with a tendency to regulate emotions and thoughts by expressive suppression may heighten, rather than reduce, stress levels. This study highlights the importance of raising awareness of the role of emotion regulation, when using music to regulate stress.

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Wednesday

Workshop

M014

16:00

RepoVizz

repoVizz: Store, browse, annotate, and share multi-modal data online

Oscar MAYOR, Panos PAPIOTIS
Universitat Pompeu Fabra, Spain

Multi-modal data stream acquisition and analysis constitute a major pursuit in much of today's data-driven scientific research. The lack of common formats and structured storage tools for heterogeneous data forces researchers to use ad-hoc formatting schemes and software tools developed "in house". Despite the obvious potential offered by collaborative, exchange-driven research, difficulties often found for sharing or browsing data sets (sometimes of large size) are, as of today, impeding research collaboration and cross-fertilization.

repoVizz is an integrated solution for structured formatting and storage, browsing, sharing, annotation, and visualization of sycnchronous multi-modal time-aligned data. repoVizz offers means for organizing heterogeneous data (different modalities, sample rates, etc.) through a totally customizable tree structure that holds identifiers, descriptions, and pointers to data files. Most of operations on datasets are carried out on-line through a powerful HTML5 visual interface that allows working on a browser. This feature, which can be considered a key aspect of repoVizz, represents a step forward because data can be explored, annotated, or downloaded from any location and with no software requirements other than a browser.

This short, hands-on tutorial will provide participants with an in-depth overview of repoVizz. First, participants will be given an introductory presentation of repoVizz. Then, participants will be guided through the steps required to create a dataset including audio, video, and motion capture time-aligned data. Participants will upload their datasets to the repoVizz server, explore them online, and experiment with the repoVizz online visualizer. Following, participants will exchange and edit datasets and annotations. Finally, participants will download segments of time-aligned data to their computers. Although data to be used through the tutorial will be provided by the repoVizz team in standard formats (audio, video, and CSV files), support will be offered to participants who are willing to try repoVizz with their own data.

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Does extramusical information contribute to emotions induced by music?

Jonna VUOSKOSKI[1], Tuomas EEROLA[2]
[1]University of Oxford, United Kingdom; [2]University of Jyväskylä, Finland

Paper session

M103

09:00

CONTEXT-DEPENDENCY

Music-induced emotions are not generated in a vacuum. Yet, little is known about how extramusical factors such as contextual information influence the emotion-elicitation process. The present study investigated this question by providing two groups of participants (both n = 30) with two different descriptions regarding the original context of a sad-sounding piece of film music (duration 8.5 minutes); a description of a concentration camp scene, or a description of a nature documentary. The induced emotions were measured as objectively as possible using indirect memory and judgment tasks. In the end of the experiment, the participants were asked to describe the kinds of thoughts and impressions they had during the music listening. The results of the two groups were compared to previously collected data (n = 60), where participants listened to either the same, sad-sounding piece of music without any extramusical information, or to neutral-sounding music. The results suggest that contextual information about a musical piece may indeed influence the emotional effects of that piece. The sad description appeared to intensify the sadness induced by the sad-sounding piece, as the participants in this group displayed a significant memory bias in the word recall task. The descriptions may have enhanced emotion induction via the visual imagery mechanism, as 80 % of the participants in both groups reported thinking about imagery related to the descriptions provided. This finding could be interpreted as giving support to the notion that music-induced imagery may emerge from a narrative mode of listening.

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Emotions induced by music: The role of the listening context and modality of presentation

Eduardo COUTINHO, Klaus SCHERER
Swiss Center for Affective Sciences, Switzerland

Paper session

M103

09.30

CONTEXT-DEPENDENCY

Scherer and Zentner previously identified a series of production rules that underlie the emotion induction through music, arguing that there is an interaction between a multitude of factors in the production of an emotional experience. In particular, they discuss how performance (e.g., physical appearance, expression, interpretative skills), listener (e.g., musical expertise, personality, mood), and context (e.g., location and event) features can modulate such experiences. The study reported here investigates in more detail the impact of the location (contextual factor), and the effect of seeing the performers (performance factors) on the emotional experiences of listeners. The method consisted of quantifying the emotional responses of listeners, in four different conditions, using a short version of the GEMS (Geneva Emotional Music Scale). The first group attended to a live performance by Christophe Pergardién (tenor) and Michael Gees (pianist). A second group attended to an audiovisual recording of the same performance in a classroom at the University of Geneva. The third and fourth groups listened the audio-only version and saw the video of the concert (without audio), respectively. Our results show that both context and modality of presentation have a significant impact in the emotions induced in listeners, as well as in the consistency of those experiences, providing important evidence about the modulatory role of contextual and performance factors in emotional experiences with music. Our results have implications to the understanding of musically induced emotions as well as for empirical methodologies in the area of music and emotion.

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Paper session

M103

10:00

CONTEXT-DEPENDENCY

Is cheerful music pleasant? Not always. Assessment of psycho-physiological effects of the listening to the cheerful music

Sergii TUKAIEV, Igor ZIMA

National Taras Shevchenko University of Kyiv, Ukraine

According to numerous evidences, music has a beneficial effect on the functional state of the human brain. But under different circumstances the same piece of music can be either a pleasant or an unpleasant stimulus. The aim of the study was to investigate the dynamics of changes of psychophysiological parameters under listening to cheerful music.43 healthy volunteers-students aged 17 to 22 years participated in this study. They were offered a 74 sec.-long excerpt of a humorous rhyme, composed by M. Dunaevsky, from the cartoon ”Flying Ship”. We used the following tests: WAM (Wellbeing, Activity, Mood), State Anxiety Inventory, the test “Acute mental fatigue” and the Syndrome of Emotional Burnout test. EEG was registered over a period of 3 minutes during the rest state, 74 sec during listening to the music, and 3 minutes of aftereffect. We estimated the spectral power density (SPD) of all frequencies from 0.2 to 35 Hz. 29 of participants perceived the excerpt to be pleasant, 14– to be unpleasant. The results of psychological tests demonstrated that participants who assessed the excerpt as an unpleasant piece of music had a higher level of burnout, and more significant changes state anxiety, acute mental fatigue, well-being and mood in comparison to those who assessed it as pleasant. In the latter group, we observed depression of the theta1-, theta2-, alpha1-, alpha2-subbands that indicated a decrease in psychic tension. Among those who assessed the excerpt as unpleasant we detected also the increase of SPD in alpha3-subband,which indicated a higher level of nonspecific activation. Thus, we established the determinants that influence a distinct emotional response to the music.

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Paper session

A103

09:00

BEHAVIOUR

Development of a measure of self-regulated performance behavior in skilled musicians

Marcos ARAÚJO

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This study aims to report a pilot of a new instrument for measuring the self-regulatory behaviors of skilled musicians during performance processes. This new instrument aims to contribute by clarifying (i) the main factors of self-regulation in the music performance domain; (ii) co-relations between these factors; and (iii) frequencies and intensity of self-regulatory behaviors during the performance processes. Undergraduate and graduate students from a Portuguese university served as participants of this study (N=30), and were characterized according to their sex, age, instrument, expertise level, and practice routines. The questionnaire content was designed based on reviews of the general literature about self-regulation and the individual performance behavior of expert musicians. For each assessed element of the questionnaire, musicians indicated responses on two Likert-type scales, one for frequency (1. never to 5. always), and the other for agreement (1. completely disagree to 7. completely agree). Results were assessed through statistical analysis with SPSS software. Preliminary results' analysis has indicated that this new instrument is reliable and has internal consistency. The results suggest that the self-regulatory performance behaviors of skilled musicians vary according to the participants' attributions, namely level of expertise and performance strategies. As the selfregulatory factors of the questionnaire were delineated from the general literature of psychology and expert musical practice, results are different in some categories from those reported by studies with students. As a pilot study, we also expect the need for some adjustments for future applications.

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Thursday

Effects of background music on the impression of partners in conversation

Sumi SHIGENO

Aoyama Gakuin University, Japan

Paper session

A103

09:30

BEHAVIOUR

The purpose of the current research is to explore whether background music move our feelings to be favorable for the other person of opposite sex. Thirty-two young people in their teens and twenties (16 males and 16 females) participated in the experiment. They were divided into two conditions, one of which was called “with-music condition,” where background music was presented during the 20-minute-conversation, and the other which was called “no-music condition,” where no background music was presented during the conversation. Another four young undergraduate students were selected as targets, whose impression was rated by the participants, who are opposite sex to the targets, before and after the conversation. The targets were instructed to make the conversation getting on amicably. In the conversation session, a small group was made, where four participants (2 males and 2 females) and two targets (one male and one female) talked freely on various topics. The results show that the targets in the “with-music condition” got overall higher scores in the post-test than those in the pre-test, while those in the “no-music condition” got higher and lower scores in some rating items. The present results suggest that music should work on our feelings directly and let you feel goodwill for the opposite sex.

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The effect of music listening on assignment anxiety and urge to procrastinate

Hollie SHANNON[1], Genevieve DINGLE[2], Eric VANMAN[1]

[1]School of Psychology, Australia; [2]University of Queensland, Australia

Paper session

A103

10:00

BEHAVIOUR

The aim of this study was to examine the effect of self-selected music listening on university students’ arousal, valence, and urge to procrastinate in a simulated assignment writing session. Sixty university students (Mage = 18.61 years) in the non-clinical range on mood symptoms were randomly assigned to one of three experimental conditions: music before, music during, or no music. Participants in the music conditions listened to self-selected music either before or while writing an assignment plan, while the no music condition completed the task in silence. Emotional arousal was measured with both physiological (i.e., skin conductance) and self-report measures. Results of mixed analyses of variance showed that participants’ arousal ratings started decreasing when they listened to music (in comparison with the no music condition). Additionally, there was a trend in the data which suggested that participants’ valence ratings started improving when they listened to music, however, this between conditions effect failed to reach significance. Music listening was found to have no effect on participants’ urge to procrastinate. Finally, there was a significant interaction between condition and time such that participants in the music before condition reported significantly reduced arousal in the anticipatory phase of the assignment task (i.e., when they listened to their self-selected music), whereas participants in the music during and no music conditions continued to report elevated arousal at this time. This supports the conceptualization of assignment anxiety as an anticipatory phenomenon.

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Thursday

Paper session

H306

09:30

IDENTITY

Active ageing: The symbiosis of music and health in third age relationships

Jill MORGAN[1], Raymond MACDONALD[1], Stephanie PITTS[2]

[1]University of Edinburgh, United Kingdom; [2]University of Sheffield, United Kingdom

Varied academic accounts exist of the emotional responses experienced through engagement with music whereby people can share emotions, intentions and meanings. However research has shown that there has been less focus on the older members of society. With over twelve million people in the UK over the age of sixty, there is a need for research into the value of music and its impact on marital relationships in retirement, with particular relevance to 'future selves' and positive ageing. This cross-disciplinary study examines the role of music in the maintenance of healthy relationships within marriage in retirement. Using Interpretative Phenomenological Analysis many facets are considered, such as listening habits, age related health issues, 'matched' musical preferences, identity, nostalgia, emotion and retirement behaviours. The main body of the investigation centres around five strategically sampled couples who offer meaningful perspectives on the phenomenon being investigated. In-depth semi-structured interviews were conducted individually with each participant; data was then recorded and analysed. Preliminary findings suggest the utilisation of music as an instrument for joint identity and as a future leisure tool when health and mobility issues become problematic. Conclusions will be drawn from the full results and discussed within the wider context of music and health research.

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Paper session

H306

10:00

IDENTITY

The effect of therapeutic songwriting on flow, identity, achievement and ownership in university students and retirees

Felicity BAKER[1], Raymond MACDONALD[2]

[1]The University of Melbourne, Australia; [2]University of Edinburgh, United Kingdom

Popular songwriters are renowned for talking about being in flow when they create their best works. Music therapists utilize songwriting as a therapeutic tool to address treatment, prevention and health promotion aims with a range of people, most of which are non-musicians. Yet we know relatively little about flow experiences in this context. A within-subjects study of non-music major university students and retirees aimed to measure the extent of flow, sense of self, achievement, identity, satisfaction and ownership experienced during the creation of personally meaningful songs. Twenty-six participants randomised into 3 groups created 3 artifacts (lyrics only, song parody, original song) each facilitated by a trained music therapist. Flow experiences during song creation were strong, and when compared with previous studies, were substantially higher than for sporting activities, dancing, yoga and performing music. Original songwriting yielded more meaningful songs when compared with lyric writing and song parody. We determined that there was a significant predictive relationship between the degree of flow experienced and the meaningfulness of the song creation. We conclude that song creation experiences generate high levels of flow in young and old participants and the degree of flow achieved predicts how meaningful the artifacts will be post creation.

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Affective structural coupling and situated affectivity in complex musical emotions

Thursday

Christoph SEIBERT, Thomas A. TROGE

IMWI Institute for Musicology and Music Informatics, University of Music Karlsruhe, Germany

Paper session

D109

09:30

AESTHETICS

Musical emotions do not seem to fit in classical explanatory models of the cognitivist tradition. Therefore, beyond appraisal-theories, different ways in which music may arouse emotions and possible underlying mechanisms have been conceptualized within philosophical and psychological considerations. Based on the notion that those different ways of emotion induction may operate simultaneously but are not 'rectified' (i.e. sometimes cumulative, sometimes divergent), musical emotions can be conceptualized as a complex of bio-psycho-social interactions, that is as polyintentional complex musical emotions. Therefore a proper investigation of complex musical emotions requires an appropriate concept of music that is able to take the biological, psychic and social conditions of music and by this its multiple affective potential into account. From this point of view a corresponding concept of music as a metasystem constituted by organic, psychic, and social systems is unfolded. Feelings, affective (neuro)physiological changes, and affective communication may be conceptualized as affective states based on changes of condensed structures of these systems. In this context, different types of musical feelings can be examined in reference to their affective intentionality and situated in a dynamic affective continuum. Since an affective state of a system can unfold its affective potential in a mutual relation to other systems only—which is conceptualized as affective structural coupling—this approach can be examined in relation to those subsumed under the term 'situated affectivity'. This theoretical framework offers the possibility to combine a holistic perspective with analytic depth and is suitable for transdisciplinary approaches.

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Friedrich von Hausegger's aesthetics of musical expression

Elisabeth KAPPEL

University of Music and Performing Arts Graz, Austria

Paper session

D109

10:00

AESTHETICS

Friedrich von Hausegger (1837–1899), an Austrian music critic, in 1885 published his treatise "Musik als Ausdruck" ("Music as Expression"). The position Hausegger argues for significantly differs from the musical aesthetics prevailing in Austria and Germany at the time. While champions of the latter tended to consider music to be a product of "pure mind", Hausegger on the contrary saw music as a fundamentally bodily phenomenon. In his view, the elements of music have developed from forms of expression of living beings; thus musical expression is related to physical states. In a further move, Hausegger joins expression to communication. He construes the aesthetics of production, performance, and reception as interacting: Building upon Darwin's approach that humans are able to recognize expressive behaviour innately, he argues that performers and listeners, by way of empathy, can perceive and even experience the emotions intended by the composer. Artistic creativity, then, consists in the ability to utilize means of art in a way that they may be understood as expression and can transfer emotions to others. Musical expression, on Hausegger's account, is relational in two respects: first as the relationship between the (emotional) inside and the (bodily) outside, secondly as the relation between embodiment of expression and their perception by (bodily and emotional) empathy. My paper is meant to introduce to Hausegger's historical but nevertheless highly topical understanding of the relation between music and expression and also demonstrates in which way composers such as Mozart conform to his idea of representing emotions in music.

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Specific emotional reactions to tonal music – Indication of the adaptive character of tonality recognition

Paper session

M014

09:00

EXPECT. II

Piotr PODLIPNIAK

Department of Musicology Adam Mickiewicz University Poznan, Poland

People report that specific emotional reactions accompany the perception of tonal relations during listening to tonal music. These reactions are not restricted only to people living in the Western culture. Different types of tonality which are observed in all musical cultures seem to evoke similarly strong emotional reactions. The emotional response to a tonal sound sequence has been predominantly explained by fulfilling or not the pitch-related expectations of listeners. However, although this model indicates the general mechanism of prediction as the main source of an emotional reaction, it does not explain why the musical pitch-related expectation causes a stronger emotional reaction than other sound stimuli such as speech. Thus, an adaptive character of a general mechanism of expectation cannot explain specific emotional reactions in response to tonal stimuli. Because a strong emotional reaction accompanying a specific behavior is usually an indicator of the adaptive value of this behavior, it is suggested that the ability of tonality recognition has to possess an adaptive character. This view is supported by the fact that tonal music is still the most popular music in the world, although atonal music has been intensively promoted for almost one hundred years. The origin of the ability to recognize tonal hierarchies could be related to the social character of tonal music performance observed among primitive cultures. A better memory for tonal than atonal sequences suggests additionally that the emergence of tonality could have been gradual and based on genetic assimilation.

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Music induced emotions: Expectancy vs. contagion

Paper session

M014

09:30

EXPECT. II

Kari KALLINEN

Aalto University, Finland

Even though the mechanisms related to the relationship between music and emotions have had widespread attention and understanding recently, there is a lack of empirical research on different theoretical approaches. The present study investigated the effects of structural features of classical music melodies related to musical expectancy (appoggiatura, subito piano) and contagion (minor and major modality, fast and slow tempo, legato and staccato phrasing) to emotional responses (valence, arousal and liking). The results suggest that in general emotional contagion have more significant role in eliciting differences in valence, arousal and liking, whereas violation of expectancy may have moderating effects to emotional responses especially among people more familiar with the genre of classical music.

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Thursday

Paper session

M014

10:00

EXPECT. II

The effects of veridical repetition and stylistic familiarity on musical expectation and preference

Kathleen AGRES, Kathryn CASEY, Jeremy GOW, Marcus PEARCE

Queen Mary, University of London, United Kingdom

Research suggests that an inverted-U shaped curve relates subjective complexity and liking, where medium-complexity music is optimally liked. As music becomes familiar, perceived complexity decreases, shifting the liking curve. However, little research explores how expectations and preferences change with repeated exposure to the same exemplars (veridical repetition) compared with different exemplars (stylistic familiarity) from a novel musical style. This project investigated these questions using stylistically unfamiliar stimuli varying in complexity. In a preliminary study, participants provided ratings of subjective complexity for unfamiliar Turkish makam melodies. The main study used these melodies (classified as Simple or Complex) to examine expectations and preference with increasing exposure. In the Veridical Familiarity condition, participants repeatedly heard one set of Turkish melodies (half Simple, half Complex). In the Stylistic Familiarity condition, listeners heard different sets of melodies (half Simple, half Complex). Each melody was rated for Liking, and Expectedness ratings were collected for one probe tone per melody. A computational model of auditory expectation was used to classify the information content (IC) of each probe tone, reflecting the predictability of that tone in context. Our results provide the first evidence that IC accurately predicts listeners' expectations of culturally unfamiliar music. Although Expectedness depended on IC, this effect was mediated by the complexity of the melodic context. Differences between Stylistic and Veridical conditions also emerged; stylistic knowledge produced greater impact of IC on listeners' Expectedness. Finally, Complexity impacted Liking such that more complex melodies were preferred.

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Keynote 3

M103

11:00

Isomorphic emotion expression in music, song, and speech

Klaus SCHERER

Swiss Centre for Affective Sciences, Switzerland

In the literature, one finds frequent reference to similarities between the emotional expression patterns in vocal and instrumental music on the one hand, and in speech on the other. Reviews of empirical studies in both the music and speech domains have supported these early suggestions. This presentation will report recent empirical results from collaborative work on emotional expression in speaking and singing (based on enacted emotions by professional actors and world-class singers) that tends to strongly confirm this isomorphism. In particular, results on the acoustic parameter profiles of enacted emotion portrayals will be analysed with respect to underlying production mechanisms (push effects). Going beyond the data, I will present a hypothetical account for the potential origin of the underlying mechanism, suggesting that phylogenetically continuous, multimodal affect bursts may have been the precursors of a parallel evolutionary development of singing, speech, and music (including a discussion of socio-cultural pull effects).

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Thursday

Paper session

M103

13:30

eMOTION

Emotions in motion: Dance Movement Therapy in the treatment of depression

Marko PUNKANEN[1], Geoff LUCK[2], Suvi SAARIKALLIO[2]

[1]Nyanssi Therapy Centre, Finland; [2]Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland

Depression is a highly prevalent mood disorder, which impairs a person's social skills and quality of life. It is a disabling medical illness characterised by persistent and all-encompassing feelings of sadness, loss of interest or pleasure in normally enjoyable activities, and low self-esteem. Depressed patients have been shown to have difficulty in identifying, expressing, and regulating emotions, especially negative emotions, such as anger. Here, we present the study, which investigates body and movement based therapy intervention in the treatment of depression. Central to this study is the use of a group form Dance Movement Therapy (DMT) intervention. Dance Movement therapy is a psychotherapeutic use of body awareness, movement and dance founded on principle of motion and emotion being inextricably entwined. It is a form of psychotherapy in which creative use of movement and dance plays a fundamental role within the therapeutic alliance. The main research question was that could short-term DMT intervention decrease symptoms of depression and anxiety? Depressed participants (n=21, aged 18-60 years), received 20 sessions of group DMT, and measurements, including psychometric questionnaires (depression, anxiety, alexithymia, emotion regulation, life satisfaction, personality and mood) were taken before and after the intervention. The results of this study will be reported in our presentation at the Conference.

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Paper session

M103

14:00

eMOTION

Movement analysis of depressed and non-depressed persons expressing emotions through spontaneous movement to music

Outi LEINONEN[1], Geoff LUCK[2], Suvi SAARIKALLIO[2], Marko PUNKANEN[3]

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Emotional skills are central to mental well-being, and individuals suffering from even mild forms of mental illness often demonstrate impairments in their emotional functioning. Clinically depressed individuals, for example, tend to suffer from diminished emotion recognition and expression abilities, while non-depressed individuals are able to express emotions, moods and emotional states both consciously and subconsciously, even through bodily movement alone. Here, we investigate how depression affects expression of emotions perceived in music through spontaneous movement. Twenty-five clinically depressed individuals and 25 non-depressed controls aged 18-60 were presented with 15 short (1 min) music excerpts. Each excerpt represented one of five basic emotions (happiness, sadness, anger, fear and tenderness), and participants were asked to express the emotion they perceived through spontaneous movement. Movement data was collected using a motion-capture system which tracked 30 body-mounted markers at 120 fps. After each excerpt, participants were asked several qualitative questions, such as which emotion they perceived in the music, and how strongly they felt it. Data collection is complete, and data processing and analysis underway. Five movement features, including speed, acceleration, jerk, distance between hands, and use of space, will be computationally extracted from the movement data and analyzed statistically. Relationships between these features and participants' clinical state will be examined, and comparisons made between movement characteristics of the depressed participants and those of the controls. We expect depression to manifest in slow and jerky movement, poor use of space and closed posture. Detailed results will be presented at the conference.

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Thursday

Oh happy dance: Emotion recognition in dance movements

Birgitta BURGER, Marc R. THOMPSON, Suvi SAARIKALLIO, Geoff LUCK, Petri TOIVIAINEN

Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland

Paper session

M103

14:30

eMOTION

Movements are capable of conveying emotions, as shown for instance in studies on both non-verbal gestures and music-specific movements performed by instrumentalists or professional dancers. Since dancing/moving to music is a common human activity, this study aims at investigating whether quasispontaneous music-induced movements of non-professional dancers can convey emotional qualities as well. From a movement data pool of 60 individuals dancing to 30 musical stimuli, the performances of four dancers that moved most notably, and four stimuli representing happiness, anger, sadness, and tenderness were chosen to create a set of stimuli containing the four audio excerpts, 16 video excerpts (without audio), and 64 audio-video excerpts (16 congruent music-movement combination and 48 incongruent combinations). Subsequently, 80 participants were asked to rate the emotional content perceived in the excerpts according to happiness, anger, sadness, and tenderness. The results showed that target emotions could be perceived in all conditions, although systematic mismatches occurred, especially with examples related to tenderness. The audio-only condition was most effective in conveying emotions, followed by the audio-video condition. Furthermore in the audio-video condition, the auditory modality dominated the visual modality, though the two modalities appeared additive and self-similar.

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The arts as the mirror of the self: Music-movement-drama interconnection: Eliciting and revealing emotions lead to awakening-awareness-anamorphosis of the self

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Paper session

M103

15:00

eMOTION

Music, dance and drama took their names after the ancient Greek muses, goddesses of beauty and truth. Creativity is born through the perpetual struggle among life and death. One form of art elicits another form of art and when an emotion is expressed, experienced and shared it is leading to another emotion, revealing one's true self and leading to self-anamorphosis. Three psychotherapists of music, movement and drama joined their expertise in a pilot project of interconnected art therapy disciplines, in a group of 6 young adults, at the Adolescent Unit of the 3rd Psychiatric Clinic (AHEPA, Thessaloniki-Greece). The main aim was to investigate if the interconnection of the arts could help in self-awareness at a group setting. The main focus was to connect, express and share inner emotions whilst one form of art elicits another form of art. Mixed methods of quantitative and qualitative research: Six questionnaires were answered. The questionnaire was divided in two parts: 1st included demographic and close-ended questions regarding the outcome of the personal experience in the group. The data was analyzed by SPSS statistics v 17,0 with frequency. The 2nd included open-ended questions describing the personal experience in the group. The answers were analyzed through the qualitative method of content analysis. 1. The members of the group projected their own issues on the arts. 2. The arts offered a safe space and facilitated the members to express, share and process their own strong emotions about loneliness, abandonment and death.

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Thursday

Paper session

A103

13:30

COMMUNIC.

An ethological interpretation of affective displays in music

Vishnu SREEKUMAR, David HURON

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In this study we draw on the field of ethology for ideas concerning affective communication through sound. Ethologists make a useful distinction between those states that are overtly communicated (signals) and those that are not (cues). We assume that signals are more likely to be multi-modal. That is, if signals are motivated by an imperative to communicate, then using more than one sensory modality ought to be more effective than using a single modality. If music employs acoustic cues related to signals, then, paradoxically, the affects in music that are most easily communicated will be signals that also involve distinctive visual cues such as facial expressions. We use two surveys to test the hypothesis: Affects that are judged to exhibit only unimodal characteristics are least likely to be conveyed or recognized in music, and are least likely to evoke cross-cultural agreement. In the first survey, respondents from Indian and American populations indicate how easily they can hear or see various affects: for example, how easy is it to see that someone is sad? How easy is it to hear that someone is sad? In the second survey, we will ask how easy it is for listeners to hear certain affects in music. For example, how easy is it to hear ”jealousy” in music? Should our predictions be borne out, then the results would suggest that biologically prepared signals provide an important foundation for the communication of affect through music.

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Paper session

A103

14:00

COMMUNIC.

Bodies, music and emotions in a dance ethnography

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We present here an ethnography on music and emotions in a new context, that of dance. Dance is a discipline of artistic creation which includes a key duality: the social dimension, also called relational, that starts with a group of people dancing, and the imaginative dimension, which includes the production of new steps, movements in space and figures. The richness of dance comes from the need to work with an individual body, which is not transferable, with its emotions, intentions and actions. But the body of the dancer is a part of a plural context, composed of other bodies in rhythm. The context of rehearsal is crossed by artistic and cultural traditions in a given historical moment. We address the production of emotions with music through an ethnographic work in a British dance company, together with the University of California, San Diego (UCSD). Six cameras were used to record the performances Dyad (2009), FAR (2010) and UNDANCE (2011), and most importantly, their rehearsal process (2 months each), including daily interviews to the dancers and the choreographer. As preliminary results, we see how the musical language and the emotional performance become two sides of the same coin of the subjective experience of communication. Preliminary results show how the dancers and the choreographer are aware of the emotional implication of their interactions thanks to the music. The dancers express difficulties in memorizing new moves and the choreographer mentions lack of creative feedback.

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Melodic and rhythmic contrasts in emotional speech and music

Lena QUINTO, Bill THOMPSON, Felicity KEATING

Macquarie University, Australia

Thursday

Paper session

A103

14:30

COMMUNIC.

Many cues convey emotion similarly in speech and music. Researchers have established that acoustic cues such as pitch height, tempo, and intensity carry important emotional information in both domains. In this investigation, we examined the emotional significance of melodic and rhythmic contrasts between successive syllables or tones in speech and music, referred to as Melodic Interval Variability (MIV) and the normalized Pairwise Variability Index (nPVI). The spoken stimuli were 96 tokens expressing the emotions of irritation, fear, happiness, sadness, tenderness or no emotion. The music stimuli were 96 phrases, played with or without performance expression and composed with the intention of communicating similar emotions (anger, fear, happiness, sadness, tenderness and no emotion). The results showed that speech, but not music, was characterized by changes in MIV as a function of intended emotion. However, both music and speech, showed differences in nPVI between the expression of "no emotion" and deadpan renditions, and emotional portrayals. The results suggest that these measures may signal emotional intentions differently in speech and music.

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The structure of emotional communication in musical activities

Hiroko TERASAWA[1], Reiko HOSHI-SHIBA[2], Takuro SHIBAYAMA[3], Hidefumi OHMURA[4], Kiyoshi FURUKAWA[5], Shoji MAKINO[6], Kazuo OKANOYA[2]

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Paper session

A103

15:00

COMMUNIC.

In musical activities in the real-life situations, such as listening to a live music or playing music with friends, we experience a wide range of vibrant emotions. We naturally exchange and develop emotions with the others by sharing gestures and motions. In other words, the experience of musical emotion is not solely established by sound, but situated in physical and social contexts. In this talk, we overview the various degrees of physical and social aspects in musical activities, and present a theoretical model for the communication of musical emotion that integrates physical elements of music. In this model, the emotional system of human is represented with the interface of perception and expression, the internal neural system that responds to multi-sensory musical information, and the musical emotion that is enclosed in the internal system. The communication of musical emotion is modeled as a network of the emotional systems, while music is an intersubjective medium for expressing and retrieving emotions, supported by non-acoustic information. The network of emotional systems forms a feedback-loop structure, allowing the dynamic change, synchronicity, and amplification of musical emotion.

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Thursday

Paper session

H306

13:30

MEMORY

Cascading reminiscence bumps in music

Carol Lynne KRUMHANSL[1], Justin ZUPNIK[2]

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Recall of autobiographical memories generally peaks for events in late adolescence and early adulthood, a phenomenon called the “reminiscence bump”. Similarly, previous studies have found stable life-long preferences and associated biographical memories evoked by music from this period of one’s life. Using 5 ½ decades of top hits, we probe personal memories and their contexts, as well as recognition, preference, quality judgments, and emotional reactions in young adults. All these measures show the typical increasing function during the two recent decades of their lives. Unexpectedly, we find that the same measures peak for the music of their parents’ generation and to some extent that of their grandparents’ generation. The context of these memories was predominantly from listening when growing up, suggesting childhood is also a period when music makes an important impact. We refer to this pattern of musical cultural transmission as “cascading reminiscence bumps”.

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Paper session

H306

14:00

MEMORY

Emotion and memory in Debussy’s piano works

Richard ASHLEY

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This study explores the ways in which Debussy’s music can evoke the feeling of different temporalities, namely past vs. present, memory vs. perception. Debussy’s music is often understood as depicting visual scenes of some kind; the evocative titles given to many of his works support this stance. However, there is evidence from Debussy’s own writings, as well as the testimony of those who knew him, that external references in his music are better understood as representing states of feeling rather than visual images per se. These states of feeling are often reminiscences rather than direct perceptions. This study explores such affective states in Debussy’s music as representing two different temporalities or “worlds,” with one being a world of present perception, and the other being a world of memory, reverie, and reflection. These different temporal frames can be distinguished from one another on the basis of their musical features but also on the affective states they evoke. A theoretical framework, derived from the psychologist Theodule-Armand Ribot, the most eminent French psychologist of Debussy’s time, is presented. This framework is first examined in the light of statements by music theorists and musicologists about Debussy’s music. Then, results of a first set of experiments which test hypotheses generated both Ribot’s writings and from music analysis are presented, focusing on “Les sons et les parfums tournent dans l’air du soir,” “La terrasse des audiences du claire de lune,” “Des pas sur la neige,” and “Soirée dans Grenade.”

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EEG-based emotion recognition to enhance gaze-controlled music performance

Zacharias VAMVAKOUSIS, Rafael RAMIREZ
Music Technology Group, Spain

Thursday

Posters 3

M014

13:30

NEUROPHYS.

There has been little research in creating musical instruments for people with severe motor paralysis, e.g. locked in syndrome. In this paper we describe a new musical interface, the EyeHarp, combining gaze-control and brain activity input to produce emotion driven expressive performances. Using the Emotiv Epoch EEG device we estimate the performer's emotional state. Based on left and right hemisphere's alpha and beta power we assign a value in the Thayer's arousal-valence plane in real time. In our musical interface melody is gaze-controlled while the estimated arousal is mapped to arpeggio intensity and the estimated valence to sad/happy chord progressions. This system was tested in a concert setting with satisfactory results. Combining EEG information about the emotional state of the performer might enrich the expressiveness of instrument designed for people with motor disabilities.

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Cross-cultural emotional psychophysiological responses to music: Comparing Western listeners to Congolese Pygmies

Hauke EGERMANN[1], Nathalie FERNANDO[2], Lorraine CHUEN[3], Stephen MCADAMS[4]
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Posters 3

M014

13:30

NEUROPHYS.

Previous research has indicated that emotion recognition might be based on universal features. However, whether a similar cross-cultural comparison can reveal universal emotion induction remains unexplored. The study compared subjective and psychophysiological emotional responses to music from two different cultures within two different cultures. Two similar experiments were conducted, the first in the Congolese rainforest with an isolated population of Mbenzele Pygmies without any exposure to Western music and culture; the second with a group of Western music listeners, with no experience with Congolese music. 40 Pygmies (age in yrs.: M=35, SD=14, 22 males), and 39Western listeners (age in yrs.: M=22, SD=6, 22 males) listened in pairs of two to 19 music excerpts of 29 to 99 seconds in duration in random order (8 vocal from the Pygmy population and 11 western instrumental excerpts). For both groups, emotional responses were continuously measured on the dimensions of subjective feeling, (using a two dimensional rating interface which measures arousal and valence), as well as psychophysiological response (GSR, HR, Respiration Rate, facial EMG). Results suggest that the dimension of valence might be mediated by cultural learning, whereas changes in physiological arousal might involve a more basic, universal response to implicit acoustical characteristics of music.

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Thursday

Posters 3

M014

13:30

NEUROPHYS.

Resting heart rate variability predicts music-induced chills

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Listening to one's favorite music can elicit the sensation of chills. This sensation is highly rewarding and produces physiological arousal. Because resting heart rate variability (HRV) reflects physiological arousal during experimental task, we hypothesized that resting HRV would be an accurate predictor of the sensation of chills elicited by listening to one's favorite music. Twenty-eight participants took part in the experiment individually. They were connected to an apparatus to record heart rate in a soundproof room. Participants were asked to relax while their resting HRV was assessed for 3 minutes. Next, they listened to either their favorite music or music selected by the experimenter. Each time participants experienced musical chills, they reported this event by clicking a mouse. After the music listening experience was completed, participants rated the intensity of the overall musical chills experience. We calculated correlation coefficients between RMSSD (which is an index of HRV), the number of chills, and the intensity of chills. RMSSD was negatively correlated with both the number of chills ($r = -.393$, $p < .05$) and the intensity of chills ($r = -.388$, $p < .05$) when participants listened to their favorite music but not the experimenter-selected music. Low HRV could indicate parasympathetic withdrawal and physiological arousal. Because resting HRV was significantly correlated with musical chills only when participants listened to their favorite music, this correlation cannot be attributed to the participants' mouse click responses or evaluation bias, but most likely to the rewarding experiences of musical chills.

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Posters 3

M014

13:30

NEUROPHYS.

Sound oscillations or brain self dynamics on music ornaments?

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In a 1991 study, Sloboda reported that some musical mechanisms – e.g., appoggiatura, cycle of fifths harmonic progression, would potentially be behind emotional phenomena such as crying. Recently, a new wave of discussion on the topic was triggered by a popular song that is at the base of one of the most reported phenomena of audience weeping. Most theories postulated that the process derives from the phenomenon of tension resolution operated on the brain provided by the expectation created by the temporary transgression of a note (a note that anticipates the resolution) that responds to an additive need such as internal released of certain neurotransmitters a base of emotional phenomena such as pleasure. The problem we see here is that most of the studies reviewed, focus on the mechanisms of emotion as an internal autonomous phenomenon rooted in that particular need but clearly not explore the possibility of the mechanisms that support those primers derived mainly from the phenomenon of the relationship of external oscillations, i.e., the sounds generated (music), with the internal, i.e., the "brain waves". We propose, as an non nonexclusive alternative and as a proposed laboratory study based on readings transversal to various disciplines studying the phenomenon of oscillations, that it is the interaction of the acoustic oscillations (music) with those of the brain potentially summative e.g., synchronization, phase lock, i.e., harmonic enhancement the main protagonist of the phenomenon under discussion in this context.

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Musical pleasure and dopaminergic learning: Group and individual effects

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Posters 3

M014

13:30

NEUROPHYS.

Neuroimaging has linked music listening with brain areas implicated in emotion and reward, such as the ventral striatum, that are regulated by endogenous dopamine transmission. Levels of striatal dopamine influence reinforcement learning behavior: subjects with more dopamine tend to learn better from rewards, while those with less dopamine tend to learn better from punishments. In this study we explored the practical implications of musical pleasure through its ability to enhance dopamine release. To this aim we measured the effect of musical pleasure on reward-based learning in a probabilistic selection task dependent on dopamine transmission. Musicians, amateur musicians, and non-musicians completed at-home listening tests to select pleasurable and neutral music from an experimenter-created database. We then pseudo-randomly divided the subjects into four groups according to the music (pleasurable or neutral) they would hear during the Training and Test phases of the experiment. Training involved visual pairs of different reward probabilities that participants learned through trial-by-trial feedback, and the Test consisted of recombined stimulus pairs and no feedback. During Training, pleasurable music quickened and enhanced the learning of the visual pairs, supporting our hypothesis on the enhancement of dopaminergic release during musical pleasure. However, this effect was most pronounced in non-musicians, whereas amateur musicians learned the visual pairs better while listening to neutral music. Overall, musical pleasure had a greater effect on Training, facilitating dopaminergic learning in non-musicians but distracting amateur musicians perhaps due to non-optimal striatal dopamine transmission. Questionnaire data regarding the subjects' listening behaviors and fMRI data are both forthcoming.

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Classification of discrete emotional states from brain activity patterns

Heini HEIKKILÄ[1], Athanasios GOTSOPOULOS[1], Iiro P. JÄÄSKELÄINEN[1], Jouko LAMPINEN[1], Patrik VUILLEUMIER[2], Riitta HARI[3], Mikko SAMS[1], Lauri NUMMENMAA[1]

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Posters 3

M014

13:30

NEUROPHYS.

Categorical emotion models argue for basic emotions that are evolutionary scripts with distinct neural and physiological basis. In the present functional magnetic resonance imaging (fMRI) study, we tested this assumption using multi-voxel pattern analysis (MVPA) to classify whole-brain activity patterns associated with basic emotions. During fMRI scanning, we induced basic emotions using either movie clips (Experiment 1: disgust, fear, happiness, sadness, neutral; 20 subjects, four runs for each) or mental imagery guided by emotion words (Experiment 2: anger, disgust, fear, happiness, sadness, surprise; 14 subjects, six runs for each). A MVPA classifier was used for categorizing the emotional state based on the brain activity pattern within a whole-brain cortical mask, and the results were validated using a leave-one-run-out crossvalidation. Mean classifier performance was significantly above chance level in both experiments (42% against 20% and 52% against 17%) and for all emotion categories. In both experiments, brain regions with largest contribution for classification included amygdala and ventromedial prefrontal cortex. In the movie experiment, additional important contributors included lateral thalamus and visual areas. In the word experiment, also left inferior frontal cortex, supramarginal gyrus, anterior prefrontal cortex, medial thalamus, and motor areas contributed significantly. In conclusion, our results demonstrate discrete activation patterns of widespread brain networks related to separate emotional states. The successful application of MVPA methods in classifying basic emotions from brain activity patterns suggests that MVPA methods could be used also in the study of more complex and abstract emotions such as the aesthetic emotions elicited by music.

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Thursday

Posters 3

M014

14:00

STRUCTURE/ FEATURES

Do emotions depend on musical structure? Score, performance and tension

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In western culture music is often considered expressing emotional substance, but musical context is experienced differently. Emotional qualities are considered on different levels of musical structure. We refer to musical structure as specific formal category, but define musical context as category including sub-texts, relations on mental, phenomenological, and philosophical levels. Our hypothesis is, that people respond rather to the Tension Design (TD) of the music than to basic emotions Sadness and Gladness (SG). Seven performances of classical music (Beethoven, 7th symphony, mvt. 2) were chosen as experimental stimuli obtained from internet. Participants (N=7) will be tested twice within short period. They are asked to respond to the level of SG using slider controller for real-time continuous data capture (TEDEA, Tension Design Experimental Apparatus), and to judge the TD of the stimuli with the same apparatus. The calculated Index of Melodic Activity (IMA) will be used as comparative output against the curves of the continuous data capture experiments. As it is evident, the perception does not identify for basic emotions in music equally to those in speech. In the contrary, the tension seems to express more adequate contextual impulses in music. For the results we consider the score-based IMA, juxtaposing it to the perception-based results of SG and TD curves which enable us to explore individual perceptivity of the musical structure.

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Posters 3

M014

14:00

STRUCTURE/ FEATURES

Acoustic and perceptual features of eating-places in Singapore.

PerMagnus LINDBORG

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The relatively few investigations of restaurant soundscapes (aka servicescapes) have focussed on how music style and ambient levels influence repeat patronage behaviour and appraisal). Dimensional emotion models underpin both Novak's work and the outdoors-oriented Swedish Soundscape Quality Protocol (SSQP). There is evidence that acoustic features other than A-weighted SPL are salient for urban soundscape quality perception. The author and his students investigated 118 'eating-places', from hawker stalls via coffee bars to upmarket restaurants, noting Size, Priciness, Occupancy etc, full SSQP, and sound pressure level; other acoustic features were extracted from recordings. Results indicate that 'Chinese' eating-places had significantly higher ambient levels than 'Western', but lower than 'OtherAsian'. Priciness was highest at 'OtherAsian' places, followed by 'Western', then 'Chinese' (all Tukey's HSD). Levels were consistently higher than those suggested by Novak to elicit the "highest levels of pleasure and approach behaviour". Further perceptual investigation with raters (N=36) employed SSQP, a spatial metaphor, and a colour association task. Convergent validity with the on-site single-person evaluations was high. Photography, gathered from 87 locations, were used in the design of another two experiments: a forced-choice audiovisual matching task ("Which photo matches the soundscape you hear?"), and a Priciness estimation task from a) soundscape alone b) photo alone c) soundscape and photo together. Data collection is imminent, and results will be presented at the conference.

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A simple, high-yield method for assessing structural novelty

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Posters 3

M014

14:00

STRUCTURE/ FEATURES

The structural dimension of music plays an important role in its affective appreciation. One particular aspect is related to the temporal succession of moments, each characterized by particular musical properties. One classical approach in computational modelling of this aspect is based on similarity matrix representations, where successive states are visualized by successive squares along the main diagonal, bearing some resemblance to checkerboards. One referential method estimates a so-called novelty curve, representing the probability along time of the presence of transitions between successive states, as well as their relative importance. Novelty is traditionally computed by comparing – through cross-correlation – local configurations along the diagonal with an ideal checkerboard kernel. The method is limited by a strong dependency on kernel size, which imposes a single level of granularity in the analysis and fails to grasp common musical structures made of a succession of states of various sizes. We introduce a simpler but more powerful and general method that automatically detects homogeneous segments of any size. Only half of the similarity matrix is retained, in order to compare each new instant solely with the past and exclude the future. For each instant in the piece, novelty is assessed by first determining the temporal scale of the preceding homogeneous part as well as the degree of contrast between that previous part and what just comes next. Detailed results show how and why this method offers a richer and more intuitive structural representation encompassing all granularity levels.

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The influence of individual differences on emotion perception in music and speech prosody

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Posters 3

M014

14:00

STRUCTURE/ FEATURES

The study reported here investigates the influence of individual differences on perception of emotion in music and speech: specifically we tested the mediating influence of personality, emotional intelligence, gender and musical training. A behavioural study collected two main types of data: continuous ratings of emotion perceived while listening to extracts of music and speech, using a computer interface which modelled emotion on two dimensions (arousal and valence), and demographic information including measures of personality (TIPI) and emotional intelligence (TEIQue-SF). We employed the novel statistical method of functional analysis of variance on the time series data which revealed a small number of statistically significant differences according to gender, emotional intelligence, emotional stability and musical training. This is the first time to our knowledge that effects of individual differences on continuous measures of emotion have been tested.

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Thursday

Posters 3

M014

14:00

STRUCTURE/ FEATURES

Acoustical and musical structure as predictors of the emotions expressed by music

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Based on the Geneva Emotion Musical Scales (GEMS) model, we performed a behavioral experiment in order to investigate the dynamic relationships between emotions expressed by music and acoustical features and musical structure. Using a method of dynamic judgments, asking participant to judge continuously the emotion expressed by music during the listening of musical excerpts, we showed that acoustical and musical structure can predict complex emotions such as Power and Nostalgia. The high Cronbach Alpha values, ranging from .84 to .98, revealed a strong agreement between participants for the dynamic judgement of emotion expressed by music. In order to test to what extent the acoustical features and the musical structure, especially in terms of novelty computed with the MIRtoolbox, can predict emotions we performed a principal component analysis allowing us to investigate how the extracted dimensions can predict the emotional judgments. The PCA revealed the importance of four dimensions related to the emotional dynamic judgments. The specificity of the predictors and how they are related to the different GEMS emotions will be discussed in this contribution.

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Posters 3

M014

14:00

STRUCTURE/ FEATURES

Sounds and emotions during emergency situations

Jukka SEPPÄNEN
Department of Music, University of Jyväskylä, Finland

The role of sounds and emotions during emergencies was studied by analyzing narratives written by maritime and aviation professionals who were asked to describe what kind of sounds they have heard in normal and abnormal situations, and how sounds and music have affected their emotions. In total, eight responses were received in an internet inquiry which was advertised in professional magazines in Finland. The answers were analyzed using the five-step Awareness Wheel model (sensory data, feelings, thoughts, wants, actions). The respondents described the auditory data, i.e. sounds and noise in vessels or aircrafts and feelings they provoke as familiar, harmless, sudden, disturbing, question provoking, worrisome, mind oppressing, startling, frightening and dangerous. In order to function in operating situations and control their emotions, the respondents used methods such as using common sense, keeping calm, isolating feelings from conscious thinking, relying on experience when estimating the seriousness of danger, keeping a poker face (all found in thoughts and wants), assembling, using manuals, acting as a good example and according to the protocol (actions). Although music is often used as encouragement and people listen to music to regulate and improve their mood, music was spontaneously mentioned only by two respondents (25%). They described music as a soothing, recovering and comforting medium. Previous studies by the author have also shown that, for some reason, music is rarely mentioned spontaneously: For example, when military police conscripts were asked how they cope with strong emotions, music was stated only by few respondents (7%).

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Buildup, breakdown and drop. An initial experimental approach for explaining the emotional impact of DJ performances in Electronic Dance Music (EDM)

Steffen LEPA, Marcus BLEISTEINER, Alexander FUß, Dominik STEGER
Audio Communication Group, Technische Universität Berlin, Germany

Posters 3

M014

14:30

NEW DIRECTIONS

Within EDM culture, audio tracks are typically considered as “unfinished” musical material with their aesthetic potential not realized until being used as part of a DJ performance in the club. A reportedly very emotional part of such performances is “the drop” – referring to a moment, when a strong anticipative tension that has been build up by means of the formal track structure is increased even further by help of a so-called “breakdown”-part, additionally coined by intensive application of DJ handcraft (volume, filters, effects), and is then finally released with the return of the base drum and the sounding “core theme” – often accompanied by collective feelings of ecstasy and happiness expressed by a cheering crowd on the dance floor. To experimentally explore the responsible generative mechanism, 18 participants with a personal preference for EDM listened to one of two versions of the same EDM audio track. The second was different only regarding an artificial prolongation of the last “breakdown”-part, a strategy often employed by DJs to create a highly intensive “drop”. Listeners were instructed to continuously express their emotional feelings by help of a 2-dimensional continuous response measurement instrument. Resulting time-series data were analyzed by multilevel regression techniques demonstrating a significantly longer retention of positive valence after the drop for the prolonged version only, while there were no differences regarding arousal. Findings are interpreted with regard to the concept of “contrastive valence” and future prospects of examining the emotional impact of related DJ performance techniques are discussed.

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Emotion-related musical variables affect person perception: Differential effects for men and women in a synchronization task

Fabia FRANCO, Stanislava ANGELOVA
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Posters 3

M014

14:30

NEW DIRECTIONS

Keeping together in time (e.g. dance, drill) has been described as crucial in human social evolution. Recent studies showed enhanced cognitive performance, increased liking, similarity and prosocial measures in participants synchronising simple behaviours to a metronome. Attempting a more ecologically valid framework, we investigated the above responses in function of variables associated with affect in music (tempo and mode) when participants synchronised motor behaviour to music rather than metronome. 128 participants were tested using a 2x2x2 independent factors design: gender, tempo (fast/slow) and mode (major/minor), in a task involving stepping with a researcher to the musical beat. Dependent measures were [1] incidental memory, and ratings of [2] likeability of the researcher, [3] similarity to the researcher, [4] willingness to help the researcher on another timeconsuming experiment and [5] how interesting was the experience (all 1-7 scales). ANOVAs revealed a significant gender x mode x tempo interaction for Likeability. Follow-up analyses by gender yielded a significant mode x tempo interaction for women, who liked the researcher most with major/slow or minor/fast music and least with minor/slow. Men presented independent effects of mode on likeability, as they liked the researcher best when stepping with major mode, and tempo on how ’interesting’ the experience was (more with slow tempo). Thus variables associated with affect perception in music, such as mode and tempo appear relevant for person perception in a synchronised motor behaviour task in ways that differ for men and women. These results instigate revision of previous findings and consideration of evolutionary questions.

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The effect of nicotine on music-induced emotion

Theresa VELTRI, Renee TIMMERS, Paul OVERTON
The University of Sheffield, United Kingdom

Posters 3

M014

14:30

NEW DIRECTIONS

Nicotine is a legal and freely available drug widely self-administered in the context of music (e.g. pubs, clubs). We therefore sought to better understand the relationship between nicotine and music-induced emotion and to understand why these elements often co-exist. Furthermore, nicotine changes one's physiology, which allowed us to test the effects of these physiological changes on the emotional experiences of music. We hypothesized that because nicotine changes one's physiology it may also change one's affective arousal in response to music. To test this, a health-screening procedure identified smokers and non-smokers who were then administered nicotine gum at either 2mg, 4mg, or placebo level. After nicotine absorption participants listened to 4 different musical excerpts. Excerpts were 2 minutes long and were each of one of the following emotions: happy, sad, neutral, and self-selected chill-inducing. During each listening physiological measurements were recorded. After each listening participants rated their emotional responses on 6 intensity scales: arousal, pleasure, happy, sad, familiar, and liking. Results showed significantly higher mood ratings for those ratings taken immediately after nicotine intake comparing to those taken directly before intake. However, these results were not related to nicotine dosage conditions. Other results, although non-significant, showed a trend between nicotine levels and intensity ratings for pleasure and happiness. That is, as nicotine levels increased pleasure and happy intensity ratings correspondingly decreased. Future research may be interested in testing these effects in dependent and nondependent smokers, who are more familiar with the effects of nicotine.

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Walking with music in a natural setting

Marek FRANEK[1], Leon VAN NOORDEN[2], Lukas REZNY[3]
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Posters 3

M014

14:30

NEW DIRECTIONS

The goal of the study was to investigate effects of music listening while walk on walking speed and emotions. Selection of music was based on the concept of motivational music characterized by fast tempo and strong rhythm, which stimulates fast and intensive bodily movements. 120 undergraduate students took part in the experiment. Participants were walking on a 2 km long circuit through various environments (park, quiet street, street with heavy traffic) in the town of Hradec Králové in the Czech Republic. They listened to either motivational or non-motivational music. The walking speed was measured in 16 sections with length about 50 m. The participants were asked to complete the Positive and Negative Affect Schedule (PANAS) before and after the walk. Moreover, they completed a personality questionnaire based on the Big-Five personality model. Results showed that motivational music made the participants to walk faster than the group with the non-motivational music (1.7 m/s vs. 1.4 m/s). In motivational music condition, positive emotions significantly increased and the level of negative emotions significantly decreased after the walk. In non-motivational music condition, only negative emotions significantly decreased after the walk. Further, in motivational music condition it was found negative correlation between walking speed and neuroticism, while in non-motivational music condition it was found negative correlation between walking speed and extraversion indicating that personality features effect reaction on music listening while walk. The results demonstrated effects of different types of music on emotional and behavioral reactions during a walk.

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Using tags to select stimuli in study of music emotion

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Posters 3

M014

14:30

NEW DIRECTIONS

A wealth of research on musical emotion has been studied. In the past studies, the four basic emotion tags labelled with “happy”, “sad”, “angry” and “relax” were retrieved from Last.FM, and a total of 2904 excerpts were fetched from 7Digital.com. Previous research has used tags to classify musical emotions. However, the relationship between the musical emotions and human annotated information is still very unclear. The study of the difference between induced emotion (also called felt emotion) and perceived emotion is at a very early stage. Therefore, a music emotion listening test with 40 participants from various backgrounds has been made. In this experiment, we find that the emotion in a majority of the selected songs are considered to be perceived emotion. Furthermore, we explain how well can tags represent the musical emotion, and explore the other cultural and musical factors which influence our musical emotion perception.

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Modeling acoustic qualities of moods in popular genres of music using social media

Pasi SAARI, Tuomas EEROLA
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Posters 3

M014

14:30

NEW DIRECTIONS

Digital music consumption environments provide inimitable ways to explore links between music listening habits, semantic and acoustic contents of music, and the ways these are expressed and used in social media. The field of Music Information Retrieval (MIR) has taken variety of approaches to model moods with acoustic features. However, ground-truth concerning moods in these studies is usually based on expert opinions, which imposes limits on the size, quality, and validity of the data. Our previous research suggests that moods in music tracks can be fairly accurately predicted from social media tags, enabling mood assessment in very large and heterogenic music data. This study aims at predicting mood with acoustic features in large music data available through social media, assessing also the role of music genres in mood modeling. We estimate mood characteristics of 10 000 tracks by semantic computation and aim to model these with variety of acoustical features extracted from short audio previews. Linear modeling is compared to sophisticated machine learning methods such as Support Vector Regression. Systematic validation of the models is achieved by cross-validation and 600 expert-annotated tracks. Results show moderate success ($R^2 \approx 0.50$) in overall and application of genre taxonomy as a mid-level in modeling gives significant performance gains for several genres and moods. This study highlights for the first time the challenges related to mood modeling with acoustic features in large and heterogenic music data. We emphasize the need of using music genre as a descriptor to increase the efficiency of mood modeling.

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Thursday

Paper session

M103

16:00

PERFORM. II

Clap, shuffle, waggle and say; Cross-orchestra evaluations

Katharine PARTON

The University of Melbourne, Australia

Orchestral musicians work in a high pressure environment within which there are frequent evaluations of their performance of music works. Indeed, such evaluation is one of the tenets of orchestral rehearsal; the conductor works to align the scores of musicians and their individual understandings of a music work creating a coherent performance which is comprehensible and meaningful to both musicians and audience. This study aims to investigate the role this evaluation potentially has for the emotional dynamic of both individuals and the group. It examines instances of 'unusual' evaluation, positive and negative, within orchestral rehearsal, including verbal, non-verbal, individual and collective acts. This study uses a Conversation Analysis (CA) framework for analysis and is also informed by Ethnomethodological observation of an orchestra over a period of 4 months. The data discussed in this paper comes from a corpus of twenty-two hours of footage, filmed using four digital cameras, of a professional orchestra working with a professional conductor rehearsing a work for performance, collected as part of an ongoing project examining orchestral musician interaction. This study will show that 'usual' evaluation, understood as feedback which occurs frequently and is encoded within the orchestral hierarchy (conductor to soloist, concertmaster to violin section), is performed and responded to differently compared to 'unusual' feedback (wind player to string section, whole ensemble to individual). 'Unusual' feedback is argued to provoke (at least) the demonstration of greater emotional impact, and may therefore have a greater potential effect on the emotional dynamic of the orchestra in rehearsal.

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Paper session

M103

16:30

PERFORM. II

Misirli Ahmet: The clay darbuka technique and its performance analysis

Esra KARAOL

Istanbul, Turkey

There have not been extensive discussions about the "darbuka" instrument and its performance in musicology studies despite the fact that it originates from ancient ages and that it has an important role in the historic process of Turkish and world music until today. This essay emphasizes the parts that are analyzed in the context of the technique, which is shaped especially on clay darbuka, that "Egyptian" Ahmet (Yildirim), the darbuka performer. It has developed from the point of view that musical technique is transmitted orally and visually from master to apprentice. The evolution process of the instrument varies with the parallel to cultural changes and development of civilizations in the historical process. Thus, the material of the clay darbuka has been the most affecting factor on the change of its playing technique. The reason why performance analysis is emphasized is that performance structure is analyzed depending upon importance of connection between the clay darbuka and Misirli Ahmet's technique. Studying and evaluating this structure on the platform of musical theory discipline is within primary purposes in terms of analysis and determination of structural characteristics. One of the determinant elements of the study is the analytical examination of this technique through the example of Misirli Ahmet as a darbuka performer. His technique is known in the world as the "split-finger technique" and turned over a new leaf in the performance of the darbuka instrument. A standard evaluation is aimed to be established with unique notation specifically created for the technical movements.

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Thursday

Study on the expressiveness in the performance of children

Anna Maria BORDIN
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Paper session

M103

17:00

PERFORM. II

This work studies the characteristics of musical expressiveness in children's performances through comparison of musical structures and behavioral patterns in executing music. The aim of the study is to offer effective information useful in instrumental teaching, and elements of comparison with the performance of advanced students and professionals. Three ten-year-old piano students learned a piece previously unknown to them from the third and sixth volume of Bartok's Mikrokosmos. The piece was suitable to their preparation and overall cognitive level. During the learning process their teacher kept a log of the indications given to the children regarding musical content and performance practices. When the children could play the piece fluidly by memory, a video tape was made during a lesson. After one week during which the students received new indications, they performed the piece in a protected environment (private concert) and were videotaped. After another week they faced a third videotaped performance in a non-protected context (public recital). The quantity and quality analyses of the videotapes was done following two methods: one rigorously analytic, based on the presence of structural elements of the piece during performances, the second one based on the interpretation of the expressive behaviour in order to identify the emotional categories manifested by the performer. The comparative work combined this information with the teacher's log. The audio and video observations demonstrated that the children's performances showed remarkable emotional characteristics, supported by the structural features, proportional to the assimilation of the information given by the teacher.

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The sensed experience of the forms of vitality as elicited in performance

Isabel Cecilia MARTINEZ
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Paper session

M103

17:30

PERFORM. II

While intermodal perception of visual, aural, and/or audiovisual temporal stimuli takes place, the temporal dynamic profile of event´s change induces the activation in our sensed experience of what Daniel Stern calls the form or contour of vitality. Vitality as experienced is part of thought, emotion and action. Vitality forms are described using dynamic and kinetic terms such as emerging, fading, exploding, rushing, flowing, and many more. In a previous study that analyzed the dynamic experience that emerged out of participants´ descriptions of a musical piece, it was found that certain features of the vitality forms were preserved in the different modalities of participants´ stimulus reception (aural, visual, audio-kinetic, and audio-visual). The current study aims at analyzing the forms of vitality as configured during performance. A group of pianists were required to produce six different performances of Chopin´s Prelude Op. 28, 7: their own rendered interpretation, and five different renditions as conveyed by the following linguistic descriptions: fluttering, effortful, flowing, gentle and hasty. A number of sound features that were assumed to account for vitality forms in performance were measured: total duration, timing, tempo, dynamics, and sound articulation. Results are in progress and will be presented at the conference. It is discussed the extent of vitality forms as sonic articulations of the sensed experience during performance. In particular, it is considered the value of each sonic output as a non-linguistic description of the sensed dynamic contour experiencing during the performative motor activity as prompted by a given linguistic description.

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Thursday

Paper session

A103

16:00

TONALITY

Emotion and reorientation in tonal space

Marina KORSAKOVA-KREYN

School of Music and the Arts, USA

Tonal modulation is the reorientation of a scale on a different tonal center in the same musical composition. Modulation is one of the main structural and expressive aspects of music in the European musical tradition. We conducted two experiments to investigate affective responses to tonal modulation by using semantic differential scales related to valence, synesthesia, potency, and tension. Experiment 1 examined affective responses to modulation to all 12 major and minor keys using 48 brief harmonic progressions. The results indicated that affective response depends on degree of modulation and on the use of the major and minor modes. Experiment 2 examined responses to modulations to the subdominant, the dominant, and the descending major third using a set of 24 controlled harmonic progressions and a balanced set of 24 excerpts from piano compositions belonging to the First Viennese School and the Romantics; all stimuli were in the major mode to maintain the ecological validity of modulation to the dominant. In addition, Experiment 2 investigated the affective influence of melodic direction in soprano and bass melodic lines. The results agreed with the theoretical model of pitch proximity based on the circle of fifths and demonstrated the influence of melodic direction and musical style on emotional response to reorientation in tonal space. Examining the affective influence of motion along different tonal distances can help deepen our understanding of aesthetic emotion.

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Paper session

A103

16:30

TONALITY

Perceived emotion in Phrygian mode in musically trained children

Manuel TIZON, Francisco GOMEZ, Sergio ORAMAS

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It has been hypothesized by some authors that the Phrygian mode is associated with emotions of negative arousal. Here this hypothesis is further examined with children with musical background. The emotional responses of 32 children (ages 4 to 7) to music written in Phrygian mode were studied. Music presented to children was taken from two distinct corpora where the Phrygian mode is common, flamenco music (South of Spain mainly) and Galician music (North-west of Spain mainly). Children were presented with 12 short unaccompanied melodies randomly selected from the two corpora and rendered in three different tempi. They had to associate each piece to one of the four give emotions under study: happiness, anger, sadness, and serenity. An examination by tempi revealed differences in emotion responses: at slow tempo, sadness dominated; at medium tempo, happiness and sadness were almost tied; at a fast tempo, happiness took over. All these are in agreement with previous findings. However, when corpora were studied separately, unexpected differences arose. In Galician music happiness and sadness were almost equal at slow tempo (35.29% and 33.33%, respectively), and at fast tempo happiness percentage grew up to 42.85%. In flamenco music sadness-happiness percentages were 38.88%-22.22% at slow tempo, 37.5%-25% at medium tempo, 24.56%-31.57% at fast tempo. Here sadness was less affected by tempi than in the case of Galician music. This suggests musical mode is less deciding than expected and music structure may be a significant variable. Questions concerning enculturation and the Phrygian mode are addressed in our work.

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Schenkerien prolongation and the emotional connotations of major-minor tonality

Richard PARNCUTT
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Thursday

Paper session

A103

17:00

TONALITY

In a previous work, Huron investigated scale-step transitions in typical melodies. Transitions between scale steps 6 and 7 were surprisingly rare – consistent with Schenker's idea of tonal music as a prolongation of the tonic triad (cf. "Ursatz"). Similarly, Parncutt showed that Krumhansl's key profiles correlate with the pitch-salience profiles of tonic triads. In the Renaissance, major and minor triads were often prolonged due to (i) their consonance, which combines smoothness (no seconds) and harmonicity (perfect fifths), and (ii) their cardinality: all three pcs are separately perceptible, and all seven scale steps lie 0-1 steps from a chord tone (chord-scale compatibility). On this basis, I propose that the emotional connotations of major and minor keys depend on the Schenkerian background. On average, major triads and keys are more common than minor, presumably because of harmonicity and consonance; anger, sadness, distress, and tragedy are associated with ambiguity and uncertainty. Major keys may have positive valence simply because on average (i) they are more common than minor, and (ii) emotionally positive music is more common than negative (cf. music's main social functions). Both major keys and emotionally positive music may be the norm from which minor keys and negative music deviate ("Others"). Minor keys may also have negative valence because scale degrees 3 and 6 are lower than expected, just as sadness is communicated in speech by lower pitch. What, then, is more important for the negative connotations of minor keys: lower pitch or pitch ambiguity?

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Evaluating the consonance and pleasantness of triads in different musical contexts

Yuko ARTHURS, Renee TIMMERS
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Paper session

A103

17:30

TONALITY

This study investigates the way in which musical context influences judgments of the consonance and dissonance (C/D) and the pleasantness and unpleasantness (P/U) of chords. The C/D and P/U of augmented and diminished chords are expected to vary depending on musical context. This can be ascribed to the fact that, though augmented and diminished chords are normally considered dissonant, they nonetheless commonly appear in certain harmonic progressions of Western tonal music. A series of experiments tested the C/D and P/U levels of four types of chord: major, minor, augmented and diminished triads. They were presented alone ('without musical context') and as part of a cadence (IVV- I, 'with musical context'). The C/D level of the chords were judged, both with and without musical context, as was the overall C/D and P/U level of the cadences. The results for single chords without musical context show that major triads were considered the most consonant, followed by minor and diminished triads, while augmented triads were considered the most dissonant. As for chords with musical context, significant differences were found in the C/D and P/U levels of diminished and augmented triads heard in different contexts. Diminished triads were most consonant when on the subdominant, while augmented triads were least consonant when on the tonic. These findings lend support to the theory of the stability of chord functions. A positive correlation was found between C/D and P/U ratings, though the degree of correlation was moderate.

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Symposium 3

H306

16:00

BEYOND EMO.? MUSIC & ASC

Music and dissociation: Experiences without valence? 'Observing' self and 'absent' self

Ruth HERBERT

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Empirical studies of music listening in everyday life frequently frame individuals' experience of music primarily in terms of emotion and mood. Yet emotions – at least as represented by categorical and dimensional models of emotion – do not account for the totality of subjective experience. This is particularly apparent in the case of a range of so-called 'alternate' or 'altered' states of consciousness including 'flow', aesthetic and spiritual experiences. Some researchers have responded by highlighting the process of absorption (effortless attention) within significant experiences of music. To date however, the role of dissociation (detachment), the counterpart of absorption, has received little research attention outside ethnomusicological accounts of ritualistic trance. This paper explores the importance of dissociation to everyday musical experiences, drawing on findings from the author's past and ongoing empirical studies of psychological processes of everyday involvement with music in 'real-world' UK contexts. Free phenomenological reports from unstructured diaries compiled by participants aged 9-85 indicate dissociation from self, surroundings or activity in conjunction with music is a common occurrence in everyday life, particularly for teenagers. Significantly, a number of experiences appear to possess neither positive nor negative valence, instead functioning to offer a relief from aspects of self (emotion and thought). Dissociation and Absorption are accepted characteristics of trance in hypnotherapeutic literature. Results from the data discussed here suggest that moves away from a perceived baseline state of consciousness in conjunction with hearing music in daily life are a common phenomenon and that such experiences may facilitate freedom from emotion.

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Symposium 3

H306

16:30

BEYOND EMO.? MUSIC & ASC

Changes in the representation of space and time while listening to music

Thomas SCHÄFER[1], Jörg FACHNER[2]

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Music is known to alter people's ordinary experience of space and time. Yet it is unclear how these alterations occur and whether they are one dimensional or multidimensional. The authors review experimental and metaphoric (i.e., subjective) evidence of the influence of music on the representation of space and time and present prominent approaches to explaining these effects. They discuss the role of altered states of consciousness and their associated changes in attention and neuro-psychological processes, as well as prominent models of human time processing. Using qualitative interviews and content analysis, the authors identified the dimensions of alterations in the representation of space and time when people are captivated by music. Disappearance arose as the most frequent of three derived dimensions of altered representation of space. Disappearance and acceleration arose as the two derived dimensions of altered representation of time. Participants reported having experiences more frequently when they were not in motion. Integrating these results and the reviewed research, the authors conclude that research on the influence of music on the representation of space and time is still quite inconclusive.

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Shamanistic musical practices of the Khanty – An ethnomusicological perspective

Pekka TOIVANEN
University of Jyväskylä, Finland

Symposium 3

H306

17:00

BEYOND EMO.? MUSIC & ASC

The shaman tradition found among the Khanty people has taken an interesting course in recent decades. While the earlier literature on the subject essentially regarded the phenomenon as no longer living, ethnographic documentary films made on the bear ceremonies of the Khanty ethnic group -- the work of Lennart Meri in particular -- drew attention to one of the last surviving shamans. In the spiritual culture of the Khanty, of great importance is the bear cult and its associated set of rites. The most significant example of this cult are ceremonies called as "Bear Feast". About 300 various songs, dances, sketches are performed at such games which may last for four or five days. Songs reflect events in the history of tribes and peoples having populated the West Siberia. That is why merely from the historical point of view those songs are very significant and valuable, but one should neither overlook their emotional and spiritual significance either. This paper discusses some practices and characteristics of music associated to rituals practiced by the Khanty people, and roles of the shamans as musical practitioners in them. The shamans have played a very important role in the ritual ceremonies of the Khanty, where they often used music instruments. The focus of this paper is on "Bear Feast" and the use of musical instruments (primarily the 'torop-yuh' and the drum) and their extra-musical worlds of association with the spiritual world, not forgetting their emotional content either.

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Reframing emotional intensity – Music in drug-induced altered states of consciousness

Jörg FACHNER
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Symposium 3

H306

17:30

BEYOND EMO.? MUSIC & ASC

Researching intense emotions has led to several brain investigations stressing the comparable activation of reward processes during pleasurable music experiences and drug action. Today, drug use and a referential sound design in popular music are part of popular culture. What is the drug's influence on emotional and perceptual processes? Drugs are binding to endogenous receptors of certain neurotransmitters and therefore emphasize, amplify or weaken certain brain functions that – even in extreme form – are also possible without drugs. Drugs have the capacity to reframe perspectives on musical materials through an altered temporality and a temporarily more intense stimulation and evocation of physiological functions. These changes take place in the context of personal musical preferences, in a habituated set and setting that significantly influence the listener's focus of attention on emotional processes the musical time-space. If the information revealed in the time course of some music becomes meaningful for the listener or performer, the brain has various strategies available to it to zoom into particular parts of the music in order to process musical elements more distinctly and in a more focused manner, in a hypofrontal state of enhanced sensory perception. Studying drugs and music informs about activity of endogenous neurotransmitter activity during music perception and appreciation. Much of this field still remains under-researched and speculative, and more systematic experimental research is needed to investigate the claims of listeners and musicians that drugs like cannabis alter consciousness and enhance music perception and production.

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Thursday

Paper session

D109

16:00

HISTORICAL MUSICOLOGY

The eloquent hautboy

Georg CORALL

University of Western Australia

Scholars have investigated ’music as speech’ and the ’weapons of rhetoric’ in musical execution in order to understand the importance of text in historically-informed performance practice (HIP). This has led to the current vocal practice of declamation in, for example, the cantatas of Johann Sebastian Bach, who communicated his emotional messages to the congregation in part through the careful selection of a suitable instrumental soundscape. His contemporary Johann Mattheson (1681-1764) referred to the oboe as ’der gleichsam redende Hautbois’ (the eloquent hautboy) and reckoned it to be one of the instruments to most closely resemble the human voice. The investigation of contemporary treatises that provide commentary on articulation and rhetoric, as well as documents dealing with the balance of the forces available for Bach’s own performances allow conclusions to be drawn on sound balance and transparency in the performance of Early Music on period instruments; however, it appears that many present-day habits in HIP may not withstand scrutiny. Currently much attention is given to the close focus on articulation and text delivery required by historically-informed singers, whereas Early Music instrumentalists are deemed to merely support the vocalist’s words. Decades of personal experience in aiming to reconstruct historical hautboy reeds, together with a thorough analysis of wind instrument treatises dating from the 17th and 18th centuries reveals that ’articulation’ referred to the attack of notes as means to imitate text rather than merely defining the beginning and ending of a ’vocal’ sound on an instrument.

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Paper session

D109

16:30

HISTORICAL MUSICOLOGY

The role of Gefühlsempfindung in Carl Stumpf’s theory of musical emotion

Daniele BUCCIO

Conservatorio “Alfredo Casella” dell’Aquila, Italy

Throughout his life Carl Stumpf (1848-1936) pursued a lively interest in investigating the nature of feelings, intending it as a culmination of the psychological research. In dedicating himself to the elaboration of his general theory on emotions, he often drew the consequences from the results obtained by his observations on acoustic and musical phenomena. As announced by the author in 1890, the study of Tongefühle and Musikgefühle would have constituted the content of the fourth volume of the Tonpsychologie, a programmatic purpose he did not accomplish in the way he foresaw. In 1928, Stumpf republished his three main writings on emotion (previously published in 1899, 1907 and 1916), annotating them with a relevant introduction. The statement and the ultimate apology of the distinction between the Gemütsbewegungen, or Affekte, and the Gefühlsempfindungen – term that Stumpf proposed in its English designation as “emotional sensations” and that other scholars preferred to render with “sense-feelings”, “affective sensations” or “algedonic sensations” – led Stumpf to protract unresolved controversies with Edward Bradford Titchener, Oswald Külpe, and his mentor Franz Brentano, among others. The aim of the present paper consists in a historical reconsideration of Stumpf’s conception about feelings and sense-feelings, within the debate of his contemporaries and with particular reference to the musical field, such as the role of feeling in his definition of the nature of concordance and his evaluations on the loss of affective sensation by a player in a military band (musikalische Anhedonie).

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Stravinsky’s approach to interpretation

Jani SUOMINEN

Helsinki University, Finland

Thursday

Paper session

D109

17:00

HISTORICAL MUSICOLOGY

The primarily purpose of the composition is to be represented. It could be issued how interpretation should be like and what is the position of the musicians in it. During the time there have been a great variety of perceptions of the musician’s position and its role. For example, Igor Stravinsky was known for his negative attitude towards the interpretation of the music. Only a thought of inspiration and interpretation horrified Stravinsky. He even envied the military band leader who kept a revolver strapped in a holster by his side and a notebook in which he marks a player’s mistakes. For each mistake followed a day in jail. By listening Stravinsky’s own rehearsals on the tapes it could be noticed that he was not that strict in practice as the band leader he envied. Also his guidance of interpretation (as a theoretical idea of an overall act of a performance) can be challenged. Stravinsky was keen on musical rendering (as a sounding act within a space) with explicit, detailed and clean lines. To have some image of Stravinsky’s own musical rendering there are for example three recordings of Le Sacre du Printemps to compare from years 1929, 1940 and 1960. In addition to previous mentioned there is a good fourth recording to compare from year 1951 by Pierre Monteux (1875-1964) who conducted the premiere of Le Sacre. The question to consider would be if recordings were just stagnant compared to live performances. These four recordings are all very different. Each of them reflects the spirit of the time and interpretation of the conductor.

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Friday

Symposium 4

M103

09:00

MUSIC, EMO. & AUTISM

Are musical emotions chimerical? Lessons from the paradoxical potency of music therapy

Rory ALLEN

Goldsmiths, University of London, United Kingdom

The dominant psychological model of emotion posits that a cognitive process (the appraisal) precedes, and results in, the corresponding emotion, including any induced state of physiological arousal: the cognitive component of emotion mediates the effect of the external cause on the internal arousal component. If emotions in music were naturalistic, the same mechanism should apply. However, a study in which a group of people with autism were compared with matched controls showed a normal level of physiological responsiveness to music in the autism group, coupled with a reduced capacity to verbalize their responses to it. It is hard to account for these results in terms of the standard mechanism for emotion induction; I suggest that musical emotions are in fact chimerical, consisting of components of separate naturalistic emotions combined in non-natural ways. This fact can not only explain the ability of music to generate a response in individuals with impaired emotional understanding, but can also suggest ways to exploit this effect in order to teach such individuals about naturalistic emotions by pairing musically induced states of autonomic arousal with the kind of naturalistic context provided in, for example, opera.

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Symposium 4

M103

09:30

MUSIC, EMO. & AUTISM

Music therapy, mood induction and autism: Current practice, clinical insights and future directions

Emily CARLSON

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With the growth in prevalence of autism worldwide over the last decade, music therapists have seen corresponding increases in the need to provide services for this population. Several differing schools of thought characterize music therapy's approach to this population. Because of this, the clinical practice of music therapy in the treatment of autism, while broadly defined by competencies laid out by professional and certifying organizations, is difficult to describe with much specificity. To clarify this, an overview of the principal approaches music therapists currently use to treat clients diagnosed with autism, and the settings in which these approaches are employed, will be presented. The role that deliberate mood state induction, a common music therapy technique, may or may not play in these approaches will also be discussed, along with examples drawn from personal clinical experiences with clients falling towards two extremes of the autistic spectrum. Standards in assessment and empirical evaluation make the pursuit of emotion-based objectives impractical for many therapists serving populations with limited verbal expression, as is often the case with clients with autism. The Music Therapy Music Related Behaviors (MT-MRB) assessment, while originally developed for the educational setting, may have useful applications for the therapist seeking to approach this population with a more deliberate and observable utilization of therapeutic mood induction.

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Friday

Paper session

A103

09:00

MEASUREM.

Assessing the quality of experience of an audience in a live musical scenario

Cian DOHERTY, Roddy COWIE

Queens University Belfast, United Kingdom

The psychology of music needs sensitive tools to assess the experience of the listener. Research on the listening experience has traditionally focused on selected emotional reactions, but there is a wider spectrum of broadly affective responses that could contribute to the experience of an audience in a live musical setting. Our studies have explored a range of tools for assessing the quality of experience (QoE) of an audience including a questionnaire drawn from a wide literature, a continuous self-report device, and several objective measures. The empirical studies consisted of 5 separate concerts, each involving contrasting performances. Each concert had between 15 and 46 participants, lasted roughly an hour and involved a range of multimodal measures. The results consistently show that the QoE questionnaire captured differences between contrasting performances, with many of the new factors introduced being significant predictors of audience liking. This allows the evaluation of continuous measures (self-report and objective) against QoE data. The result is a new set of tools to distinguish between contrasting performances and audience experiences via an effective questionnaire representing both established dimensions in the psychology of live performance and musical listening, as well as other dimensions not previously considered.

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Paper session

A103

09:30

MEASUREM.

Music & emotion listening experiments: design, implementation & perspectives

Javier JAIMOVICH[1], Niall COGHLAN[2], Brennon BORTZ[3], R. Benjamin KNAPP[4]

[1]Depto. Música y Sonología, Universidad de Chile, Chile; [2]Sonic Arts Research Centre, QUB, United Kingdom; [3]Center for Human-Computer Interaction, VT, USA; [4]Intitute for Creativity, Arts, and Technology, VT, USA

There is currently a significant research effort focused on the role music plays in inducing and modulating emotions, both as an exploration of the human condition and as a means of developing new paradigms for human-computer interaction. During recent years, the Music, Sensors and Emotion research group has been collecting data from over five thousand people in order to understand affective responses to music stimuli. Installed as an interactive science experiment in several cities around the globe, entitled Emotion in Motion, visitors listen to short excerpts of music while the system records physiological signals (electrodermal activity and heart rate), as well as their answers to questions about their emotional response to the music. Analysis of both the questionnaire and physiological data from the experiment has shown evidence of distinguishable differences in response to different musical stimuli. This has also revealed more information on acoustic and musical features linked to specific emotional states and the corresponding changes in physiological state. Results show significant relationships between physiological features, MIR features and self-report data. We believe that many of these findings can only emerge when working with large sample sizes, and we have created a scalable experiment testbed that enables this research. This paper discusses current results as well as future directions for this research, presenting our latest discussions and findings, as well as refinements to the experiment design to explore relationships between specific variables. The design of new mobile environments, informed by the results of these experiments, will be discussed.

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Friday

Paper session

A103

10:00

MEASUREM.

The emotionality of sonic events: Testing the Geneva Emotional Music Scale (gems) for popular and electroacoustic music

Athanasios LYKARTSIS, Andreas PYSIEWICZ, Henrik VON COLER, Steffen LEPA
Technische Universität Berlin, Audio Communication Group, Germany

In the present study the Geneva Emotional Music Scale (GEMS-25) and its German offshoot, the GEMS-28-G were tested for measurement invariance across different types of musical stimuli. Additionally, the comparability of scores across the different language versions was checked. While alternative scales are often based on general dimensional or categorical emotion theories and are thus “stimulus-neutral”, the domain-specific likert-type emotion scale GEMS is designed to especially capture the emotions evoked when listening to music. Within the study, an online survey was administered (n = 245) using a stimuli set of 20 excerpts from musical pieces. By analyzing the data with structural equation modeling (SEM), we tried to verify the reliability of the scales in terms of measurement invariance towards popular/classic music as well as towards the genre of electroacoustic music, employing the latter as an extreme case of a ”non-conventional musical style”. We subsequently also tested for measurement invariance across languages. Concerning music styles, measurement invariance of the original GEMS-25 was archieved only at the “configural level”, while the GEMS-28-G could reach at least “weak factorial invariance”. This demonstrates that only for the German version the contextual meaning of the construct remains constant across different musical genres with a reasonable fit. Nevertheless, researchers should be cautious when comparing GEMS factor scores achieved with very heterogenic musical styles in future studies, regardless in which language.

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Paper session

H306

09:00

PERCEPTION I

Different moment, different tune – How emotional perception of music changes with the time of day

Olivier BRABANT
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According to the classical music tradition of northern India, the ability of a song to induce certain emotions depends on the time of day: playing a song at the right time is said to maximise its emotional effect. Transposing this idea into a Western context, I decided to investigate this claim by combining findings in chronobiology with findings in music and emotion. It has already been established that our mood fluctuations follow a cyclical pattern. Besides, it is a known fact that our current mood influences our ability to perceive emotions. However, no one has ever linked these elements together and studied diurnal mood variations and their effect on perceived emotions in music. To test the hypothesis of a link between the two, I played Western film music excerpts to 36 participants at two different times, and asked them to rate the perceived emotions. The results show that sad and tender clips were rated higher on sadness and tenderness in the morning compared to the afternoon. Furthermore, the more tired participants were, the higher was their perception of fear in angry and fearful music. Looking at conventional medicine, chronopharmacology has already shown that the effects of a drug or the results of a medical test vary depending on when they are administered. Similarly, I believe that by adding the time factor to the planning and interpretation of music therapy sessions, their health benefits could be increased.

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Single chords convey distinct emotional qualities to both naïve and expert listeners

Imre LAHDELMA, Tuomas EEROLA
University of Jyväskylä, Finland

Friday

Paper session

H306

09:30

PERCEPTION I

Previous research on music and emotions has been able to pinpoint many structural features conveying emotions in music. The role of harmony, however, has been rather neglected in such research: the main studies in harmony are concerned only with questions of consonance/dissonance and harmonic progressions, ignoring emotional connotations of the chords as such. An online empirical experiment was conducted (N = 281) where participants evaluated pre-chosen chords on 9 given emotional dimensions (selected from three-dimensional model and GEMS). 14 different chords (common triads and seventh chords with inversions) were played with piano and strings sounds. In addition, participants' musical sophistication and prevailing affective moods were measured. Significant differences between the emotional connotations of chords' root positions and their inversions were found. Some chords played on the strings (major seventh, minor seventh, minor triad) scored moderately high on the dimension of "nostalgia/longing" – this is noteworthy mainly because in the past research "nostalgia/longing" is usually held as a musical emotion rising only from extramusical connotations and conditioning, not intrinsically from the structural features of the music. The data also corroborate results of previous studies conducted on triads: major triads were regarded as significantly positive, happy and joyful, while minor triads as negative, melancholic and sad. The preliminary results also suggest that musicians and "non-musicians" evaluate emotional qualities of the chords in a similar fashion, with a small tendency of musicians to rate the emotions in stronger fashion.

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The effect of expertise in evaluating emotions in music

Fabio MORREALE, Raul MASU, Antonella DE ANGELI, Patrizio FAVA
University of Trento, Italy

Paper session

H306

10:00

PERCEPTION I

This study investigates the role of expertise in the listener judgment of emotion in music. Previous studies suggest that the most important factors are mode and tempo, respectively influencing valence and arousal. The effect is stronger when the two parameters converge (major mode combined with fast tempo and vice versa), whereas tempo predominates when they do not converge. An open question is whether and how these judgments vary with the expertise of the listener. Our hypothesis is that non-experts will base their evaluation mainly on tempo, disregarding mode, which is more complex to be aware of. On the other hand, experts will take advantage of both sources of information. The experiment involved 40 participants. Experts were students who attended at least five years at music school. Non-experts had no formal musical training. Valence and arousal were manipulated independently in a 2*2 within-subjects design. Seven short piano pieces were composed and manipulated using the four conditions, for a total of 28 snippets. For each snippet, participants were asked to rate the values of the experienced valence and arousal on a seven-point scale. Results confirmed that for both types of listeners arousal was determined exclusively by tempo. Valence was primarily influenced by mode. Non-experts were also influenced by tempo for valence evaluation, while experts were not. As regards valence, mode is predominant in cases of divergent conditions but only for experts. Implications of these findings for the design of computing systems to allow non-musicians to create music are discussed.

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Friday

An emotion-based method to perform algorithmic composition

Chih-Fang HUANG[1], Enju LIN[2]
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Paper session

D109

09:00

COMPOSITION

The generative music using algorithmic composition techniques has been developed in many years. However it usually lacks of emotion-based mechanism to generate music with specific affective features. In this article the automated music algorithm will be performed based on Prof. Phil Winosr's "MusicSculptor" software with proper emotion parameter mapping to drive the music content with specific context using various music parameters distribution with different probability control, in order to generate the necessary music emotion automatically. When the emotion scenario varies, the generative music will be logically made via the emotion and context control based on the emotion classification method. This innovative technique not only generates the emotion music according to the scenario, but also plays the different content of the music every time to make listeners feel "fresh". The emotion music classification method and the automated music development can be analyzed as the reference for the input of the automated music program. The result shows the proposed method generating music emotions successfully such as happy, angry, sad, and joy, with the correspondent parameter mapping between music and emotion. Although this paper only demonstrates the possibility of emotion-based algorithmic composition, hopefully the proposed idea can be extended to apply into the fields including multimedia and game, to make the background music automatically generated any time according to the context changed by the interaction between human and machine.

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The automated emotional music generator with emotion and season features

Chi-jung LI[1], Chih-Fang HUANG[2]
[1]Yuan Ze University, Taiwan, [2]Kainan University, Taiwan

Paper session

D109

09:30

COMPOSITION

Nowadays, there are various types of automated music generating systems to automatically compose music clips instantly; however, those randomly-generated music clips still sounded uncomfortable and discordant. This paper attempts to add with emotion and season features to assist automated music generating systems based on algorithm, and then tries to make all generative music clips sound with harmonious and emotional meaning to listeners. The automated music generator used in this topic is not only based on algorithm but also adopts Thayer's emotional model as well as four season factors, so all music clips will not only express unique music emotions but also indicate all seasons which may match to equivalent emotions. In the experiments for this automated music generator, the resultant music is generated from high-valence presets presented as positive emotions and warmer seasons, while the opposite side presented as negative seasons as well as colder seasons. Furthermore, this kind of automated music generator can be used at the occasion of children or elders' caretaking so that the children or elder people's mood would be cheered up while listening to those enlightened music clips generated by the proposed music generator.

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Towards affective algorithmic composition

Duncan WILLIAMS[1], Alexis KIRKE[1], Eduardo MIRANDA[1], Etienne ROESCH[2], Slawomir Jaroslaw NASUTO[2]

[1]Plymouth University, United Kingdom; [2]University of Reading, United Kingdom

Friday

Paper session

D109

10:00

COMPOSITION

Automated systems for the parameterised manipulation of emotional responses by means of underlying musical feature correlation are driving an emerging field: affective algorithmic composition. Strategies for algorithmic composition, and the large variety of systems for computer-automation of such strategies, are well documented in literature. Reviews of computer systems for expressive performance (CSEMPs) also provide a thorough overview of the extensive work carried out in the area of expressive computer music performance, with some crossover between composition and performance systems. Although there has been a significant amount of work (largely carried out within the last decade) implementing systems for algorithmic composition with the intention of targeting specific emotional responses in the listener, a full review of this work is not currently available, creating a shared obstacle to those entering the field which, if left unchecked, can only continue to grow. This paper gives an overview of the progress in this emerging field, including systems that combine composition and expressive performance metrics. Re-composition, and transformative algorithmic composition systems are included and differentiated where appropriate, highlighting the challenges these systems now face and suggesting a direction for further work. A framework for the categorisation and evaluation of these systems is proposed including methods for the parameterisation of musical features from semiotic research targeting specific emotional correlations. The framework provides an overarching epistemological platform and practical vernacular for the development of future work using algorithmic composition and expressive performance systems to monitor and induce affective states in the listener.

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Assessment of musical emotions in treatment of affective disorders

Esa ALA-RUONA[1], Thomas WOSCH[2]

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Paper session

M014

09:30

THERAPY: AFFECTIVE DISORDERS II

A number of emotions can be present in a single therapy session or during the therapeutic process. From a client's perspective the process of recognising emotions and their connections to past, present and future conditions in one's life is of high relevance. One of the challenges in clinical work is to perceive and understand the emotional content of musical expression. Usually this is done by investigating subjective experiences and reflecting these through the mutual process of meaning making between a client and a therapist. More objective ways to analyse musical emotions would be needed when gaining knowledge on the core elements of music therapy, and its possibilities in producing new information on the client needs, strengths, and potentials. The analysis of musical emotions could be helpful in diagnostic work, and in the planning of needed treatment and rehabilitation. Furthermore, an objective tool for following up the therapeutic process and evaluating it would be needed for developing stricter and faster analysis methods of clinical data. The presentation discusses the approaches and methods currently available, especially Finnish improvisational psychodynamic music therapy (IPMT) and German emotion process oriented music therapy, and the development of new tools for clinical assessment and evaluation, especially Finnish Music Therapy Toolbox (MTTB) and German Computer Based Emotion Analysis (CoGeEmo).

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Friday

Paper session

M014

10:00

THERAPY: AFFECTIVE DISORDERS II

Improvisation and verbal reflection on emotions – Music therapy modulates fronto-temporal resting EEG of depressed clients

Jörg FACHNER

University of Jyväskylä, Finland

Fronto-temporal (FT) areas process shared elements of speech and music. Improvisational psychodynamic music therapy (MT) utilizes verbal and musical reflection on emotions and images arising from clinical improvisation. Music listening is shifting frontal alpha asymmetries (FAA) in depression, and increases frontal midline theta (FMT). Does MT have an impact on anterior resting state alpha and theta of depressed clients with comorbid anxiety? In a randomized controlled trial (RCT) with 79 clients, we compared standard care (SC) versus MT added to SC at intake and after 3 months. Correlations between EEG, Montgomery-Åsberg Depression Rating Scale (MADRS) and the Hospital Anxiety and Depression Scale – Anxiety Subscale (HADS-A), power spectral analysis (topography, means, asymmetry) and normative EEG database comparisons were explored. After 3 month of MT added to SC, MADRS and HADS-A scores were significantly decreased. Lasting changes in resting EEG were observed, i.e., significant absolute power increases at left FT-alpha, but most distinct for theta (also at left fronto-central and right temporoparietal leads). MT differed to SC at F7-F8 (zscored FAA, $p < .03$) and T3-T4 (theta, $p < .005$) asymmetry scores, pointing towards decreased relative left-sided brain activity after MT; pre/post increased FMT and decreased HADS-A scores ($r = .42$, $p < .05$) indicate reduced anxiety after MT. Verbal reflection and improvising on emotions in MT added to SC may induce neural reorganization in FT areas. Alpha and theta changes in FT and temporoparietal areas indicate MT action and treatment effects on cortical activity in depression, suggesting an impact of MT on anxiety reduction.

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Keynote 4

M103

11:00

Staging emotions in vocal performance

Jane DAVIDSON

University of Western Australia

Emotions drive our actions and reactions. In everyday contexts emotions are manifest as natural and often involuntary phenomena, whilst on stage in performance contexts their representation is a conscious process involving amplification for a specific theatrical communicative purpose – to reach the ears and eyes of the spectator. Performing emotions requires the activation and manipulation of relevant symbolic systems. This paper explores this process of 'staging' emotion in vocal performance, focusing specifically on the challenges of working with historical sources. Cases studies from seventeenth and eighteenth century opera explore the period concerns and the interpretative requirements demanded of performers in the past. John Bulwer's Chirologia & Chironomia (1644) and Gilbert Austin's Chrinomia (1806) provide some of the source material on the specific art of rhetoric, in which comprehensive instructions are presented on how to move the affections of the audience. The historical gap in both the meanings ascribed in these texts and the appropriateness of the 'staging' instructions for today's performer is then highlighted, drawing on Dene Barnett's The Art of Gesture (1987) which offers a twentieth century synthesis of many of the historical ideas. Then, working with twentieth and twenty-first psychological theories, ideas about translating the historical to the contemporary context are explored. Further case studies are presented that emerge from creative reflective practice and systematic experimentation.

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Emotion categories and affective nuance in music reviews around 1900

Christoph DENNERLEIN

University of Göttingen, Germany

Saturday

Paper session

M103

09:00

MUSIC ANALYSIS

Throughout the 19th century, emotion words often are the means of choice when it comes to describing music. Music critics, in particular, rely heavily on emotion ascriptions in their reviews. So far, this practice has not been studied in much detail. A closer look, however, is not just a historical desideratum but may also throw some light on recent psychological models of perceived emotions in music. In my paper, I will analyze emotion ascriptions in a large set of song reviews from German music journals between 1895 and 1905. When ascribing emotions in these reviews, critics usually start by categorizing the emotion they perceive in the music, mostly as either happiness, sadness, or passion (anger and fear as well as more cognitively complex emotions like hope occur far less frequently). Crucially, though, critics often won't stop at simple categorization but will further specify these emotions, in an attempt to capture what contemporary theorists used to call the "dynamic" quality of emotions (a term coined by Eduard Hanslick). For instance, instead of just categorizing a piece as joyful, critics tend to characterize this joy in a more nuanced manner as calm, carefree, or exuberant. The blend of categorization and nuance found in music reviews around 1900 reminds us that there is more subtlety to musical emotions than so-called discrete emotion models sometimes suggest. Although most emotion ascriptions involve some sort of discrete categorization, as required by these models, discrete models will generally fail to capture the affective nuances so important to critics.

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Emotions and new formal principles in Schoenberg's Verklärte Nacht op. 4

Susanna AVANZINI

University of Milan, Italy

Paper session

M103

09:30

MUSIC ANALYSIS

Verklärte Nacht is one of Schoenberg's earliest compositions. The composer suggests that, even if it illustrates Dehmel's homonymous poem, op. 4 can be appreciated as «pure music»: it is not real program music, because it describes only the nature and the expression of human feelings. To explain the relationships between music and poetry Schoenberg provides, in the programme notes, 16 music examples, and associates them to the changing moods of the two characters during the transfigured night. Promenading in a park in a clear moonlight night, a woman confesses to her lover that she is married with a man she does not love and she is expecting a baby from him. She walks in desperation waiting for, and fearing the sentence of her beloved one, but he is capable of ignoring the tragic situation: his love will transfigure her child so to become his own. In different parts of the work, some authors recognise figures of speech, while Adorno in two unpublished lectures given in Darmstadt in 1955 and 1956 maintained that, under a cover of traditional material, in Schoenberg's early works one could already find the structural principles that the composer will later develop in his twelve-tone method. This matter remains open, but I am convinced that new formal principles are hidden under Verklärte Nacht's "traditional" material too. Starting from some of the above-named music examples, I will try to illustrate how emotions become formal devices.

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Saturday

Paper session

M103

10:00

MUSIC ANALYSIS

Isolde's multiple orgasms: Sexology and Wagner's Transfiguration

Susan DE GHIZÉ

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The final scene of Tristan und Isolde, more commonly known as Isolde's Transfiguration, has invoked images ranging from religion to death; indeed, it has even been associated with an orgasm. Although this comparison is intriguing, it has lacked convincing evidence. I intend to uncover the similarities between Isolde's Transfiguration and orgasm by incorporating musical analysis and scientific data. Sexologists describe four phases of sexual response: excitement phase, plateau phase, orgasm phase, and resolution phase. The excitement phase develops from various sources of stimulation and correlates with the fluidity of the music that leads to the Transfiguration. Wagner's use of "endless melody" plays a central role in this stage as he evades cadences and elides phrases. The plateau phase starts at the beginning of the Transfiguration: having already heard the music in the Love Duet from Act II, we reach a higher level of anticipation in the final aria. The orgasm phase is limited to those few seconds during which myotonia developed from sexual stimuli occurs: when the orgasm finally does arrive (m. 1664), one can only imagine the metaphorical myotonia Isolde experiences. The resolution phase of the sexual cycle comes after the orgasm. Women have the potential to undergo another orgasmic experience from any point in the resolution phase. Indeed, one can interpret the Transfiguration as having not one, but two "orgasms" (m. 1681). The second orgasm is the stronger of the two, and the music immediately resolves, literally and sexually.

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Paper session

A103

09:00

PERCEPTION II

Personality shapes cognitive and affective processing of musical pitch in adults and adolescents

David ELLISON, Suvi SAARIKALLIO, Elvira BRATTICO

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The neurological processing of musical pitch features has been studied extensively, but rarely in the context of affective pitch processing, and rarely in adolescence. Here adults and adolescents listened to chord cadences with which they performed either a cognitive task – rating whether they sounded correct or incorrect – or an affective task – rating whether they sounded happy or sad. Perceived correctness and emotion was varied by having the final chord of each cadence be either mistuned or in tune, and major or minor. Subjects also answered to questionnaires assessing their personality traits. Electroencephalogram was recorded and event-related brain potentials (ERPs) were extracted. Adults were more accurate than adolescents in identifying as incorrect the mistuned chords. In adolescents, and especially those scoring high in conscientiousness, this was reflected in the enhanced early brain response to the first chord of the cadence during the cognitive task, indexing increased attentional resources. Conscientiousness in adolescents also augmented the early brain reaction (resembling the mismatch negativity, MMN) to sad-sounding chords. Openness to experience decreased the amplitude of the late positive ERPs to sad-sounding cadences in both adults and adolescents. High self-esteem instead affected the frequency of "correct" ratings and the amplitude of the positive ERPs to minor chords. Furthermore, in adolescents the early negativity to sad-sounding stimuli and that to incorrect stimuli were left-lateralized whereas in adults they were bilaterally distributed. Overall, the findings evidence the influence of listening mode and strategy, age and personality on musical pitch processing in the brain.

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Emotions perceived in music and speech: Relationships between psychoacoustic features, second-by-second subjective feelings of emotion and physiological responses

Eduardo COUTINHO[1], Nicola DIBBEN[2]

[1]Swiss Center for Affective Sciences, Switzerland; [2]University of Sheffield, UK

Saturday

Paper session

A103

09:30

PERCEPTION II

There is strong evidence that the structure of affective responses to auditory stimuli is largely dependent on dynamic temporal patterns in low-level music structural parameters. Previous studies have shown that spatiotemporal dynamics in a small set of psychoacoustic features can predict two fundamental psychological dimensions of emotion: valence and arousal. The study reported here aims to determine the extent to which specific physiological responses can be used in tandem with psychoacoustic cues to predict emotional responses to both music and speech. In a behavioural study we collected two main types of data: continuous ratings of emotion perceived while listening to extracts of music and speech, using a computer interface which modelled emotion on two dimensions (arousal and valence), and physiological measures (respiration, heart rate, skin conductance, skin temperature, and blood pressure) taken while listening to each stimulus. Then we analysed the existence of linear and non-linear correlations and associations between psychoacoustic features extracted from music and speech, physiological activity, and self-reported arousal and valence. For both domains, we found very strong correlations showing that physiological measures and psychoacoutic cues account for a large proportion of the variance in reported arousal and valence. Strong correlations also emerged between psychocoustic cues and physiological responses, suggesting a possible route for the elicitation of subjective feelings. When comparing music and speech directly we found that while significant changes to physiological measures for speech stimuli are confined to a small number of features, physiological responses for music are much more diffuse across the various measures.

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Influence of musical context on the perception of emotional expression of music

Michal ZAGRODZKI

Chair of Music Psychology, Fryderyk Chopin University of Music, Warsaw, Poland

Paper session

A103

10:00

PERCEPTION II

Factors influencing the perception of emotional expression of music include those related to music itself, to the listener, and to the context. Among the latter there is also music, as we rarely listen to a single piece. A simple experimental study has been carried out into the effect of music listened to immediately beforehand on the perception of the emotional expression of a musical piece. The following variables were involved: type of emotional expression of music conceived in terms of a most basic sad-joyful dimension, initial and final mood of the listeners, their professional musical education vs. lack thereof, age, and gender. The subjects were students of three age groups: 9, 15, and 20-23 year olds, both from non-music and music schools. Each group listened to a sequence of two short pieces of music of the opposite emotional expression in two experimental conditions: sad-joyful and joyful-sad. The perceived expression of the listened music, as well as the initial and final mood of the subjects, were recorded with a simple self-report measure. The results demonstrated that the perception of emotional expression of the musical piece was entirely independent of the influence of the preceding music. The initial mood played no role. This was the case consistently in the musically educated and non-educated subjects, in all age and gender groups. Three patterns of changes in mood during the session of listening were also described: mood increase, mood decrease and mood stability. The latter proved to grow among musically educated with age.

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Saturday

Paper session

H306

09:30

PREFERENCE

What lies behind musical preferences: Putting the pieces together

Gerard MADDEN, Roddy COWIE

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Psychology has theoretical and practical reasons to study musical preferences. Previous research has identified relevant variables, involving genre, personality, emotional impact and use of music. Our research has extracted the most promising variables and brought them together so that their relationships can be explored. Data from each participant covers key personal variables, emotional responses to music, and judged suitability of different genres for various uses. Large samples are needed to deal with so many variables; we aim for 200 participants, of whom over 100 have been tested. Preliminary analysis reveals intricate relationships. Comparing across genres, uses of music are linked to the emotions they evoke. Two GEMS (Geneva Emotion Music Scale) categories (energy and joyful activation) predict most uses of music – listening, mood control, socialising, partying, exercise and travel. Contrastingly, genres that evoke transcendental emotion are preferred for worship/meditative uses, and avoided for partying or socialising. Other factors also impact; IQ predicts liking for classical and rock, and negative evaluation of rhythmic/urban music; and religious orientation predicts liking for classical music, but dislike for rock. The patterns are complex, but appear to be plausible. Our results will be discussed in the context of the theoretical value and practical potential of research in this area.

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Paper session

H306

10:00

PREFERENCE

Music in gambling contexts: What are individuals' perceptions of music experienced in gambling contexts and why do individuals self-select music to accompany gambling?

Stephanie BRAMLEY, Nicola DIBBEN, Richard ROWE

The University of Sheffield, United Kingdom

Music influences behaviours in everyday contexts and is a factor which can influence gambling behaviour. Experimenter-selected background music has been found to influence indices of gambling behaviour in laboratory gambling experiments. However, less is known about gamblers' experience of music in real-life gambling contexts. To date research has considered music's utilisation in gambling environments where fruit machines are located. Therefore further research is required to determine gamblers' responses to music in different gambling environments and when playing other gambling activities. Opportunities for individuals to gamble have increased; gambling activities can be accessed in both traditional (e.g. casinos, bookmakers) and remote gambling environments. Remote gambling permits individuals to gamble using technological devices and the same can be observed for music, as listeners access music using sophisticated electronic equipment. It is therefore feasible that individuals self-select music to accompany gambling. In the present study an online questionnaire was administered to examine gamblers' responses to music in traditional and remote gambling environments; the perceived functions and influences of music on gambling behaviour. This is the first study to examine gamblers' motivations for self-selecting music to accompany gambling. Our findings will be presented at the conference, where we will discuss the implications of music listening for gamblers and consider how future research could further the understanding of why music influences gambling behaviour.

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Saturday

GEMS-45: A promising tool for GIM therapy research. A corpus-based study of emotion terms from the Geneva Emotional Music Scale in 58 transcriptions from GIM therapy sessions

Hallgjerd AKSNES[1], Svein FUGLESTAD[2]

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Paper session

D109

09:30

THERAPY: METHODS II

This paper is based on a comparative study of transcriptions from 58 GIM (Guided Imagery and Music) sessions; a music-therapeutic method in which clients listen to selected music programs, focusing on the imagery evoked by the music. The study is part of the 5-year Norwegian Research Council project “Music, Motion, and Emotion: Theoretical and Psychological Implications of Musical Embodiment”. We have established a linguistic corpus to facilitate the comparison of the transcriptions. The specific aim of this particular substudy is to apply the Geneva Emotional Music Scale (GEMS-45) to our study of GIM transcriptions by means of corpus searches for emotion terms from GEMS-45 (translated into Norwegian). In the paper several aspects of the study are problematized – most notably the asymmetric relation between the GIM travelers' emotional experience and their linguistic expression of this experience; the fact that the emotion terms in the GIM sessions have arisen spontaneously, not from ratings of music-evoked emotions; and the fact that the emotions evoked during GIM therapy are determined not only by the sounding music, but also by the therapeutic context itself. However, our findings suggest that despite these problems, GEMS-45 is a fruitful tool for assessing emotional experience in GIM therapy; most notably because the GEMS-45 is aimed specifically at musically evoked emotions, and is thus a promising method for elucidating the role of music in the powerful emotional experience of GIM therapy. We will relate and discuss the advantages of GEMS- 45 to other adjective checklists used in the field.

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Emotional implications after Vibroacoustic Therapy (VAT)

Olav SKILLE

VIBRAC, Norway

Paper session

D109

10:00

THERAPY: METHODS II

Physical and mental well-being are closely related. VAT was originally designed for treating spasticity, pains and neuro-muscular syndromes. The basic element of VAT consists of a single, pulsating frequency, and a standard therapy session lasts 23 minutes. Advanced contents can contain up to 4 simultaneous frequencies, eventually also an upward or downward glissando frequency. The vibroacoustic frequency spectrum is defined by two octaves, ranging between 30 Hz and 120 Hz. Standard pumping frequency is 6,8 seconds between peaks. The communicative elements in music are: pitch, rhythm, dynamics and timbre. The VAT stimuli consist of all these elements, but they are reduced to a technical minimum. Some critical reports have questioned whether VAT can be called Music Therapy (MT). Experience-based research and practical use of VAT has found that we find spasmolytic and muscle relaxing effects, as well as marked, but varying effects on the vegetative system. A pilot study on stress hormones has found a marked effect on ACTH (adrenocorticotropic hormone), beta-endorphin and cortisol. As stress-related problems are today's most prominent reductors of life quality, it is evident that stress reduction also will have a marked effect on our emotional status. Monotony is an important element in MT relax programs. VAT contains the most soothing musical compositions that we know of. There are no words that can explain these reactions. They must be felt, and this experience is offered at the VIBRAC centre here in Jyväskylä.

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Saturday

Keynote 5

M103

11:00

Brain correlates of music-induced emotions

Stefan KOELSCH

Freie Universität Berlin, Germany

What happens in the brain when music evokes emotions? Functional neuroimaging and lesion studies show that music-evoked emotions can modulate activity in virtually all “limbic” and “paralimbic” brain structures. These structures are considered as core structures of emotional processing, because their lesion or dysfunction is associated with emotional impairment. They are crucially involved in the initiation, generation, detection, maintenance, regulation and termination of emotions that have survival value for the individual and the species. Therefore, at least some music-evoked emotions involve the very core of evolutionarily adaptive neuroaffective mechanisms. This suggests that music-evoked emotions are “real emotions”, rather than merely “affective illusions” of our minds. Because dysfunctions in limbic and paralimbic structures are related to emotional disorders, a better understanding of music-evoked emotions and their neural correlates can lead to a more systematic and effective use of music in therapy.

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Paper session

M103

13:30

THERAPY: AFFECTIVE DISORDERS III

A comparison of professional music therapists and music therapy students as listeners of clinical improvisations

Sanna-Mari KONTONIEMI

University of Jyväskylä, Finland

Recently the focus of music therapy research has been on therapy of clients with depression. In addition to that, in music psychology the interest in felt and perceived emotions in music has been a clear trend for two or even three decades. This experimental study focuses on perceived emotions in improvisational music from music therapy sessions. In the experiment, participants (n=30) are asked to listen to 21 short excerpts from seven improvisations that clients with depression have played during their music therapy process. Meanwhile or after the listening task, participants are asked to fill in on a paper all the basic emotions (joy, sorrow, anger, fear, tenderness) they heard in the improvisations and how clearly those emotions were present. Which, if any, basic emotions do participants recognize in the improvisations? Is there any difference in strength of recognized emotions between students and professionals? Do the emotions participants heard and the issues dealt in therapy session have any kind of connection? These are the questions this study tries to answer. The author assumes it is possible to hear at least some basic emotions also in the clinical improvisations and see the connection between conversation topics and music. Results of earlier studies seem to support this: some of the basic emotions have been perceived from any kind of (non-clinical) music, to some extent even across cultures. Furthermore, also in accordance with earlier studies, professionals may rate higher the emotions they heard in the excerpts.

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Music Therapy as an effective intervention in the treatment of depression in a patient with Korsakoff's syndrome

Stefano NAVONE

Health Mental Center Ulss 4 Alto Vicentino, Italy

Saturday

Paper session

M103

14:00

THERAPY: AFFECTIVE DISORDERS III

The main aim of this study is to demonstrate the efficacy of the Music Therapy intervention and the possibility of influencing positively on depressive symptoms of a patient with this Syndrome making significant improvements in the general condition and in particular on the "activation versus apathy". The Music Therapy approach is mainly based on a sonorous music relationship between the patient and music therapist. Active Music Therapy facilitates the expressive process, increasing communicative-relational abilities and modulation and regulation of emotions. This approach is based on intersubjective psychological theories and allows "affect attunement" moments. After 24 sessions of Music Therapy treatment, a significant decrease in depressive symptoms and an increase in the level of activation vs. apathy were observed in the patient; these results are confirmed by the analysis of the clinical tests and remain constant even after a follow-up to a month. Four independent observers analyzed the Music Therapy process from a quantitative point of view through videotapes of each session. The Music Therapy treatment showed its effects on areas involved in emotional processing and regulation, such as the limbic and paralimbic structures. Music Therapy can be an effective intervention for improving the quality of life and supporting caregivers in the management of Korsakoff Syndrome.

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"If I could only hear my mother sing again"; Music therapy and Huntington's disease

Monique VAN BRUGGEN-RUFI

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Paper session

M103

14:30

THERAPY: AFFECTIVE DISORDERS III

When words fail to express one's emotions, music kicks in. The famous American folksinger/guitarist Woody Guthrie (1912 – 1967) once wrote a song called "if I could only hear my mother sing again". He wrote the song to honor his mother who had suffered from Huntington's disease, as did Woody himself. The disease had taken away most of his mother's functions, including the ability to speak. But she could still sing for a long time. Huntington's disease (HD) is a rare neurodegenerative disorder of the central nervous system. The disease is characterized by motor – and psychiatric disturbances and cognitive decline. Since there is no cure for HD, all treatment is aimed at improving quality of life. In this presentation the emphasize will be on the effects of Music Therapy on symptoms and signs that are described in patients with HD such as depressed mood, anxiety, irritability and apathy. The presence of psychopathology has an important negative impact on daily functioning and quality of life for patients and caregivers, and increases the risk of institutionalization and suicide. The presentation will include video-footage to show the audience how Monique works with HD patients. Songwriting is a method that she uses frequently. This is the perfect way to express one's emotions. While the ability to speak is getting worse over time, the patients' desire and ability to sing will stay for a long time. This is one of the last resources to express one's emotion, as you can see on the video.

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Saturday

Paper session

A103

13:30

EMBODIMENT

Embodiment of love in Handel´s opera Giulio Cesare

Marjo SUOMINEN

Institute of Musicology, University of Helsinki, Finland

By studying metaphors of love in Handel's opera Giulio Cesare in Egitto, I will introduce how it is depicted by the protagonists' arias; via Cleopatra's and Caesar's musical relations, as a prevailing message. The atmospheric tone paintings set to the musical highlights of the protagonist arias answer the questions: how is love defined in Giulio Cesare? What kind of musical signs of love are there to be found and what will they tell us? Love is an essential theme in the work because the arias' foci are interlocked by the affectual tensions. These have encouraged various performance views of the work, for instance: ENO's "epoch" depiction in 1984; Sellar's "satirical" version in 1990; and Glyndebourne's "colonialist" perspective in 2005. I apply the theory of affects in music appearing in the writings by Handel's colleague Johann Mattheson (Das Neu-Eröffnete Orchestre, 1713) grounded on Classic Aristotelian and Cartesian ideals (Aristotle's Rhetoric, Descartes' Les Passions de l'âme). It also relates to so called Hippocratic-Galenic four elements, temperaments or humours theory by which I will show the different representations of the opera's characters, i.e. bodies as a cathartic (ethic, Lutheran based) implication by Handel.

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Paper session

A103

14:00

EMBODIMENT

Embodiment and verbalization. Metaphor analysis in investigating experiences of listening to sad music

Henna-Riikka PELTOLA, Tuija SARESMA

University of Jyväskylä, Finland

Affective experiences of listening to self-identified sad music are investigated in this study. Previous studies have concentrated on the emotions induced by music by rationalizing and labeling emotions. Since the experience of listening to music is both affective and cognitive, the subjective experiences have not been fully captured by using these methods. This study strives to acknowledge both of these aspects examining the experiences from a new point of view that requires broadening the methodological array. The conceptual framework guiding the analysis is founded on the argument that our subjective experiences are fundamentally embodied. 373 people answered open-ended questions about their experiences of listening to sad music, and content analysis method was used to identify themes not attainable by means of conventional self-report methods of emotions. The analysis focused on how the experiences are lived through and explained to others by metaphors and interactions between the body and the environment. The analysis revealed that the experienced emotions in situations, where sad music is involved, are often considered to be ambiguous e.g. causing both anxiety and enjoyment. The verbalizations about body and embodiment of the emotions were of particular interest. These verbalizations were categorized thematically into three sections: (I) At the mercy of music; (II) Spatial metaphors; and (III) Metaphors of movement. Interpretations of different metaphors used in describing of music, affective states, and body are underlined in this study.

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Rhythmic entrainment and corporeal tension building in communicating emotions through music

Hans T. ZEINER-HENRIKSEN
Department of Musicology, University of Oslo, Norway

Paper session

A103

14:30

EMBODIMENT

Research in neuroscience points to connections between motor processes and emotional reactions. These connections suggest a possible path from music to emotion that has not been investigated thoroughly. Rhythmic entrainment has previously been considered as an underlying mechanism to emotions in music, but has not been discussed in view of actual corporeal movement. Twenty-four respondents (12 male, 12 female, 12 with less than five years of musical training, 12 with more than five years of musical training) initially listened to a piece of music of their own choice, and pressed a button whenever they felt any physical reactions (goose bumps, chills, teary eyes, etc.). Simultaneous measurements of skin conductance were taken. This procedure was repeated with a 10 min. series of the same musical excerpts for all respondents. The results from the self-elected music cover a diversity of musical elements from many music genres (from electronic dance music to classical choir music). However, examples of ascending melodic lines, crescendos, and increasing rhythmic intensity are numerous. These findings verify results from non-selected music where several respondents (from 60 to 80%) had corresponding results from the two measurements pointing to specific sections in the music where the same musical elements were central. In line with the notion of embodied cognition, music is seen as fundamentally metaphoric and fundamentally related to our human corporeality. Results are discussed in relation to concepts such as rhythmic entrainment and corporeal tension building.

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The gestures mediating emotion in Rameau's Les Sauvages

Assi KARTTUNEN
Sibelius-Academy, Finland

Paper session

A103

15:00

EMBODIMENT

In my artistic research project I study rhetorical actio (voice, gesture, movement and mien) in the living body of the present-day performer. The project started in August 2011 as a collaboration of two musician-researchers; DMus Päivi Järviö, mezzo soprano and DMus Assi Karttunen, harpsichordist. The project includes concerts, workshops, rehearsals, video recordings, experiments and demonstrations as well as articles describing the working processes. Thus the approach could be called embodied study of historical performing practices. The study of movement related to music is one of the key areas of modern music research. Music perceived as sound and movement brings forth the musician´s bodily way of reading the score. The movements can include sound-producing, sound-accompanying, communicative and sound-modifying gestures. In my paper I am focusing on a slightly new subcategory; the emotion-facilitating gestures in the performance of Les Sauvages by Jean-Philippe Rameau including leaps, jumps and stamps. To conclude I discuss music-related movements' roles as mediating emotions. As a sideline I will put into question the canon of understanding the baroque affects as "consisting of rationalized emotional states".

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Saturday

Paper session

H306

13:30

CLASSIFIC.

A machine-learning approach to acoustic-based classification of musically expressed emotions across cultures

Tuomas EEROLA[1], Petri LAUKKA[2]

[1]University of Jyväskylä, Finland; [2]Stockholm University, Sweden

Past research has established that a large range of emotions can be adequately communicated to listeners within and across cultures. Also, the acoustic and musical cues contributing to such communication have been explored, although these efforts are often based on relatively small data sets. Here we analyzed the materials from one the most extensive data sets to date, which consists of performances of musically expressed emotions from professional bowed-string musicians from different musical traditions (Swedish folk, Hindustani classical, Japanese traditional, and Western classical) performing three tasks (single tones, standard-content, and emotion-specific pieces) to convey 11 emotions. We classified these emotions using an optimized set of acoustic and musical cues across and within cultures and types of tasks (297 excerpts in total). A Random Forest modeling approach provided robust cross-validation and allowed the identification of the key features contributing to emotion both within and across cultures. The classification results revealed higher-than -chance prediction accuracy (chance level = 9%) for basic emotions (31-49%) within cultures, but accuracy was significantly reduced (11-33%) for cross-cultural conditions. For non-basic emotions, the accuracies were also consistently lower. The most reliable cues across cultures and tasks were identified, with cues related to dynamics ranked first, followed by timbre, articulation, rhythm and tonality. The findings support the dialect theory of emotions in which a host of universal cues are moderated by culture-specific cues.

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Paper session

H306

14:00

CLASSIFIC.

Estimating tempo and metrical features by tracking the whole metrical hierarchy

Olivier LARTILLOT, Donato CEREGHETTI, Kim ELIARD, Wiebke J. TROST, Marc-André RAPPAZ, Didier GRANDJEAN

Swiss Center for Affective Sciences, University of Geneva, Switzerland

Meter is known to play a paramount role in the aesthetic appreciation of music, yet computational modelling remains deficient compared to other dimensions of music analysis. Classical audio-based methods detect the temporal repartition of notes, leading to an onset detection curve that is further analysed, in a second step, for periodicity estimation. Current state of the art in onset detection, based on energy and spectral flux, cannot handle complex but common musical configurations such as dense orchestral textures. Our proposed improvement of the flux method can detect new notes while ignoring spectral fluctuation produced by vibrato. Concerning periodicity estimation, we demonstrate the limitation of immediately restricting the range of tempi and of filtering out harmonics of periodicities. We show on the contrary how a complete tracking of a broad set of metrical levels offers a detailed description of the hierarchical metrical structure. One metrical level is selected as referential level defining the tempo and its evolution throughout the piece, by comparing the temporal integration of the autocorrelation score for each level. Tempo change is expressed independently from the choice of a metrical level by computing the difference between successive frames of tempo expressed in logarithmic scale. A new notion of dynamic metrical centroid is introduced in order to show how particular metrical levels dominate at particular moments of the music. Similarly, dynamic metrical strength is defined as a summation of beat strength estimated on dominant metrical levels. The model is illustrated and discussed through the analysis of classical music excerpts.

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Measuring and classification of emotions using free-choice profiling

Judith LIEBETRAU[1], Sebastian SCHNEIDER[2]

[1]Ilmenau University of Technology, Germany; [2]Fraunhofer IDMT, Germany

Saturday

Paper session

H306

14:30

CLASSIFIC.

Music is often defined as a "language of emotion". For humans it is a reasonable easy task to categorize music in terms of its emotional effect. When it comes to automatic categorization of emotionality, several problems have to be faced. Decoding the emotional content algorithmically is a cross-disciplinary task, involving signal processing and machine learning, which also requires an understanding of auditory perception, psychology, and music theory. Especially generating ground truth data for development, training and validation of classification systems is a very crucial part, where a broad understanding of emotion perception and the measurement of emotion is required. We briefly describe obstacles of measuring emotions evoked by music and propose Free Choice Profiling (FCP) to overcome drawbacks of common methods. FCP is originally developed in food sciences, but has been adapted to quality evaluation in recent years. By applying FCP, subjects define individual emotional terms by themselves. The rating of the intensity of the emotional experience during mu-sic perception is done with the help of adjectival scales, where each subject uses their emotional terms as labels. To prove the feasibility of FCP for measuring affective states induced by music, several experiments were carried out and results are presented in this paper.

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Transformation of feelings – Richard Wagner and his audiences

Sven-Oliver MÜLLER

Max Planck Institute for Human Development, Germany

Symposium 5

D109

13:30

MUSIC & EMO. IN HISTORY

Richard Wagner is not only known for his monumental music dramas but also for the notorious education of his audiences. Both, his style of interminable compositions and his silent, ordered conception of musical performances, offended the common habits of the 19th century audiences. Devotees of Wagner made themselves visible by their emotional demonstrations of an allegedly superior social status. They started to listen silently and took part in the important change in musical life to control emotional expressions in the auditorium. One could observe a bilateral negotiation process of different taste publics. Wagnerians and their enemies gradually began to shape the new emotional orders within the audiences. The mutual perception in the auditorium triggered feelings of pride and honour within the group of educated musical experts, thereby gradually stimulated a new disciplined appreciation of music. Richard Wagner himself did all he could to promote the silent habits of concert audiences in the operatic realm. He makes the perfect case to show, how musical text and musical context interacted. The semi-sacral cult of him also stimulated a reverent reception of Richard Wagner's works. But the cultural importance of his highly original music can hardly be overestimated. Apart from the outstanding dramatic quality of Wagner's operas, the constant flow of music does not leave any space for the inappropriate expression of noisy enthusiasm. Wagner's audiences were thus hardly able to escape the emotional impact of his music, for his music never ended.

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Saturday

Symposium 5

D109

14:00

MUSIC & EMO. IN HISTORY

Punk – Establishing orders of deviant emotions

Henning WELLMANN

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The emergence of punk music in the mid-1970s brought about a new phenomenon in popular music culture: the public display and intense acting out of formerly rather deviant and privatized emotions like anger, rage or wrath. Thereby punk was consciously questioning, violating and partly negating existing emotional rules and standards. Conspicuously not only the punk artists created new ways of presenting anger-related feelings, but also the punk audiences established new ways of emotional expression and experience deeply intertwined with newly developed social and cultural practices, like e.g. new dancing styles or listening habits. Far from being chaotic individual outbursts of angry emotions, like one might expect here, these new forms of emotional engagement in music were right from the start interwoven with and shaped by social and cultural orders of emotional expression and experience. On the basis of an analysis of the early German Punk movements between 1977 and 1987 the process of dealing with such orders, altering them and finally establishing new ones will be elaborated. By taking a close look at the social and cultural practices, including the development of new musical aesthetics and new modes of subjectification the early punk scenes provided in the context of a new musical style, the emergence of a new and deviant nexus of music and emotions will be outlined.

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Symposium 5

D109

14:30

MUSIC & EMO. IN HISTORY

The Liszt concert as an emotional space in 19th-century Berlin

Anabelle SPALLEK

Max Planck Institute for Human Development, Germany

Taking the "Lisztomania" as an example, the concert in the first half of the 19th-century will be analysed as an emotional space. This space was the materialisation of an emotional order. On the one hand, the meaning of this order for emotional subjectificaction in the 19th century will be examined, on the other hand, the concert will be analysed as a space of juxtapositional and coexisting orders in the historical context of the Lisztomania in the Prussian capital Berlin 1841/42. Liszt recreated the romantic piano concert performing in different locations and towns. He invented the ‚recital' so he could perform on his own and he positioned the piano in a new way so that the audience would be able to see his face while he performed. Liszt made use of the developments in the piano action to create new sounds effects. The audience expressed their feelings by applause and bravos. Some even collected things Liszt had touched as devotional items. Music was an important practice for emotional subjectification in Romanticism. According to the aesthetics of feeling, music was an expression of emotions. But one could experience music only live. The concert was a social space especially used for cultivating emotions. People and social goods were situated in a specific relation to each other and connected by practices. This paper examines how the concert as a space was (re)created by positioning practices and how this material order structured the actions and experiences of its listeners.

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Saturday

"All together now" – Emotional styles in Beat music

Tim BIERMANN

Max Planck Institute for Human Development, Germany

Symposium 5

D109

15:00

MUSIC & EMO. IN HISTORY

The screaming fans at a Beatles concert, the liberated bodily movements of twist, the violence at concerts and the rise of club culture: The Beat fans, bands and producers of the 1960s found fundamentally new ways and places of expressing their emotions towards and with music, creating new emotional styles in the process. These styles, which are the focus point of my talk, are understood as specific sets of emotional practices and discourses that define the emotional order of a community like, in this example, the Beat community. By creating new ways of expressing their emotions towards or with music, artists and audiences challenged existing emotional orders and pushed the boundaries of what could be thought, done and felt. I will explain how the Beat fans developed new ways of expressing their emotions by analyzing the creation of emotional styles e.g. through cultural artifacts and mass media. Especially in the course of events in which concerts lost their culture-defining value due to the emergence of records, magazines and collectible paraphernalia of all kinds, the importance of mediatization processes becomes apparent. New ways of distribution allowed the Beat scene to spread past the boundaries of its club locations and facilitate the construction of emotional styles transcending local and site-specific restrictions. Analyzing these processes of the emergence of a globalized fan community, including their own emotional styles reveals elucidating insights into the development of emotional orders.

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Aural-based detection and assessment of real versus artificially synchronized string quartet performance

Panos PAPIOTIS, Perfecto HERRERA, Marco MARCHINI, Esteban MAESTRE

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Paper session

M014

13:30

PERFORM. III

In a musical ensemble musicians can influence each other's performance in terms not only of timing but also in other aspects of the performance such as dynamics, intonation, and timbre. The goal of this work is to test whether this influence can be perceived by a listener from an audio recording solely. We utilize a set of string quartet recordings where every piece is recorded in two experimental conditions: the solo condition, where each musician performs alone; and the ensemble condition, where the musicians perform together after a brief rehearsal. Using state-of-the-art audio analysis/ synthesis methods, we artificially synchronize the recordings in the solo condition note-by-note, thus generating a set of pseudo-ensemble performances where there is no interaction between the musicians. We then carry out a series of listening tests: first, the subjects are tasked with comparing the quality of the performance and the degree of coordination for the two recordings, without knowing that one of them is artificially synchronized. Then, we reveal to the listeners that one of the two versions is artificially synchronized and ask them to point out which recording is which. The results suggest that listeners cannot easily discriminate between the real and artificially synchronized recordings; furthermore, the accuracy of their judgements appears to be affected by the listeners' level of musical training as well as the piece that is performed.

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Paper session

M014

14:00

PERFORM. III

Emotions in concert: Performers' experienced emotions on stage

Anemone VAN ZIJL[1], John A. SLOBODA[2]

[1]Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland; [2]Guildhall School of Music and Drama, United Kingdom

Music is often said to be expressive of emotions. Surprisingly, not much is known about the role of performers' emotions while performing. Do musicians feel the musical emotions when expressing them? Or has expressive playing nothing to do with the emotional experiences of the performer? To investigate performers' perspectives on the role of emotions in performance, we conducted qualitative in-depth interviews with nineteen musicians teaching or studying at a European conservatoire. In the interviews, musicians were first asked to describe a recent performance experience in as much detail as possible, then to make a visual representation of their experiences on stage, and finally, to answer some general questions about the role of emotions in performance. Qualitative Thematic Analysis of the interview transcripts revealed a difference between performance related emotions and emotions related to the music. In addition, a difference was found between emotional and expressive playing. To allow the music to be expressive of emotions, performers seem to feel the musical emotions to some extent, while they make sure to have the technical ability to express them on their instrument, and stay in control of their playing.

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Paper session

M014

14:30

PERFORM. III

Inducing rules of ensemble music performance: A machine learning approach

Marco MARCHINI, Rafael RAMIREZ, Panos PAPIOTIS, Esteban MAESTRE

Universitat Pompeu Fabra, Spain

When interpreting a piece, ensembles keep synchronization among their voices while introducing expressive deviations to the score. Existing literature on expressive music performance has described in several ways how solo musicians intuitively shape each note (e.g. timing and dynamics) in relation to local/global score contexts. However, in ensemble performance, each individual voice is executed simultaneously and in relation to other voices. We present an exploratory study in which the performance of a string quartet is recorded and analysed by a computer. We use contact microphones to acquire four sound signals from which a set of audio descriptors is extracted individually for each musician. Moreover, we use motion capture to extract bowing descriptors (bow velocity/force) from each of the four performers. The gathered multimodal data is used to align the performance to the score. Then, from the aligned data streams, we obtain a note-by-note description of the performance by extracting note descriptors (onset-deviations, loudness) and quantifying inter-musician asynchronies and discrepancies. We apply machine-learning algorithms to induce human-readable rules emerging from the data in an unsupervised fashion. The dataset consists of three performances of Beethoven's quartet n°4 in C minor by a group of professional musicians: a "normal", a "mechanical" and an "over-emphasized" execution. We run our analysis on the three conditions separately as well as jointly, deriving rules specific to each condition and rules of general domain. Apart from encoding knowledge of expressive performance, the rules shed light on how ensemble entrainment and musicians' roles are affected by score context.

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Saturday

Paper session

M014

15:00

PERFORM. III

What emotions and free associations characterize different musical styles?

Florian ECKL, Erica BISESI, Richard PARNCUTT

University of Graz, Austria

In a previous work, Bisesi, Parncutt, & Friberg extended Director Musices (DM) – a software package for automatic rendering of expressive performance that relates the expressive features of a performance not only to global or intermediate structural properties, but also to local events (grouping, metrical, melodic and harmonic accents). Friberg & Bisesi applied the new rule system to model stylistic variations corresponding to different historical periods and styles in piano music. In this project, we extend pDM – a pure data system for real-time expressive control of music performance – by adjusting algorithmic formulations inspired by a theory of musical accents and by introducing new gestural interfaces based on qualitative data. First, different presets corresponding to different stylistic conventions and interpretations are implemented in DM, and corresponding sound files are generated and recorded. Second, we ask 20 participants (10 musicians and 10 amateurs) to rate the character of the performances on rating scales depending on a previous categorization involving emotions and free associations. Terms involve basic and complex emotions, and free associations such as static/ dynamic and living/non-living things. Results will be used to map music expression into multidimensional spaces of emotions and free associations, and to develop new gestural interfaces in pDM.

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Keynote 6

M103

16:00

Emoacoustics: How music and sound induce emotions

Daniel VÄSTFJÄLL

Linköpings universitet Institutionen för beteendevetenskap och lärande, Sweden

Music (and the “sound” of music) induces emotions in the listener. In recent years a great deal of progress has been made to understand when and how music and sound induce emotions. In this talk I will present a research program called Emoacoustics that aims to systematically document determinants of auditory-induced emotions (i.e. emotions aroused by sound/acoustics, including music). According to the emoacoustics framework four broad categories of determinants can be identified: 1) Physical characteristics of the sound, 2) Psychological determinants such as the mechanisms underlying emotion induction through sound, 3) Spatial characteristics (the space the music/sound occur in), and 4) Multimodal determinants (the fact that we do not only hear with our ears but also other modalities such as vision). I will review research findings from both sound and music that can be categorized into these four categories. This framework can be used to understand how sound and music (in its most basic sense) can induce emotion. Examples of how the emoacoustics framework has been used to design information/warning sounds as well as musical excerpts intended to induce emotions will be given.

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Symposia

Musical emotions in the brain

Lauren STEWART[1] (Discussant), Mikko SAMS[2], Elvira BRATTICO[3,4], Peter VUUST[5], Petri TOIVIAINEN[4]

[1]Goldsmiths, University of London, United Kingdom; [2]Aalto University, Finland; [3]Cognitive Brain Research Unit, University of Helsinki, Finland; [4]Center of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland; [5]Royal Academy of Music, Aarhus, Denmark and Centre of Functionally Integrative Neuroscience (CFIN), Aarhus University Hospital, Denmark

Sympo. 1

M103

16:00

Tuesday

The sparse studies utilizing neuroimaging methods with healthy adult subjects for identifying the neural correlates of emotions in music have obtained discrepant findings. Following Ekman's theory of basic emotions in the visual domain, these studies have mainly investigated simple, discrete categories of emotions, namely happiness, sadness, and occasionally fear. It has been found that musical emotions activate a network of limbic and paralimbic brain areas, including the orbitofrontal and cingulate cortices, the parahippocampal gyrus, insula and ventral striatum. This symposium will comprise recent findings and proposals aimed at composing a more unified and coherent knowledge of the neural substrates of musical emotions by following novel theoretical or methodological strategies. First, Mikko Sams will present evidence pointing at a novel vision of the circumplex model of emotions, and particularly of the dimension of valence and its application to the music domain. Second, Elvira Brattico will illustrate how the degree of attentional focus and intentionality in the processing of the emotional aspects of music, along with individual factors, might modulate the limbic and cortical neural responses to affective music. Third, Peter Vuust will propose a theory accounting for musical pleasure derived from rhythm. Finally, Petri Toiviainen will introduce a new method of voxel-based analysis of brain signal in relation to continuous behavioral affective ratings and to continuous listening to music, which represents a promising tool to predict the neural substrates of musical emotion from the brain signal.

Brain-computer interfaces, emotion and music

Rafael RAMIREZ[1] (Discussant), Rafael RAMIREZ[1], Zacharias VAMVAKOUSIS[2]

[1]Universitat Pompeu Fabra, Spain; [2]Music Technology Group, Spain

Sympo. 2

M103

09:00

Wednesday

Electroencephalogram (EEG) systems provide useful information about the brain activity of humans and are becoming increasingly available outside the medical domain. Similarly to the information provided by other physiological sensors, Brain-Computer Interfaces (BCI) information can be used as a source for interpreting a person's emotions and intentions. This symposium focuses on the application of BCI as an intelligent sensor, similar to a microphone or camera, which can be used in the study of the inter-relationship between music and emotion. The main questions the symposium aims to investigate and discuss include: How could BCIs as intelligent sensors be integrated in emotionaware musical systems (may be alongside other modes of input control)? What constitutes appropriate musical adaptation in response to physiological data? How to best present the emotional state of the user in the context of music systems? How is the user experience of music systems enhanced through emotion-based BCIs as intelligent sensors?

Beyond emotion? Music and altering states of consciousness

Eric CLARKE[1] (Discussant), Ruth HERBERT[2], Thomas SCHÄFER[3], Pekka TOIVANEN[4], Jörg FACHNER[4]

[1]University of Oxford, United Kingdom; [2]Oxford University, United Kingdom; [3]Chemnitz University of Technology, Germany; [4]University of Jyväskylä, Finland

Sympo. 3

H306

16:00

Thursday

Music functions to alter consciousness in many different contexts, and yet may not always do so. The most determining influences seem to be the context, personal set, socio-ecological setting, cultural beliefs, and intentions an individual might possess with relation to inducing ASC. Is music then, merely the soundtrack of a context in which participants aim to achieve altered or alternate states of consciousness (ASC), i.e. a neutral or idiosyncratic vehicle for their intentions? Certainly, individuals project their intentions onto music, but music needs to possess the immanent attributes to serve them. In this symposium we will discuss different aspects of the interaction between music and ASC. In particular, the common occurrence of dissociative experiences without negative or positive valence in everyday life ; how time and space perception may change when listening to music; how music is used to induce ASC in specific cultural contexts of shamanistic practice; how intense emotions induced by mind-altering drugs may reframe the music listening experience. A discussant will reply to the studies and perspectives presented.

Music, emotion and autism

Rory ALLEN[1] (Discussant), Emily CARLSON[2]

[1]Goldsmiths, University of London, United Kingdom; [2]University of Jyväskylä, Finland

Sympo. 4

M103

09:00

Friday

A collaboration between a psychologist and a music therapist. Autistic people are less good than average people at understanding emotions in others and less good at imagining emotions that they do not feel. Autistic listeners are also less competent than average listeners at giving linguistic descriptions of music in terms of emotion. Nevertheless, empirical evidence points to the fact that the autistic experience of listening to music is statistically normal. Their music experience is not defective. It follows that their musical experience is a matter of imagining or understanding emotions. And accounts of music that posit an essential connection with such states are defective. If such accounts were correct, autistic musical listening should be defective; but it is not.

Symposia

Sympo. 5

D109

13:30

Saturday

In search for emotional orders – Music and emotions in history

Sarah ZALFEN (Discussant), Sven-Oliver MÜLLER, Henning WELLMANN, Anabelle SPALLEK, Tim BIERMANN

Max Planck Institute for Human Development, Germany

An elucidating contribution to the study of music and emotions can be made by taking their historicity into account. Over the last decades studies in the field of the "history of emotions" substantiated the assumption that emotions do vary over time and are therefore historically, culturally and socially contingent. Not only emotional expressions were shown to be subject to social orders, but also the emotional experiences themselves.

Following that assumption we consider the relation of music and emotions as deeply socially structured and therefore depending on historical and cultural context. Emotions within the production and reception of music have changed over history as much as the music itself did. In the course of these developments music related orders of emotional expression and experience emerged and vanished, allowing audiences and individuals to feel about music in many different ways. Theory provides distinct models to explore such frameworks: Whether described as "feeling rules", "emotional styles", "emotives", "emotionology", or "emotional regimes" - they all assume socially construed and historically situated emotional orders, whose analysis allows us to get insights into what, how and why people felt while making or listening to music in history - and also in the present.

We would like to propose a symposium with theoretical and empirical approaches to explicitly strengthen this historical dimension of the relation between music and emotions. By looking at emotional practices and discourses in different historical situations of music production and reception, we would like to elaborate patterns of emotional orders in European music life.

Proceedings

ARE MUSICAL EMOTIONS CHIMERICAL? LESSONS FROM THE PARADOXICAL POTENCY OF MUSIC THERAPY

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Abstract

The dominant psychological model of emotion posits that a cognitive process (the appraisal) precedes, and results in, the corresponding emotion, including any induced state of physiological arousal: the cognitive component of emotion mediates the effect of the external cause on the internal arousal component. If emotions in music were naturalistic, the same mechanism should apply. However, a study in which a group of people with autism were compared with matched controls showed a normal level of physiological responsiveness to music in the autism group, coupled with a reduced capacity to verbalize their responses to it. It is hard to account for these results in terms of the standard mechanism for emotion induction; I suggest that musical emotions are in fact chimerical, consisting of components of separate naturalistic emotions combined in non-natural ways. This fact can not only explain the ability of music to generate a response in individuals with impaired emotional understanding, but can also suggest ways to exploit this effect in order to teach such individuals about naturalistic emotions by pairing musically induced states of autonomic arousal with the kind of naturalistic context provided in, for example, opera.

Keywords: autism, music, emotion

1. Introduction

The practical experience of music therapists appears to show that music evokes powerful and beneficial responses in people with emotional or social difficulties (Boso et al., 2007, Kern et al., 2007, Wigram & Gold, 2006). It is reasonable to assume that it is music's raw emotional power that is responsible for these effects: music is after all the "language of the emotions" (Heaton, 2009, p. 2897). But this leads to a paradox: if a person is emotionally unreactive, how can it be that they respond so well to music, when by definition they have difficulties with understanding the language of emotions, which music is supposed to embody?

I will attempt to resolve this paradox by arguing that whilst the responses induced by music do indeed have something in common with ordinary emotions (which is why music can be therapeutically helpful in dealing with emotional problems), they also differ in key respects from naturalistic emotions (which is why they can induce meaningful responses in people with emotional difficulties). I suggest that experiencing musical emotions in the right context can represent a kind of half way house in the journey towards learning about naturalistic emotions. Key to this conclusion is a comparison between the responses to music in typical adults and high-functioning adults with autism.

2. Musical emotions: the same and yet different

The current dominant explanation for naturalistic emotions is the appraisal theory. This postulates that emotions arise from an individual's interpretation of the implications of external changes for their personal wellbeing. This interpretation is, at least in the most basic version of the theory, cognitive, and therefore neither automatic nor particularly rapid. Since this conflicts with the observed ability of emotions to arise very quickly, more sophisticated models have been proposed, though there is some disagreement about details (Marsella & Gratch, 2009; Smith & Kirby, 2009).

All models, however, have in common the idea that emotions involve some form of appraisal of the relationship between a person and their environment, and that this appraisal is relevant to the overcoming of problems, or the achievement of goals, which are important to the individual. The appraisal may – in fact, usually does – result in the arousal of the autonomic nervous system, preparing the individual for what are sometimes referred to as the "four f's", which include fighting, fleeing and feeding.

If we accept this model, one can see objections on purely logical grounds to the idea that this process of appraisal can operate in the context of listening to music, at least in its purest, instrumental form. There appears to be nothing to appraise, suggesting that musical emotions cannot be fully naturalistic. Perhaps the first author to express this objection clearly (not, of course, in terms of modern theories of emotion) was the nineteenth century critic Eduard Hanslick (Hanslick, 1854/1986), but his lead has been followed by a number of subsequent workers in the fields of both psychology and philosophy (Kivy, 2001, 2009; Konecni, 2005, 2008; Zangwill, 2004, 2007, 2011).

This case has not gone unanswered. A number of authors (e.g. Zentner, Grandjean & Scherer, 2008) have maintained that there are considerable overlaps between the musical and naturalistic emotions.

3. Fast and slow emotions

Although we have so far mentioned only the appraisal theory of emotion, other possibilities are sometimes considered. For example, it has been suggested that emotions can be induced via a "fast", subcortical route, providing a mechanism to respond to emergencies which might need more urgent action than is possible via the slower, cortical route used by the appraisal mechanism (see, for example, LeDoux, 2000). The initial response to this fast route alert is to prime the autonomic nervous system for fight or flight, and cognitive appraisal is brought in subsequently to monitor the appropriateness of the response. If musical emotions are indeed naturalistic, this seems a more likely route for their induction. The fast route allows for subsequent cancellation of the emotion by the higher centres of the brain, if they assess the threat as being a false alarm. Indeed it has been suggested (Huron, 2011) that this is the explanation of why we can enjoy listening to "sad" music: the music induces a kind of "sham pain" via the fast route, but the conscious brain realizes that the situation is not threatening, and responds with relief, so that the net effect is pleasurable.

4. Evidence from autism: fast or slow route?

Psychologists have perhaps been a little late to appreciate the importance of music in the lives of people with autism. *A priori* arguments, based on theories of the evolution of musical aptitude in humans for which empirical evidence is lacking, have been used to suggest that people with autism will not have an aptitude for, or any deep appreciation of, music (for a fuller discussion and references, see Allen & Heaton, 2010). However, the first in-depth study to explore the actual experiences of high-functioning adults with autism found that their uses of music in their daily lives followed a very similar pattern to that already found in the typical population (Allen, Hill & Heaton, 2009). Here again, we can see the paradox of music's effectiveness: some of our participants clearly used music in their daily lives to overcome emotional crises, despite having, by their own account, limited understanding of their emotional experiences.

Following up this work, an experimental study comparing matched control and autism groups found that the autonomic arousal induced by music in the two groups was comparable, whereas the verbally reported level of emotional arousal in the autism group was lower than in controls (Allen, Davis & Hill, 2013). This partly explained why our previous autism participants had reported finding music so moving: music was leading to normal levels of autonomic arousal in them. At the same time, the results had implications for deciding between alternative mechanisms for the production of musical emotions.

In a subsequent paper (Allen, Walsh & Zangwill, 2013), we drew on these results to suggest that if musical emotions were naturalistic at all, they must be using the fast, not the slow route. This is because the appraisal route is inconsistent with reduced appraisal activity in the autism group coupled with normal levels of autonomic activity. Reduced cortical activity in the autism group should have resulted in reduced autonomic activity if indeed the autonomic component was downstream of the cognitive component, but this was not observed. It appeared that on the contrary, the autonomic response came first, and was then interpreted only subsequently by the higher centres of the brain. In other words, musical emotions must be using the fast track, not the slow track.

However, there are difficulties even with the fast track explanation. The conclusion of our paper was that the most probable scenario was that musical emotions exploited a combination of subcortical fast route mechanisms, including brain stem responses and emotional contagion (as claimed in Juslin & Västfjäll, 2008) together with top down cortical responses induced by means such as the expectation induction/resolution process described in the "ITPRA" mechanism (Huron, 2006). Musical emotions should in fact be regarded as chimerical, not in the sense of being absurd or imaginary, but in the original meaning of the word as describing an animal composed of parts of other animals. We proposed that musical emotions involve activation of parts of different naturalistic emotion circuits. These components are in themselves naturalistic, but experienced together in non-naturalistic combinations. Typically, the autonomic components of standard emotions will be found in combination with an incongruent activation of the higher brain centres, as in the case of Huron's example of sad music. The higher brain centres will be engaged by the ITPRA mechanism, and the sub-cortical responses will be induced by, for example, brain stem and emotional contagion responses (Juslin and Västfjäll, 2008).

Incidentally, in a remarkable series of studies (Salimpoor et al., 2009; Salimpoor et al., 2011; Salimpoor & Zatorre, 2013) it has been shown that the brain's pleasure and reward circuits are crucial in determining individual musical preferences. It appears likely that if musical emotions are characterised by possession of any one common feature, it is that they include (but are not confined to) activation of this dopaminargic network. Such activation is the probable outcome of the ITPRA mechanism: dopamine is key to modulating expectation as well as pleasure. It may also be the outcome of other, sub-cortical cues. It is known for example that rhythmic entrainment is represented and mirrored at a fundamental neurological level (Nozaradan, Peretz & Mouraux, 2012) and that it can affect higher level functions such as attention across modalities (Bolger, Trost & Schon, 2013). Much work remains to be done to clarify the details of these mechanisms, even if the outlines are now becoming clearer.

5. Uses of music in learning about emotion

I have suggested that a partial answer to the paradox of the unreasonable effectiveness of music therapy is that musical emotions are non-naturalistic: music is effective because it relies on responses which are preserved in disorders which disrupt the experience, or understanding, of the more complex naturalistic emotions. But this is to explain only half of the paradox. How is it possible to use music to learn about real emotions if musical emotions are not real? It would be like attempting to give a blind man sight by talking to him about the visible world.

One explanation was offered by the second author of Allen, Walsh and Zangwill, 2013, who has autism and who independently and empirically developed a method of using music to learn about emotions. Walsh's preferred musical repertoire largely consists of pieces which in some way tell a story, such as a musical or an opera, where the lyrics give a plot or a context. The emotions felt and expressed by the characters are articulated in the dialogue, as well as being expressed in the characters' reactions to the events affecting them. The cognitive aspects of the emotions, in terms of the circumstances which cause their emotions, can therefore be studied, in order to learn about their nature and origins. At the same time, the physiological components of the emotions are automatically induced by the music. The two components of emotion, cognitive (in the plot) and visceral (evoked by the music) are distinct and complementary.The affective response to music is experienced, by Walsh, as something different from, and less threatening than, a genuine emotion. It might be described as a purified, distilled, predictable form of affective experience, cut loose from its causes and the person undergoing it. These purified affective experiences are presented in a form which is ordered, and therefore accessible.

Walsh believes that many (though not all) individuals with autism have an unfulfilled craving for emotional experience. The non-naturalistic emotions in music help to satisfy this craving, but without the difficulties involved in engaging in an emotional relationship with another human being, where the unpredictability of the emotional responses may be terrifying.

By learning the links between the physiological correlates of emotion (induced by the music) and the cognitive aspects (as conveyed simultaneously in the lyrics or the plot), Walsh has found that it is possible to apply this to the arena of day to day human relationships. By learning to identify the physiological correlates, induced by the music, of certain real emotions, it is then possible to begin to identify the same correlates of real emotions in other people. A further effect is a heightened ability to empathise actively with others: the emotions of other people can not only be identified more easily, but also the learned association of a similar emotion in music enables Walsh to feel that same emotion, as a consequence of concern or attachment to the other individual, so that it is possible to experience pleasure in another's happiness, and regret at another's sadness. In this way, Walsh considers, the correlation between the two factors of emotion, cognitive and physiological, can be learned in a deliberate, intelligent way, by people – such as individuals with autism – who may never have formed these associations in the usual way during infancy and childhood.

It seems likely that these ideas already form part of at least some standard applications of music therapy, as discovered empirically by individual practitioners. They were instrumental in the design of a pilot study made possible by the generous support of the Baily Thomas Charitable Fund. The results of this study, so far incomplete, suggest a degree of validity for the approach (Allen, Shah & Bird, 2012). If this is confirmed, it would also provide some support for the theoretical background outlined in the present paper.

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EVALUATING THE CONSONANCE AND PLEASANTNESS OF TRIADS IN DIFFERENT MUSICAL CONTEXTS

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Abstract

This study examines whether the consonance and pleasantness of triads (major, minor, augmented, and diminished) varies according to the musical context in which it is presented. The level of consonance and dissonance (C/D) of each chord when they were played alone without any musical contexts was judged. Following this, each chord was accommodated in a different position in a short cadence, and the level of C/D for each chord was judged. Additionally, the C/D and the pleasantness and unpleasantness (P/U) of the whole sequence were rated on a 7-point scale. . The results show that, for major and minor triads, there was no significant difference in C/D levels between the 'without musical context' and the 'with musical context' conditions. However, both augmented and diminished triads were judged less dissonant when they were played in isolation than when in a cadence. Augmented triads were rated most dissonant and unpleasant when on the tonic, while diminished triads were most consonant and pleasant when on the subdominant. We interpret this result as reversely reflecting the stability of chord function.

Keywords: consonance, pleasantness, musical schemata

1. Introduction

The purposes of this study are to investigate the influence of musical context on the perception of triads in terms of pleasantness and consonance, and to explore the relationship between pleasantness and consonance. Pleasantness is one of the most responses to stimuli (approach or rejection) and a principal dimension that differentiates emotions (Russel, 2003). Such basic responses seem to include rejection of dissonance and appreciation of consonance in musical contexts. However, actual pleasantness experience of consonance-dissonance (C/D) in terms of pleasantness of chords is likely to be complicated than a simple one to one mapping.

The sensation of C/D can be explained with reference to psychoacoustic theories such as frequency ratios, beats and roughness (Helmholtz, 1877/1954), and the relation to critical bandwidth (Plomp and Levelt, 1965. Kameoka and Kuriyagawa, 1969). At the same time, the perception of C/D is also susceptible to cultural influences and a posteriori factors. According to Lundin (1947) and Cazden (1980), judgments of C/D are determined not only by acoustical features of what is heard, but also by the musical rules of the culture and the listener's familiarity with these rules, or musical schemata in cognitive terms. A listener judges musical events based on musical schemata he has been developing through a lot of amount of exposure to particular styles of music. So judgement of C/D is influenced by what the listener's musical schemata - which are in turn determined by the rules of music he listens to - define as C/D. An acoustically identical chord can be consonant for one, but dissonant for the other depending on their musical schemata. Additionally, the context in which a chord appears might also be an influential factor in determining C/D perception. Roberts (1986) shows that the chord can be more consonant when it is in a 'traditional' harmonic progression than when in a 'non-traditional' harmonic progression.

This study focuses on differences in the C/D perception of chords, and in particular augmented and diminished chords in different musical contexts and with different chord functions. Chord function may affect C/D perception of augmented and diminished chords in two ways. The first hypothesis is that they will sound most consonant when heard on their most familiar function, such as the tonic or dominant for augmented chords, and the dominant for diminished chords. The subdominant is the least familiar for both chords. It is for this reason that augmented chords often act as neighboring or passing chords in the progressions I-I+-IV, I-V+-I, and diminished chords often function as leading tone chords. The second hypothesis is based on the violation of the stability of the chord function. According to the hierarchy of chord function (Krumhansl, 1990), the tonic is the most stable function, followed by the dominant, while the subdominant is the least stable. Accordingly, an unexpected chord on the tonic might sound more dissonant than the same chord on the subdominant because it would represent a greater violation of stability for the tonic to be unstable than the subdominant.

The second aim is to test the relationship between listeners' perceptions of C/D and P/U. It is reported that there is a congruency between C/D and P/U perceptions, such as C/D and P/U perceptions of dyads (Guthrie and Merrill, 1928), dissonant dyads and negative word connotation (Costa, Bitti, and Bonfigilioli, 2000), and faster and more accurate judgments of positive and negative words when positive words are paired with consonant chords, and negative words with dissonant chords (Sollberger, Reber, and Eckstein, 2003). From this C/D and P/U congruency, it is hypothesised that if the C/D level of the same chord differs according to its function, the P/U level of the chord should also change.

2. Experiment 1. Chords in isolation

2.1. Participants

36 adults (Male: 16, Female: 20. Age range: 21-74, with a mean age of 33.72), all with a moderate amount of musical experience, were recruited.

2.2. Materials

Materials consisted of major, minor, augmented and diminished triads played in all 12 keys, and all played in root and close position, thus making a total of 48 triads. Each triad was made using a piano sound, created by software, *Cubase*. The duration of each chord was approximately 1 second.

2.3. Procedure

48 single triads in root position and close position, each one either a major, minor, augmented or diminished triad, and utilising all 12 keys, were played in a random sequence. Participants were asked to judge whether each chord was either consonant or dissonant by pressing one of two keys on a computer keyboard as quickly as possible. Participants' response times were also recorded.

2.4. Results

Figure 1 shows the mean judgment of C/D and the standard deviation for each chord. As can be seen, major triads were judged to be the most consonant type of triad, followed by minor triads, and then diminished triads, while augmented triads were the most dissonant triad. This result is consistent with Helmholtz (1874/1955) and Roberts (1986). One-way ANOVA with Repeated Measure found a main effect of Chord Types: $F(3, 105)=59.04$, $p=.000$, $r=.79$. Pairwise comparison revealed that all of the four types of chords are different from each other with the exception of major and minor triads ($p< .001$). Augmented and diminished triads are significantly different from each other, and both major and minor triads are significantly different from both augmented and diminished triads ($p< .001$).

Reaction times were analysed using a one-way ANOVA for Repeated Measures after log-transformation of the reactions times. No main effect of Chord Type on response time was found ($p > .05$).

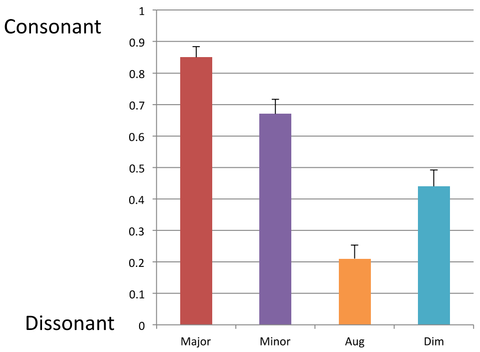

Figure 1. Mean and Standard Deviation for C/D judgements of four types of chords

3. Experiment 2. Chords in a cadence

In Experiment 2, the perception of four triads in different musical contexts and with different harmonic functions was examined. As discussed above, it is thought that the C/D perception of augmented and diminished chords might vary according to the musical context and the chord's harmonic function. As we have seen, it has been hypothesised that both augmented and diminished chords will sound more consonant when heard in a familiar/typical scenario, or when heard on the subdominant, as this is the least stable chord function. In this experiment, both augmented and diminished chords appeared in a scale consisting of three chords, IV-V–I, and the perception of these chords in terms of their C/D and P/U levels was examined.

3.1. Participants

The participants were the same individuals who took part in the previous experiment.

3.2. Materials

72 chord sequences with 12 keys were used. Each chord sequence is preceded by a diatonic scale in order to present the key to the participant, which is then followed by the following three chords: IV-V–I. All chord sequences contained one target chord, which was either an augmented or diminished triad, or neither – in which case either a major or minor triad was played depending on the mode of the context.

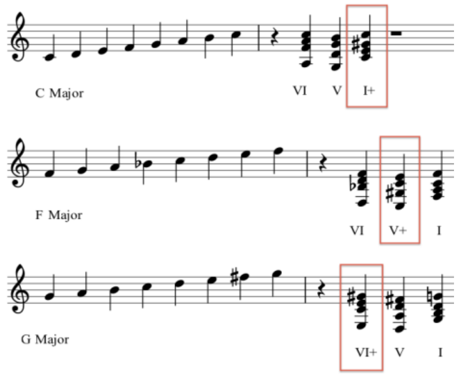

Figure 2. Example of the sequence

Target chords were put in either the tonic, dominant or subdominant position in each chord sequence (Figure 2), although normally occurring harmonic patterns were avoided in order to rule out their effect, thus allowing the effect of functions to be seen more clearly. Sound materials were all played using a piano sound. The duration of each sequence was 6.74 seconds, and the tempo and loudness of all materials were kept constant throughout.

3.3. Procedure

72 chord sequences consisting of a scale and three chords were presented. Participants were asked to judge whether each of the three chords they heard was either consonant or dissonant, which they did by pressing one of two keys directly after each chord was played.

After each sequence, participants rated the C/D and pleasantness levels of the whole sequence on a 7-point scale, with 1 being extremely dissonant/unpleasant and 7 being extremely consonant/pleasant.

3.4. Results

3.4.1. C/D judgment of target chords

Figure 3 shows the mean judgments for major, minor, augmented, and diminished triads in terms of dissonance (0) and consonance (1).

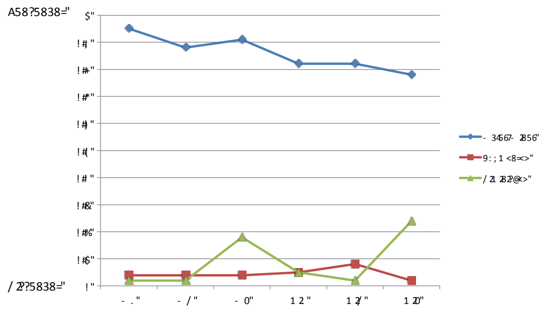

Figure 3. The mean of C/D judgement of each chord presented in musical context. M=major mode, mi= minor mode, T=tonic, D=dominant, S=Subdominant

A three-way ANOVA with repeated measures indicated a main effect of Chord Types: $F(2, 70)=445.698$, $p=.000$, $r= .096$, and both major and minor target chords were judged very consonant, while augmented and diminished chords were very dissonant. There was also a significant interaction between Mode and Chord Types; $F(2, 70)=12.440$, $p=.000$, $r=.51$, and between Chord Type and Function: $F(4, 140)=6.375$, $p= .000$, $r=.39$. The effect of Function varies according to Chord Type, with diminished chords being judged more consonant when on the subdominant in both major and minor contexts ($p< .001$). As participants merely chose either 'Consonant' or 'Dissonant' and the data was therefore not normally distributed, a non-parametric test (related-samples Friedman's two-way analysis of variance by ranks) was performed to confirm the result. Diminished triads on the subdominant in major and minor contexts were significantly different from those on both the tonic and the dominant ($p= .002$, and $p= .000$ respectively), while no significant difference was found in either augmented or control triads (major and minor triads).

Participants' reaction times (the length of time between the end of the sound stimuli and participants' responses) were also analysed after log-transformation of the reaction times. A three-way repeated measures ANOVA indicated a significant main effect of Function: $F(1.68, 59.02)=14.720$, $p=.000$, $r= .54$. Participants responded quickest to dominant chords ($p< .001$), followed by chords on the tonic, and then the subdominant.

3.4.2. Overall consonant/dissonant level

After listening, participants rated C/D and pleasantness levels, and the mean rating for C/D can be seen in Figure 4. A three-way ANOVA with repeated measures was performed to test the effect of Mode (major vs. minor), Chord Type (augmented, diminished, and control), and Function (tonic, dominant, subdominant). There was a significant main effect of Mode: $F(1, 35)=11.29$, $p=.002$, $r=.49$, as major chords were rated more highly (in other words, were considered more consonant) than minor chords. Both major and minor triads were rated higher than either augmented or diminished triads ($p<.000$); Chord Type: $F(1.24, 43.39)=155.21$, $p=.000$, $r=.90$. There was a significant interaction between Mode and Chord Type: $F(2, 70)=12.52$, $p=.000$, $r=.51$. As for the effect of Function, this had a significant main effect: $F(2, 70)=15.50$, $p=.000$, $r=.55$. There was significant interaction between Chord Type and Function: $F(3.32, 116.19)=15.11$, $p= .000$, $r=.54$, also as pairwise comparison revealed that the effect of Functions varied according to Chord Type. Augmented triads on the tonic in a major context were rated significantly lower (more dissonant) than those on other functions ($p< .001$), while diminished triads on the subdominant in both major and minor contexts were significantly more consonant than those on either the tonic or dominant, replicating the results of the evaluations of specific chords reported above ($p< .001$).

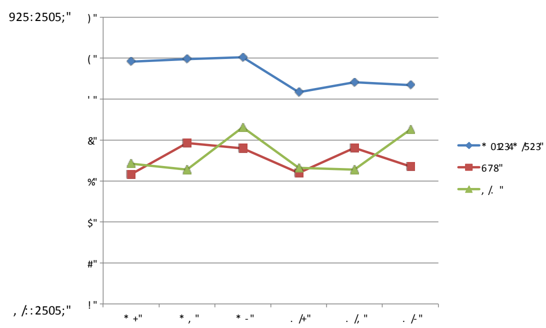

Figure 4. The ratings for overall C/D level

As for reaction times for C/D rating, there was a significant main effect of Chord Type: $F(2, 70)=18.565$, $p= .000$, $r=.58$. Control chords (major and minor triads) were rated quickest among the three types of chord, and significantly quicker than diminished chords ($p<.001$). The effect of Chord Types varies according to Mode, and control chords in a major context (all of which are major triads) were processed significantly quicker than augmented and diminished triads ($p<. 001$), although there was no difference in reaction time between minor triads, and augmented and diminished triads. An interaction between Mode and Chord Type was also found: $F(2, 70)=9.04$, $p= .000$, $r=0.45$.

3.4.3. Overall pleasantness

Figure 5 displays the mean pleasantness rating for all sequences containing target and control chords. A three-way ANOVA with repeated measures was performed again. All factors were found to be significant: Mode: $F(1, 35)=4.51$, $p=.041$, $r=.33$, Chord Type: $F(1.21, 42.62)=88.37$, $p=.000$, $r=.84$, Function: $F(2, 70)=17.51$, $p=.000$, $r=.57$. The general trend is very similar to that for overall C/D ratings. There were significant interactions between Mode and Chord Type: $F(2, 70)=11.22$, $p=.000$, $r=.49$, and between Chord Type and Function: $F(4, 140)=18.072$, $p=.000$, $r=.58$. The effect of Function varied according to Chord Type, as augmented triads on the tonic were significantly different from the same triads on the dominant and subdominant. Also, the sequences with diminished triads on the subdominant were the most pleasant ($p< .001$).

As for reaction times, there was only a main effect of Chord Type: $F(2, 70)=13.23$, $p= .000$, $r=0.52$. Responses for control chords were the quickest among the three types of chord, and were significantly quicker than responses for augmented triads ($p< .000$).

3.4.4. Chords Without and With Musical Context

The data for C/D judgments were compared with those from the previous experiment for single chords, in order to see how judgments

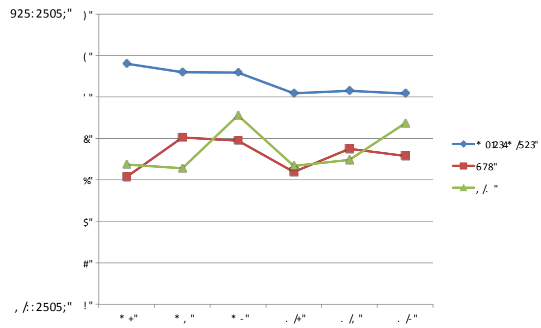

Figure 5. The ratings for overall P/U level

differ between chords without and with musical context. C/D judgments for single triads were compared with judgments for triads on the tonic, dominant, and subdominant. Data for all four types of chords were analysed separately. A one-way ANOVA with repeated measures indicated no significant effect of musical context for major triads and minor triads ($p> .05$). However, in the case of augmented triads, there were main effects of musical context: $F(6, 108)=4.60$, $p= .000$. These were judged to be most consonant when presented alone. The same was true in the case of diminished triads: $F(6, 108)=7.91$, $p= .000$.

3.4.5. Correlation between C/D and P/U

Pearson's product-moment coefficient revealed that C/D ratings were significantly correlated with P/U ratings: $r(647)= .43$, $p= .000$. As for the correlation in each condition, major triads on the tonic had the highest positive correlation between C/D and P/U ratings: $r(35)= .748$, $p= .000$, while minor diminished triads on the dominant had the least positive: $r(35)= .264$, $p= .120$.

4. Discussion

Across all tasks, the control chords (major and minor triads) were rated higher than both augmented and diminished chords. This is consistent with the results of Helmholtz (1877/1955) and Roberts (1986). This result seems to validate the typical categorisation of consonant and dissonant chords, according to which major and minor chords are considered more consonant than augmented and diminished ones. Major chords were rated most consonant/pleasant and were processed most quickly.

The difference between functions was strong in the case of diminished chords in both major and minor contexts. Diminished chords on the subdominant were always judged and rated more consonant and pleasant than the same chord appearing in any other function. As for augmented chords, these were given their lowest C/D and P/U ratings when they were played on the tonic in a major key. These results support the second hypothesis, based on the stability of chords. According to this theory, chords are most stable when they are on the tonic, followed by when on the dominant, and they are least stable when on the subdominant (Krumhansl, 1990). The results of Experiment 2 map quite neatly onto this theory, suggesting that C/D judgments of augmented and diminished chords have an inverse relationship with chord stability. In other words, the more stable a chord function is, the more dissonant an augmented or diminished chord played on that function is likely to be. As such, we should expect an augmented or diminished chord in an unexpected context to be most consonant when played on the subdominant, followed by the dominant, and least consonant of all when on the tonic. This is because the level of C/D is inversely proportional to the amount of stability violation, and so the smaller the violation the more consonant the chord will sound, and, likewise, the bigger the violation the more dissonant it will be. However, that diminished triads on the subdominant were judged most consonant and pleasant might be partly due to familiarity, as a diminished triad on the subdominant is identical to a diminished seventh chord built on the supertonic (II) of the key without the root, which is often followed by V and I chords to make a common harmony progression.

The comparison of data showing C/D judgments of chords both without and with musical context reveals something of the unique character of each type of chord. As was predicted, major chords maintain their consonance level in whatever musical context they find themselves. On the other hand, musical context had an influence on both augmented and diminished triads: both were judged more consonant when played alone than when they were played with musical context.

As the general trend for C/D and P/U ratings are very similar, with a positive correlation between the two, it seems likely that participants perceived them similarly. This supposition is consistent with the findings of Guthrie and Morrill (1928), who noted that judgments of the consonance and pleasantness of intervals were very similar. However, the data revealed that the degree of correlation varies according to the condition.

Experiment 2 demonstrated the influence of context and function on the C/D and P/U levels of chords. Both the influence of the stability of chords and familiarity were seen clearly in the results, which leant support to both the first and the second hypothesis.

Which hypothesis best applies may vary according to the type of chord in question: for instance, the results for augmented chords lend support for the stability of chords theory, whereas in the case of diminished chords both hypotheses clearly apply. Finally, the data also revealed a positive correlation between C/D and P/U ratings, although this varies according to the condition.

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WHAT EMOTIONS AND FREE ASSOCIATIONS CHARACTERIZE DIFFERENT MUSICAL STYLES?

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Abstract

Bisesi, Parncutt, & Friberg (2011) extended *Director Musices* (DM) - a software package for automatic rendering of expressive performance (Friberg et al., 2006) that relates the expressive features of a performance not only to global or intermediate structural properties, but also to local events (grouping, metrical, melodic and harmonic accents). Friberg & Bisesi (2013) applied the new rule system to model stylistic variations corresponding to different historical periods and styles in piano music. In this project, we extend pDM - a *pure data* system for real-time expressive control of music performance (Friberg, 2006) - by adjusting algorithmic formulations inspired by a theory of musical accents and by introducing new gestural interfaces based on qualitative data. First, different presets corresponding to different stylistic conventions and interpretations are implemented in DM, and corresponding sound files are generated and recorded. Second, we ask 20 participants (10 musicians and 10 amateurs) to rate the character of the performances on rating scales depending on a previous categorization involving emotions and free associations (Bisesi, Bodinger, & Parncutt, in progress). Terms involve basic and complex emotions, and free associations such as static/dynamic and living/non-living things. Results will be used to map music expression into multidimensional spaces of emotions and free associations, and to develop new gestural interfaces in pDM.

Keywords: performing styles, emotions, free associations

1. Introduction

The noteheads in a musical score may be equal in size, but when the music is performed, the notes do not sound equally important. Accents are local events that attract a listener's attention and are either evident from the score (immanent) or added by the performer (performed) (Parncutt, 2003). Immanent accents are associated with (temporal, serial) grouping (phrasing), metre (downbeats), melody (peaks, leaps), and harmony (or dissonance). Performed accents involve changes in timing, dynamics, articulation, and timbre; they vary in amplitude, form (amplitude as a function of time), and duration (the period of time during which the timing or dynamics are affected).

The usual relationship between immanent and performed accents is that performers tend to "bring out" immanent accents, i.e. to attract the listener's attention to them. For example, a performer may slow the tempo or add extra time in the vicinity of certain kinds of immanent accent, or change dynamics or articulation in consistent ways. This relationship is complex and depends on many factors such as musical and personal style, local and cultural context, intended emotion or meaning, and acoustical and technical constraints. In both cases, the perceptual *salience* of an accent is its perceptual or subjective importance, or the degree to which it attracts a listener's attention.

Following the analysis-by-synthesis approach of Sundberg (1988) and Friberg (1991), and their rule-based performance rendering system *Director Musices* (DM) (Friberg et al., 2006), we have developed a new algorithmic model of music expression that relates the expressive features of a performance not only to global or intermediate structural properties (i.e. different levels of phrasing), but also to local events (individual notes corresponding to accents) in a systematic way (Bisesi and Parncutt, 2011; Bisesi, Parncutt & Friberg, 2011; Friberg & Bisesi, 2013). DM is a software package for automatic rendering of expressive performance developed by Sundberg and Friberg that comprises performance rules (mathematically defined conventions of music performance), which change specific note properties, including timing, duration and intensity. By manipulating program parameters, meta-performers can change the degree and kind of expression by adjusting the extent to which each rule is (or all rules are) applied.

In its previous formulation, the main structural principle of DM is phrasing. The *Phrase Arc* rule assigns arch-like tempo and sound-level curves to phrases that are marked in the score. DM also models aspects of tonal tension. The *Melodic Charge* rule emphasizes tones that are far away from the current root of the chord on the circle of fifths, and the *Harmonic Charge* rule emphasizes chords that are far away from the current key on the circle of fifths. Several of the rules presented in DM have been interpreted in terms of Parncutt's (2003) taxonomy of accents. This suggests that a conflation of the two models may yield new insights into expressive performance and possibly lead to artistically superior computer-rendered performances.

On this basis, we have developed DM in a new direction, involving both the previous set of rules, and the new formulation based on accents. Our approach to performance rendering involves two separate stages. First, we automatically extract accents from the score. The output of the first stage comprises two independent hierarchical structures (for grouping and metrical accents) and a series of harmonic and melodic accents (considered as local events). For each hierarchical level or accent, our model estimates the musical importance or perceptual salience. In a second stage, we manipulate timing and dynamics in the vicinity of immanent accents (e. g., getting slower and/or louder near an accent). Let's now describe these two separate stages in detail.

According to our model, a *phrasing* (or *grouping*) accent occurs at the start of a phrase at any hierarchical level. The listener's attention is drawn to structural boundaries because they delineate the structure: the first note of a phrase or section is important because it announces something new, and the last note is important because it announces the end of a group. Repp (1998) demonstrated the psychological reality of phrases by showing that listeners are generally more sensitive to what happens near phrase boundaries than within phrases, and Bisesi, MacRitchie & Parncutt (2012) found that there is a general agreement about the position of phrase beginnings, endings and climaxes across performances and listeners. The salience of grouping accents corresponds to the number of levels at which a given event marks the start of a phrase. The phrasing structure can be determined by subdividing the entire piece into longer phrases, then dividing each phrase into subphrases and so on. The starts and ends of subphrases and sub-subphrases are marked according to repetitions of motives or introduction of new structural elements. Our model of phrasing-based timing is based on music analysis rather than physics (Todd, 1995). We begin by looking at accents within the phrase and apply timing/dynamic curves which are adjusted to start or end at phrase boundaries (just as phrase boundaries have been found in psychological studies to mark chunks of musical memory).

A *metrical* accent occurs at the start of important metrical units such as the start of a measure or group of measures (hypermeter). Again, salience is the number of different levels of pulsation (beats) to which an accent belongs.

A *melodic* accent occurs at local peaks and valleys of the melody and following leaps. To identify melodic accents, we first label the highest and lowest tones of the whole melody, and then label the local peaks and valleys, i.e. the highest and lowest pitches in a given phrase. Melodic accent salience depends on a number of factors. Peaks normally have more salience than valleys. Tones that are further away from the average pitch of the melody (or the local average of a phrase) are more salient.

Tones immediately preceding or following large intervals have more salience.

The *harmonic* accent of a chord in a progression has several components of dissonance: roughness, harmonic ambiguity, harmonic relationship to context, and familiarity or expectedness. Harmonic accents in major-minor tonal music are produced by tones foreign to the prevailing key. If the key of a passage is relatively clear, the salience of this kind of accent can be predicted using the key profiles of Krumhansl and Kessler (1982). These profiles may be considered as quantitative estimates of the harmonic stability of each tone in the chromatic scale in a given major or minor key. The lower the stability of a tone, the greater the harmonic accent at that tone. The harmonic accent of a chord may be estimated by combining accents for individual tones.

Figure 1 provides an example of subjective immanent accentuation. Here, the first accent in the upper voice in the first bar is a local peak relative to previous and following tones; because the peak is relatively prominent we have assigned a melodic accent (C) with intermediate salience (3). As peaks normally have more salience than valleys, and the melodic theme is played by the upper voice, the simultaneous melodic valley in the lower voice has lower salience (2). The second melodic peak in the inner voice of bar 1 is preceded by a smaller interval than the previous one, so the melodic accent has even lower salience (1). The first chord in the first bar feels new by comparison to the preceding context, so we marked a harmonic accent of salience 3. The harmonic accent at the end of bar 1 is a roughness accent.

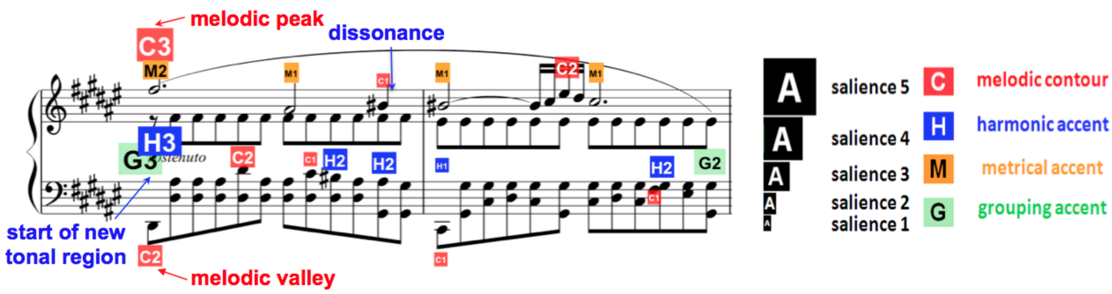

Figure 1. Subjective analysis of immanent accents and their salience in the first two measures of the central section of Prelude Op. 28 No. 13 by Frédérick Chopin.

On this basis, Parncutt, Bisesi & Friberg have developed a computational model of immanent accent salience in DM (Parncutt, Bisesi & Friberg, paper in progress). The new formulation of DM automatically extracts metrical, melodic and harmonic accents from a score and provides to each accent a salience from 1 to 5. Regards grouping accents analysis, as different theorists might offer different analyses for the same passage, the output is sometimes ambiguous and we have not attempted an automatic analysis here.

Automatic notation of metrical accents starts by defining bars (the notated barline as the slowest pulse) and beats (pulses next to bars, as determined by key signature conventions). Then different pulses or metrical levels are defined including groups of bars (hypermetre) and each metrical level is weighted with a Gaussian curve with a peak near 600 msec. (Parncutt, 1994). Finally, the code evaluates the salience of any metrical level as determined by the weighting curve, and the metrical accent salience of each onset in the score by superposing two or three pulses and adding the saliences of pulses that coincide at a given point.

Melodic accent salience depends on two factors: the size of the leap preceding or following the accent, and the distance of the tone from the center of the melody's range. These are combined together so that for example repeated very high or low tones receive small melodic accent because the preceding interval is zero. Melodic peaks receive stronger accents than melodic valleys (arbitrary set at twice).

As since now there is no accepted general model for the dissonance of a sonority in western music, an algorithm for harmonic accents is difficult to formulate. At this stage, to predict the salience of harmonic accents in single tones or in chords, we use existing rules for Melodic and Harmonic Charge.

In the second stage, the code automatically manipulates timing and dynamics in the vicinity of accents. Each accent is modeled by means of two new functions, respectively for timing (duration) and dynamics (sound level) variations in the vicinity of the accent. These rules associate to each accent an arch-like tempo curve and a sound level curve according to a given parameterization. Each function admits 5 free parameters: the event peak, the width of the interval preceding the accent, the width of the interval following the accent, the shape of the curve before the peak, and the shape of the curve after the peak. Curves' shapes are linear, quadratic, cubic, exponential, Gaussian, cosine, and hand-gesture (a function using a mathematical model for approximating point-to-point hand gestures; Juslin et al., 2002). As most of the rules in DM, accent rules have a general quantity parameter k, which is used to control the overall degree to which each rule is applied. A value of k = 1 corresponds roughly to a neutral use of a rule, i.e. a noticeable but modest variation determined intuitively during the development phase. For timing and dynamics, an increment of k = 1 in a rule means an increase of 10% in the local tempo and an increase of 4 dB in the local sound level respectively. The quantity parameter is multiplicative in that k = 2 normally double the amount added (or multiplied) to the parameter in question. As the new accent rules are often triggered at the same position in the score (for example, a harmonic change often coincides with the start of a measure thus triggering both the harmonic and metrical accent), we also implemented a scheme for rule interaction (Friberg & Bisesi, 2013). Our system also gives the user the opportunity to manipulate emotional effect by changing the shapes of the curves.

A further aspect of our algorithmic approach to accent salience is the dependence on the stylistic context. Friberg & Bisesi (2013) addressed the question of how a performance style can be conceptualized as a collection of expressive gestures, and provided a set of examples belonging to different historical contexts (a baroque, a romantic and a modern piano piece respectively) and featuring different stylistic conventions as representative of the main performance techniques applied by musicians in their renditions. The aim there was to code specific performance styles as a set of DM performance rules, in order to model and automatically render these pieces by associating style-specific rule palettes. Based on that study, in the current project we asked musical participants to rate rule presets corresponding to different stylistic conventions and interpretations of pieces.

2. Aims

Our computational model of immanent accent salience in tonal music in DM (Bisesi, Parncutt & Friberg, forthcoming) addresses several questions, such as: (i) According to what general principles can immanent accents be identified? (ii) What general principles determine their salience? (iii) How are tempo, dynamics and other parameters typically varied in the vicinity of accents? (iv) Over what time period before and after an accent are they varied? (v) What is the shape of the timing or dynamic curve leading up to and away from the accent? (vi) How do musically acceptable performances fit with possible ranges of parameter values? (vii) Which parameter ranges correspond to particular qualities of performance such as emotions and free associations? (viii) How do all these findings depend on stylistic context?

In the remainder of this paper, we will discuss a preliminary experiment whose aim was to contribute to an answer to questions (vi), (vii) and (viii).

3. Main contribution and methods

To get insight into the relationship between performed accents and performed emotions, we related together different categories of accents, corresponding model parameters, and specific properties of a performance, such as musicality, expressivity, and evoked feelings. According to the analysis-by-synthesis procedure, musicians with different levels of expertise evaluated different renditions of selected passages and pieces, and parameters were adjusted accordingly.

Our methodology involves two different stages. In a first stage, we investigated the relationship between possible parameter values and musically acceptable performances. In the second stage, presets of parameters selected in the first stage will be linked to specific categories of emotions and free associations.

The first stage comprised three tasks. In each task, sound stimuli corresponding to different combinations of accents and model parameters were presented to expert listeners and amateurs for evaluation. Data taking is still in progress and will involve 20 participants (10 musicians and 10 amateurs). The aim of the first task was to quantify the musical acceptability of the pieces. Participants were asked to rate on a scale from 1 to 10 how much they liked the way the performers were playing, where 1 stood for "not at all" and 10 stood for "a lot". We asked participants to imagine they were hearing the sound stimuli in a concert or on a CD and to rate only the interpretation and not the music itself. The aim of the second task was to quantify the degree of expressivity of different renditions as compared with deadpan performances. We asked participants to rate on a scale from 1 to 10 the difference between two sound stimuli (a deadpan and an expressive performance), where 1 stood for "small" and 10 stood for "big". Deadpan performances correspond exactly to the score with the same MIDI velocity for each tone. The aim of the third task was to describe automatic performance renditions from the viewpoint of the listeners. Participants were asked to describe the sound stimuli subjectively from their viewpoint and in their native language with the first adjectives (feelings, images, or other descriptions) they think of. Between the three tasks, participants had the possibility to take short breaks. Overall, the experiment was about 40 minutes long.

To design the experiment, we used the open source software Psychopy v1.76.00 (Peirce, 2008). Before hearing to the stimuli, participants read instructions on the computer screen. During the experiment, they listened to different stimuli and evaluated each stimulus by clicking on a rating scale, which appeared on the screen at the end of the sound.

We used 27 different sound stimuli. There were 9 different interpretations for each of 3 short excerpts belonging to different musical styles - from the baroque, the classical and the romantic periods respectively: the Bach Bourrée from Cello Suite No. 3 BWV 1009, the first movement of Haydn Quartet Op. 74 No. 2, and the first movement of Mendelssohn Violin Concert Op. 64. Scores for the three excerpts are shown in **Figure 2**.

Figure 2. Musical scores for the three pieces (1: Bach, 2: Haydn, 3: Mendelssohn; details in the text) used in this study (adapted with the open source music composition and notation software Musescore 1.1).

Interpretations were produced by the new version of DM (based on automatic mark of accents). For each piece, there were 8 different expressive performances and a deadpan performance. Expressive performances differed from one another by emphasis on different kinds of accents (metrical and melodic/harmonic respectively), by the presence of timing or dynamics variations in the vicinity of accents, and by the mathematical curves employed to model timing and dynamics variations on accented notes or chords (steep versus smooth profiles). Stimuli were produced by systematically adjusting model parameters in the new version of DM, and corresponding midi files were listened to on a Clavinova CLP 370 previously calibrated with our system. After having been recorded through the open source software Audacity 2.0.2, stimuli were stored in wav format and presented to participants. Each stimulus lasted approximately 15 sec.

In task 1 and 3, each of the 27 performances was provided to participants separately. In task 2, for each piece, each stimulus consisted of a combination of a deadpan performance and one of the 8 expressive performances, separated by a gap of 3 sec. In all the three tasks, stimuli were presented in a random order.

Table 1 lists stimuli provided to participants in each task. Columns 1-2 and 3-4 refer to task 1 and 3, and task 2, respectively. Numbers in columns 1 and 3 indicate the stimuli as referred to in the data analysis. Columns 2 and 4 illustrate the expressive content of the stimuli by mean of acronyms. Acronyms "1", "2", and "3" refer to different pieces of music (Bach, Haydn, and Mendelssohn, respectively); "N" stands for nominal (or deadpan); "M" and "CH" mean that expressive variations are applied to metrical or melodic/harmonic accents respectively; "T" and "D" stand for local deviations in the tempo or in the dynamics; "W1" and "W2" indicate that the profiles of the curves employed to model expressive variations are steep or smooth respectively. In order to make values comparable, all performances were produced with the same default values (as currently set in DM) and the same quantity (k = 1).

Table 1. Stimuli provided to participants in tasks 1, 2, and 3. Acronyms' explanation: "1": Bach; "2": Haydn; "3": Mendelssohn; "N": nominal (or deadpan) performance; "M": expressive performance based on metrical accents; "CH": expressive performance based on melodic and harmonic accents; "T": local deviations in the tempo; "D": local deviations in the dynamics; "W1": steep curve profile; "W2": smooth curve profile.

TASK 1, TASK 3		TASK 2	
#	**performance**	**#**	**performance**
1	1N		
2	1MTW1	1	1N – 1MTW1
3	1MTW2	2	1N – 1MTW2
4	1MDW1	3	1N – 1MDW1
5	1MDW2	4	1N – 1MDW2
6	1CHTW1	5	1N – 1CHTW1
7	1CHTW2	6	1N – 1CHTW2
8	1CHDW1	7	1N – 1CHDW1
9	1CHDW2	8	1N – 1CHDW2
10	2N		
11	2MTW1	9	2N – 2MTW1
12	2MTW2	10	2N – 2MTW2
13	2MDW1	11	2N – 2MDW1
14	2MDW2	12	2N – 2MDW2
15	2CHTW1	13	2N – 2CHTW1
16	2CHTW2	14	2N – 2CHTW2
17	2CHDW1	15	2N – 2CHDW1
18	2CHDW2	16	2N – 2CHDW2
19	3N		
20	3MTW1	17	3N – 3MTW1
21	3MTW2	18	3N – 3MTW2
22	3MDW1	19	3N – 3MDW1
23	3MDW2	20	3N – 3MDW2
24	3CHTW1	21	3N – 3CHTW1
25	3CHTW2	22	3N – 3CHTW2
26	3CHDW1	23	3N – 3CHDW1
27	3CHDW2	24	3N – 3CHDW2

The design for the second stage is based on results from the first stage. In the following, we will discuss results from a preliminary investigation concerning the first stage, while design and results from the second stage will be presented at the conference.

4. Preliminary results

Results for an explorative study conducted on a small number of listeners (5) are displayed in **Figures 3** and **4.**

Figure 3 shows ratings provided to the 24 expressive (i.e., non deadpan) performances presented in task 1, as a function of the piece (upper-left), the typology of accent (upper-right), the parameter deviating from the nominal value (bottom-left), and the slope of the curve used to model expressive deviations (bottom-right). For these selected pieces, we found that participants tended to prefer baroque- and classical-style performances (p=0.0056), whose expressive variations from the nominal score are provided by changes in the dynamics (p=0.0005).

As performances were produced with the same default values in DM, we assume that they are comparable and interpret differences in the ratings as due to the different way different parameters affect perceptual listening. Nevertheless, the case that default values determined intuitively during the development phase in DM are not correct is possible, and should be further tested.

A possible reason why system worked better in the cases listed above is that, in current formulation, our model is not yet appropriate for romantic music (of which piece 3 is a typical example). A possible explanation of higher ratings provided to excerpts based on dynamical variations is that these pieces may imply a motor quality that is better achieved if the tempo is regular.

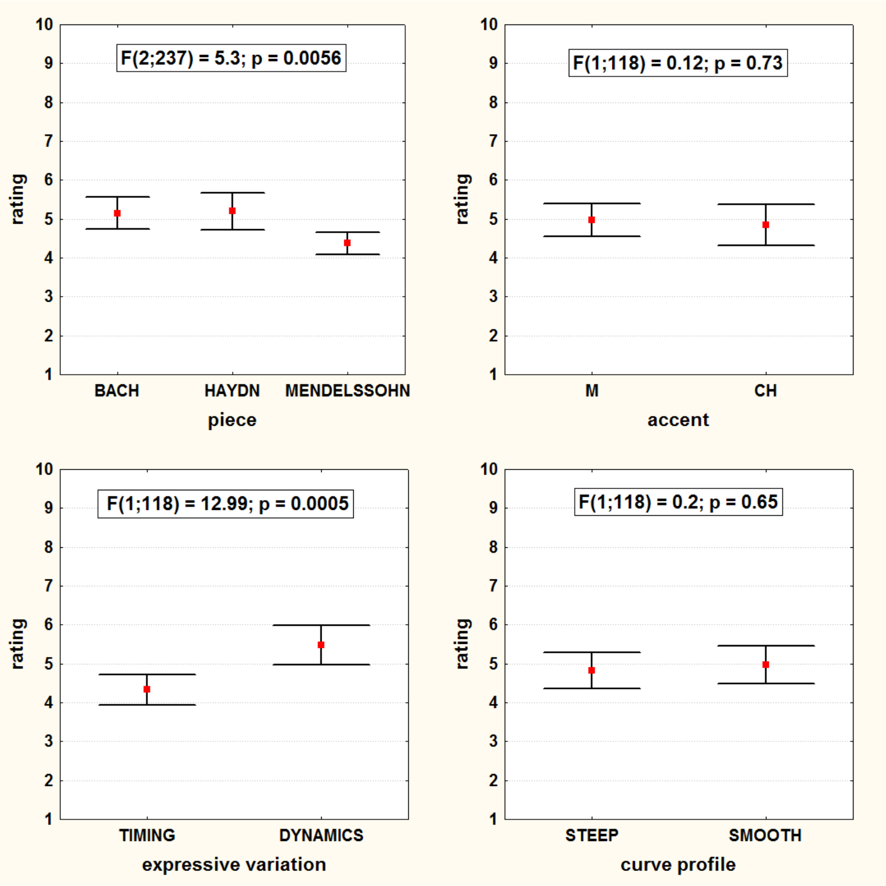

Figure 3. Ratings provided to the 24 expressive (i.e., non deadpan) performances of task 1, as a function of the piece (upper-left), the typology of accent (upper-right), the parameter deviating from the nominal value (bottom-left), and the slope of the curve used to model expressive deviations (bottom-right). Vertical bars denote 0.95 confidence interval.

The four panels in **Figure 4** display ratings provided to stimuli presented in task 2. Consistently with results for task 1, baroque- and classical-style performances were rated as more different from deadpan performances than romantic performances (p=0.03), and ratings were higher when differences were due to changes in the dynamics than in the timing (p=0.007). Furthermore, renditions based on emphasis on melodic and harmonic accents modelled by mean of steep curve profiles were perceived as more different from deadpan performances than renditions based on metrical accents and/or smooth curve profiles. A possible explanation is that melodic and harmonic accents occur less regularly than metrical accents, and therefore they are perceived as more unexpected events. The more a performance sounds unexpected, the higher it is rated as different from a deadpan performance. The degree of unexpectation is higher when expressive features are achieved suddenly (by mean of a steep curve) than gradually (by mean of a smooth curve).

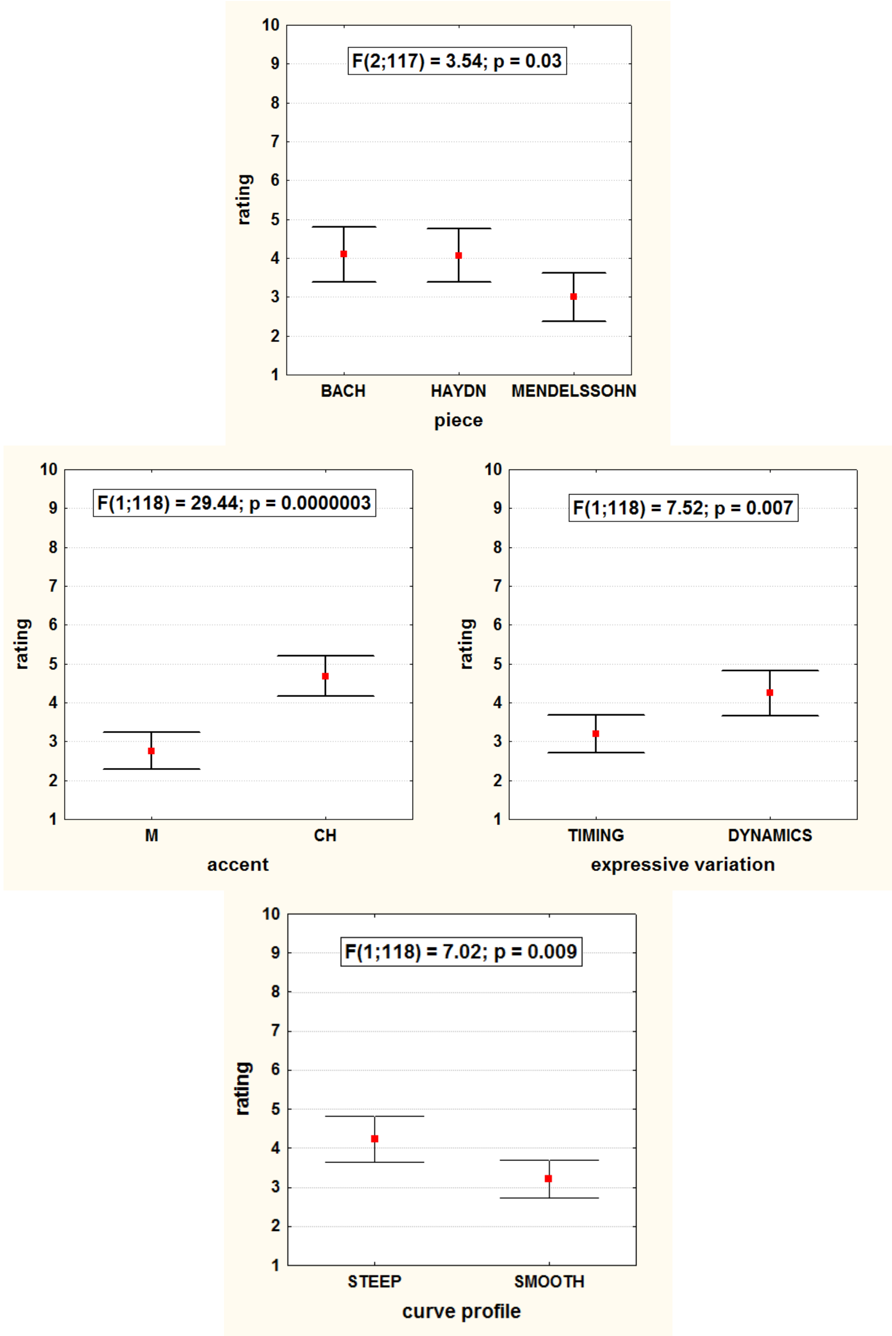

Figure 4. Ratings provided to the 24 performances of task 2, as a function of the piece (upper-left), the typology of accent (upper-right), the parameter deviating from the nominal value (bottom-left), and the slope of the curve used to model expressive deviations (bottom-right). Vertical bars denote 0.95 confidence interval.

As amounts of different rules are still under testing, a detailed statistical analysis may seem inappropriate. Nevertheless, we carried out the following preliminary analysis, in order to get insight into general tendencies.

According to the Kolmogorov-Smirnov test, in both task 1 and 2 performance ratings are not normally distributed (Z=0.19, p=0.000); therefore, we run non-parametric tests. In task 1, the Kruskall-Wallis test showed no significant main effect on the performance factor (X2=28.175, df=26, p=0.35) (probably due to the small number of participants). Mann-Whitney-U test returned significant differences between performances 6 and 9 ($U=2$, $p=0.03$), 7 and 9 ($U=2$, $p=0.03$), 9 and 16 ($U=1$, $p=0.016$), 9 and 21 ($U=1$, $p=0.016$), and 9 and 24 ($U=2$, $p=0.03$). On average, performance 9 received higher ratings ($M=6.8$) than performance 6 ($M=4.4$), 7 ($M=3.8$), 16 ($M=4$), 21 ($M=3.8$), and 24 (3.6). In task 2, the Kruskall-Wallis test showed a significant effect on the performance factor ($X2=58.66$, $df=23$, $p=0.0$). According with the Mann-Whitney-U test, there are significant differences between performances 1 and 5 ($U=0$, $p=0.008$), 1 and 6 ($U=0$, $p=0.008$), 1 and 7 ($U=0$, $p=0.008$), 1 and 8 ($U=0$, $p=0.008$), 1 and 9 ($U=1.5$, $p=0.016$), 1 and 11 ($U=1.5$, $p=0.016$), 1 and 13 ($U=0$, $p=0.008$), 1 and 14 ($U=0$, $p=0.008$), 1 and 15 ($U=1.5$, $p=0.016$), 1 and 23 ($U=1.5$, $p=0.016$), 1 and 24 ($U=1.5$, $p=0.016$), 2 and 5 ($U=1.5$, $p=0.016$), 4 and 5 ($U=0.5$, $p=0.008$), 5 and 10 ($U=1$, $p=0.016$), 5 and 12 ($U=2$, $p=0.03$), 5 and 17 ($U=1.5$, $p=0.016$), 5 and 18 ($U=0$, $p=0.008$), 5 and 20 ($U=1$, $p=0.016$), and 5 and 22 ($U=1$, $p=0.016$). On average, participants' rating for performance 1 ($M=1.6$) are closer to ratings for performance 5 ($M=6$), 6 ($M=5.4$), 7 ($M=5.6$), 8 ($M=4.8$), 9 ($M=3.2$), 11 ($M=5.4$), 13 ($M=4.2$), 14 ($M=3.8$), 15 ($M=6$), 23 ($M=5$), and 24 ($M=3.8$). Participants' ratings for performance 5 ($M=6$) are more distant to ratings for performance 2 ($M=2.6$), 4 ($M=2.2$), 10 ($M=2$), 12 ($M=2.6$), 17 ($M=1.8$), 18 ($M=1.6$), 20 ($M=2.2$), and 22 ($M=2.2$).

Specific qualities of performances as provided by participants' descriptions in task 3 will be used in a further stage of the study. In general, stimuli were described with words concerning musical aspects related to the structure, feelings and free associations. For instance, they described performances with words like "slow", "experiencing something new", "light-footed", "waking up" (performance 1), "harmonious", "relaxing", "developing ideas" (performance 14), "very accented", "not fluent", "being sick" (performance 20), "too slow", "not fluent", "more accented", "nervous", "confusion" (performance 24), "exiting", "vital", "stressful", "danger" (performance 25), "harmonious", "cozy", "meditative", "nursery rhyme", "children birthday" (performance 27).

Final results, carried on the whole set of participants, will be presented at the conference.

5. Implications

Stimuli associated with best ratings in task 1 and 2 will be used in the second stage of the experiment, whose aim is to relate parameters' presets to specific words describing emotions and free associations. These words will be selected in two ways. First, we will use descriptions provided by participants in task 3. Second, we will include new categories of emotions and free associations obtained in separate studies.

Bisesi & Parncutt (2010) explored listeners' informal vocabularies for describing expression in piano music. Most words felt into three categories: musical structure, emotion, and free association. Subcategories included immanent/performed attributes of the sound (tempo, dynamics, pitch and timbre), accentuation, character and meaning, basic/complex emotions and static/dynamic or living/non-living associations. Bisesi, Bodinger, & Parncutt (2013, in progress) are now investigating the relationship between emotions and free associations in more detail. 21 participants (7 musicians, 7 amateurs and 7 non-musicians) are listening to 8 piano pieces in different "classical" styles. They are then asked to describe their experience of the music (open question). After that we ask them to focus on emotions and free associations (or abstract images). Results are currently being processed. We are exploring qualitative relationships and quantitative correlations between subcategories of emotions and images by grounded theory, multidimensional scaling, and correspondence analysis.

We are mapping out possible ranges of parameter values in a multidimensional parameter space that correspond to musically acceptable performances, and specifying parameter ranges that correspond to particular qualities of performance as expressed by words as bright and dark, joyful and sad, static and dynamic, expected and surprising. Our target is to associate a given accent's salience (as estimated by automatic musical analysis in DM) to specific "effective" combinations or presets of model parameters, then describe and classify presets according with emotions and free associations by mean of a semantic differential (a collection of rating scales to evaluate different aspects of an object, event or concept).

Results will be used to develop new gestural interfaces in pDM - a *pure data* system for real-time expressive control of music performance (Friberg, 2006). The current version of pDM is based on the old formulation of DM and includes several examples of emotional expression mappers. They are the arousal-valence two-dimensional space commonly suggested for describing emotional expression in the dimensional approach (happy, tender, sad, and angry; Sloboda & Juslin, 2001), a kinematics-energy space (hard, light, heavy, soft; Canazza et al., 2003), and a gesture-energy space (gentle, expressive, light, and strong; Friberg, 2006). We plan to implement a new version of pDM based on our model of accents by adjusting algorithmic formulations inspired by accent theory, by introducing new gestural interfaces based on our qualitative data, and by relating different regions in multidimensional spaces with specific music and performing styles.

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STUDY ON THE EXPRESSIVNESS IN THE PERFORMANCE OF CHILDREN

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Abstract

This work studies the characteristics of musical expressiveness in children's performances through comparison of musical structures and behavioral patterns in executing music. The aim is to offer effective information useful in instrumental teaching, and elements of comparison with the performance of advanced students and musicians. Three ten-year-old piano students learned a piece previously unknown from Bartok's Mikrokosmos. During the learning process their teacher kept a log of the indications given to the children regarding musical content and performance practices. When the children could play the piece fluidly by memory, a video tape was made during a lesson. After about ten days during which the students received new indications, they performed the piece in a protected environment (private concert) and were video taped. A third videotaped performance in a non-protected context (public recital) ended the experiment. The analyses of the videotapes was done following two methods: one rigorously analytic, based on the presence of structural elements of the piece, the second one based on the interpretation of the expressive behavior in order to allow comparison with the structural aspects and with the teacher's log. The presence of important evidence in proximity of the conjunction points between the principal parts which define the structure of the pieces performed - mistakes, omissions, acceleration, memory lapse - all induce one to think that in the absence of analytic training and of awareness of form, the performance of the three children pivoted on the fundamental musical structures of the piece.

Keywords: children, expressiveness, musical structures

1. Introduction

The object of this work is based on the contributions of three different areas of study:

- Music analysis
- Music and emotions
- Musical development

Instrumental music training is founded on the development of multiple skills, which are related to three different kinds of abilities: those govern the decoding of the musical text in each of its aspects, technical-gestural and expressive abilities. Teaching and learning paths develop these three types of abilities through strategies, which focus on specific problems and are progressively ordered according to complexity and difficulty. The ultimate purpose is to make music, which means to utilize the acquired musical skills in a perfectly synergistic manner, creating an event which is beyond each of them, and more than their synthesis: i.e. the expressive communication of a musical text.

In the performance of professional musicians these abilities are perfectly integrated and appear as a harmonious whole, functional, and substantially centered on the affective and emotional profile. Studies on the analysis of performance (Seashore, 1938; Cone, 1968; Schmalfeldt, 1985; Pozzi, 1999; 2009; Rink, 1995; Duke et al. 2009) show evidence that a performer at a high or complete level of training, does not play exactly the contents of a score, but something more and/or less in terms of tempo, dynamics, articulation and sometimes even pitch: something that results impossible to translate from the writing (Shaffer, 1992; Shaffer, 1995) but which is of substantial importance from the standpoint of expression. Since the 1960s, this phenomenon has affected new technologies (Bengtsson et al., 1969) and progressively brought about the development of sophisticated software, first for measuring the shapes of sound waves, and later to measure other important parameters of sound.

In the case of piano performance, obviously, timbre and pitch are normally excluded from the computations, but the variables of the attack of the note (more or less legato or staccato), of dynamics (more or less soft or loud), and of duration (more or less conforming to what is written) have been repeatedly measured in numerous and well known cases (Todd, 1985; Repp, 1992; Friberg et al., 2006).

However, the study procedures utilized for adults or advanced level students have proven to be scarcely apt for research of the same phenomenon in children, since most of them are based on the full awareness of what the instrumentalist is playing and on his/her ability to describe the strategies utilized or the opinions developed on the subject. For this reason, it is necessary to consider also the fields of study, which deal more specifically with the preparation phase for a performance in all of its aspects, which in the case of working with children must be necessarily organized by a teacher.

Studies on the didactics of performance (Shaffer, 1995; Brendel, 1997; Monelle, 2002), on the research on mnemonic learning, (Williamon, 2002; Chaffin et al.,2009), on cognitive and motor theories applied to performance skills (Hallam, 1995; Cox, 2001; Davidson, 2007), on methods for the organization of personal study (Miklaszewski, 1989; Jørgensen, 2004; McPherson-Evans, 2007), on the tools for expressive interpretation (Clarke, 1991; Rothstein, 1995; Juslin et al., 2007), and finally on the analysis "for performance" (Dalmonte, 1999; Rink, 2002) have amply investigated the scope of expressiveness in performance, presupposing the acquisition of that perfect synthesis of information which characterizes trained musicians. In the cognitive scenario of the artists themselves (Rink, 2002; Chaffin et al., 2009), all of these aspects are inseparably intertwined: even the fingering of a single musical passage (Clarke et al., 1997) is based on a combination of motor reasons, considerations on the structure of a piece and the expressive characteristics of the passage to perform.

There are also equally detailed studies on musical expression in the absence of a training program, taking into account vocal musical expression at the preschool and infant age and in the prenatal environment, and investigate expressiveness at its very beginning. (Sloboda, 2010; Tafuri, 2007; Trevarthen, 1999/2000).

Despite the wealth and depth of all these studies, instrumental teaching, traditionally linked to a laboratory setting and to the historical roots of the instrumental schools, has in fact developed methodologically based paths regarding technical-gestural abilities and the skills of decoding a musical text. At the same time, it has scarcely considered the evolution of expressive capacity, which has remained an area of development made up of unconscious and often unintentional paths, entrusted to the experience of the teachers, the tradition of the school and the presence of talent and sensitivity in the students.

2. Beginners and the expressive performance

This study, therefore, takes into consideration the problem of expressiveness in beginners, that is in very young students who have recently started their formative training, but have already experienced the division between decoding skills, technical-gestural ability, and expressiveness. The study poses three specific questions:

- Can it be affirmed that expression in beginners, being the perfect synthesis of all the acquired skills, finds its basis in the structure of the musical piece, as happens with adult pianists?
- Are observable gestural behaviors connected to the perceived structure of a piece?

- What are the indications which can truly support and improve the process of instrument teaching in the matter of expression?

Studies of this nature can be truly useful to instrumental teaching methods, since they may be naturally compared to studies on professional pianists, highlighting the differences and similarities of expressive behavior during performance, defining a starting point and an arrival point. In fact, the study of performance in beginners who are developing various abilities (decoding, technical-gesture, expressive) and with similar analytical criteria (structural and technical-gesture aspects of expression), truly expresses both the relationship with the expected result (the fully trained pianist) and the relationship between the abilities themselves. It must not be forgotten that in fully trained pianists these are perfectly integrated in the expressive performance, while in children this does not necessarily happen.

This work takes into consideration the characteristics of musical expression in the performance of three 10-year-old girls through the study of both the analytical aspects recognizable in their performances, as well as the corresponding technical and gestural behaviors with the scope of contributing to the improvement of instrumental teaching methods, giving start to new theoretical reflections useful in building expressive abilities.

3. Phases of the study

Three young pianists, age 10, each studied a piece new to them, of unfamiliar structure and expressive profile, but suitable to their level of musical ability. The three children are enrolled in a piano course at the Pavia Conservatory of Music (Italy), where admission is by means of an entrance exam, and they regularly follow all of the mandatory courses (Theory and Choral Singing), and once a week attend a piano lesson. They have already experienced public performance and the preparation necessary to guarantee an adequate level. Chiara and Clara have been certified at the 1st level, and Luisa has been certified at the 4th level. The pieces chosen have been taken from Bela Bartok's *Mikrokosmos*: Chiara studied *Five-tone Scale* and Clara studied *Melody Against Double Notes* both taken from Volume III, while Luisa studied *Minor Seconds, Major Sevenths,* taken from Volume VI. The pieces chosen, though having very different levels of difficulty, do have some characteristics in common: they all have titles with no semantic references other than music terms, use an atonal musical language, and make use of simple and recognizable structures.

During the entire learning process for the piece, the teacher kept a diary in which the instructions given to the children during lessons were recorded. All the instructions had to refer strictly to the musical writing, to the sound quality and to the structure of the piece, and had to present a language which made no use of any semantic image different from musical language, such as stories, characters, metaphors, drawings, etc., and had to clearly indicate what the children should study at home to improve the piece.

When the children were able to play the piece by memory with fluidity, a first video recording was made during the lesson. It was done in the room where the children usually have their piano lesson, in the presence of their teacher and of the audio-video operator. During this first recording session, the children had the chance to perform the piece a second time, in case their first performance turned out to be particularly problematic. In fact, making a video recording during a lesson was new and surprising to them, even though it had been planned and amply described in advance: Clara, for example, continued to look for her teacher with her glance, while Chiara seemed to be very curious and distracted by the taping procedure itself and by the presence of an operator. This prompted the operator to use cautious flexibility during the procedure.

After a period of 7 to 10 days in which the children received new instructions, annotated in the work diary, the pieces were preformed and videotaped a second time, in a more official context, but still limited to more or less familiar people which in any case they had already met within the context of their piano class. The recording took place in the auditorium of the Institute. The teacher, the parents of the children, and some schoolmates were present, making a total of five or six people. The children were aware of the fact that they would not be able to repeat the recording.

After another period of time, different for each of the children, a public recital took place during which the third performance of the girls was taped. In this context, other students performed as well, in the presence of about 50 people. Obviously, the time needed to learn the pieces was different for each child and there were interruptions and the typical problems of the learning process of very young children. For example, Clara had to postpone her final recording quite a bit due to an illness. Luisa, dealing with a very challenging study program, needed a long time before she was able to make her first recording. In all three cases, there were difficulties related to scheduling problems with the family when planning the recording.

The quantitative and qualitative analysis of video recordings followed two paths. One was strictly analytical, based on the presence of structural elements during the execution of the piece, and the other focused on the observation of the related gestures. This analysis was followed by a comparison of the data with the teacher's diary, which helped to clarify and deepen their interpretation.

4. Recordings and teacher's diary

Clara's first recording took place on January 25, 2013. She performed her piece in 1 minute and 22 seconds, rather than in 1 minute and 8 seconds, as indicated by the composer (figure 1), and brought out the melodic line very much, underlining the entrances of the right hand with a gesture bringing her body and head closer to the piano, and the entrances of the left hand with a gesture towards the right and pulling slightly away from the piano. In measure 8-9 she highlighted the duration of 6 quarter notes of the two dotted half notes with a light gesture of the body and the leg. In measure 18, before the beginning of the coda, she forgot the diminuendo and began the upbeat of bar 19 with a mp / mf dynamic.

Figure 1.

Chiara was able to make her first recording on March 1st, and she performed her piece, *Five Tone Scale*, in 45 seconds, while the composer indicated a duration of 27 seconds (figure 2). She respected the phrasing following the closing and the beginning of phrases with her hand gestures, underlining the dynamic distension with care, especially in measure 9. She performed a very natural rubato between measure 16 and 19, which does not find a correspondence in the indications given by the teacher. In measure 27, she had a memory lapse, coinciding with a mistake of the left hand, where she played an E instead of a G in the second quarter note, and skipped bar 28 and played bar 29, the final measure, commenting "I did it all wrong".

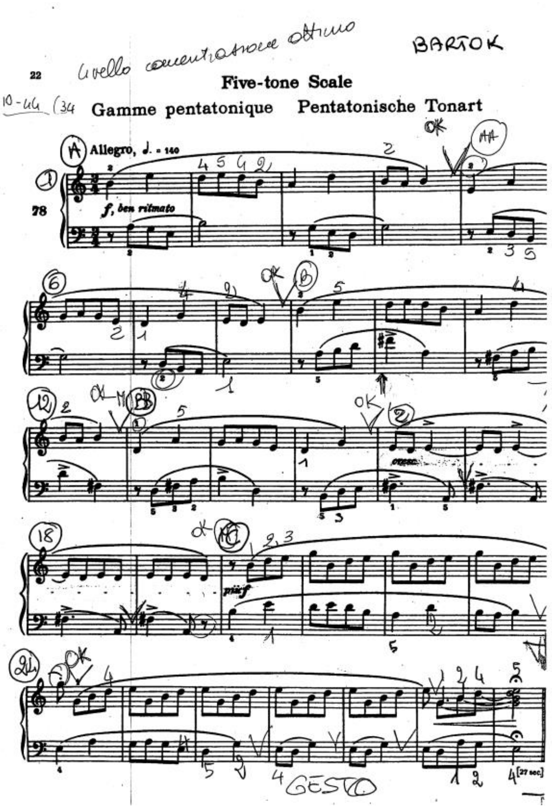

Figure 2.

In the second previous recording, made in a context of a semi-public performance, Clara adopted similar expressive behaviors with a few relevant differences: she performed her piece in 1 minute and 17 seconds (figure 1), and in bars 8 and 9, at the end of the first section of the piece, she shortened the duration of the tied eighth-notes of a quarter note value, and she did not highlight the pulse with the movement of her body as it had happened in her first recording; in bar 19 she omitted a quarter note rest, coinciding with the beginning of the last section.

The second recording by Chiara lasted 35 seconds at ♩=100, she did not make any mistakes, but an acceleration took place starting at bars 14 and 15 (figure 1), which brought her to ♩=112 in bar 20. The acceleration corresponded to the crescendo and relaxes exactly with the beginning of the third section of the piece. The phrasing was always respected, as were the accents. The recording on March 25 was made in public, and represents the third and last performance of the children. Clara performed her piece in 1 minute and 16 seconds, and reproduced her second performance rather closely.

Chiara performed her piece, *Five Tone Scale*, in 34 seconds with two mistakes, both relevant ones. The first was in bar 10, where the left hand has an hesitation to land on the F#, showing a slight disorientation right at the moment in which, in the left hand part, the descending and perfectly pentatonic line of the first 8 measures is abandoned.

The second mistake happens in the last 4 bars, where the phrasing of the left hand is shortened and is reduced to one bar repeated twice: in this situation, we can see a very light movement of the head.

In the conclusion Bartok writes a *crescendo*, but Chiara ends in *diminuendo*, using instinctively the more usual mode of concluding a phrase in general.

Luisa performed her piece for the first time in 3 minutes and 24 seconds, rather than 3 minutes and 25 seconds as indicated by Bartok, and a general lack of precision appears evident from the start, on the execution of the 16th note - dotted 8th note rhythm, which characterized the entire first part of the piece, with a tendency to lengthen the 16th note. Several errors are noticeable, almost always near the end or the beginning of the main sections of the piece: in bar 14, she omitted the "poco stringendo", in bar 33 the "Double movement", in bar 51 she omitted the quarter note rest, in bar 61 she did not accelerate, and in bar 67 she did not go back to "Tempo I". Other errors of a mechanical type occurred in bar 39 and 56, both on double stops.

Figure 3a.

Figure 3c.

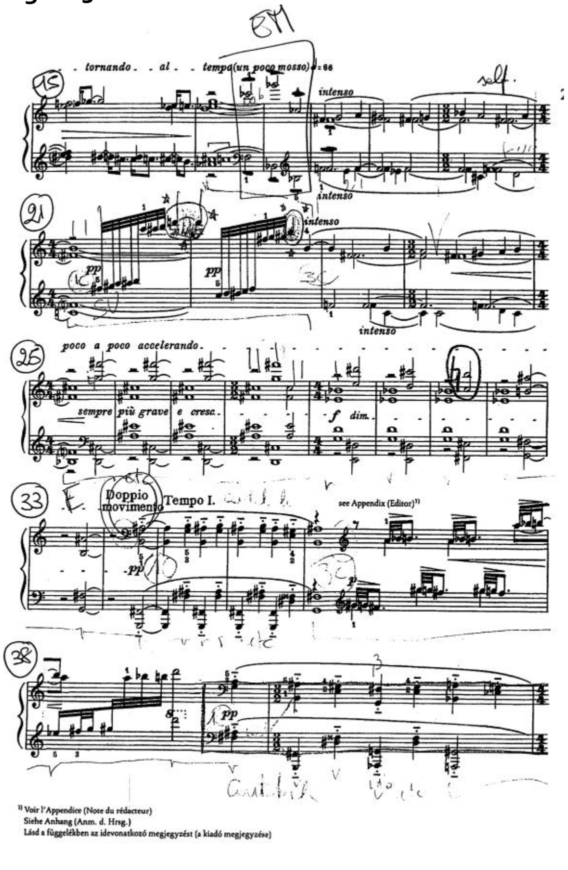

Figure 3b.

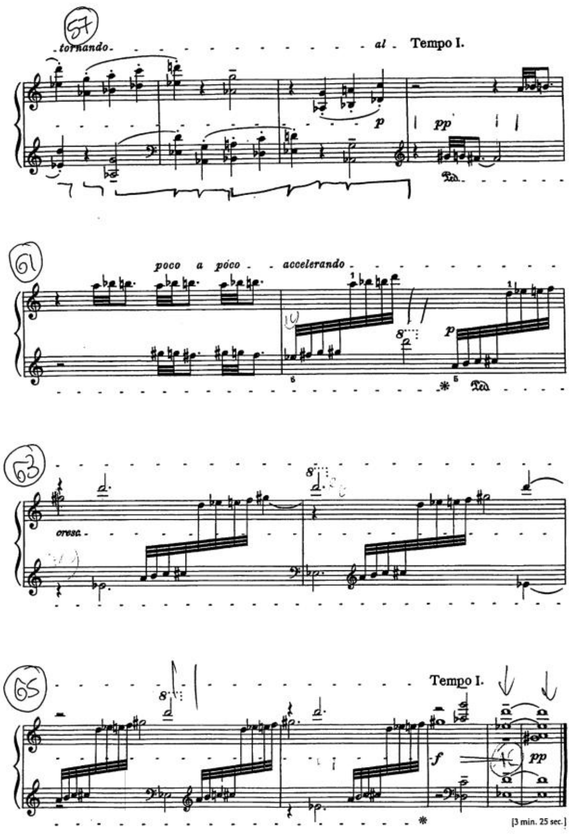

Figure 3d.

In the second recording Luisa performed her piece in 3 minutes and 4 seconds, with three mistakes similar to those reported in the first performance.

In the third performance she had a memory lapse in bar 16 and 17, in correspondence to the end of the first section and the beginning of the second. She made a mistake again approaching the change of section, in bar 34, *Movimento doppio*, and in bar 43, where for a mechanical error she played a C rather than a D flat. Her head and body were nearly immobile, and she was very focused on the necessary movements of the hand, wrist and arm in order to play her piece with the timbres that she had studied.

The diary of the teacher contains general information about the study method of the children: they initially learned their assigned piece studying it with separate hands, trying to understand its musical sense right from the very first reading by paying attention to phrasing and being aware of the parts which compose the piece. Joined hands practice followed, as well as a study of the dynamics, tensions, the definition of the velocity of piece, memorization and the progressive fine tuning of all of the information necessary for the performance. This method of procedure and the type of information linked to it, were in fact very similar to the diaries of the three children. However, other interesting information which was much more related to each single child's course of study was not so similar:

- The time necessary to learn the assigned pieces, evaluated in weeks starting from the date in which the piece was assigned to the date of the first recording, with annotations of the rest period due to absences, illness or other problems;
- The type of difficulty or mistakes which took place during their study;
- The persistence of difficulties and mistakes;
- Memorization times, expressed in weeks;
- Thoughts and/or reactions of the children regarding their study or their piece.

The learning and memorization times of the piece are well illustrated by graphics 4, 5 and 6. They are very different in the three cases: Luisa was able to record for the first time after 13 lessons, Chiara after 12, and Clara after 8. We also observe that the Luisa was engaged in memorization from the seventh lesson on, for 7 lessons. Chiara from the eighth, for 3 lessons. Clara from the sixth, for 5 lessons.

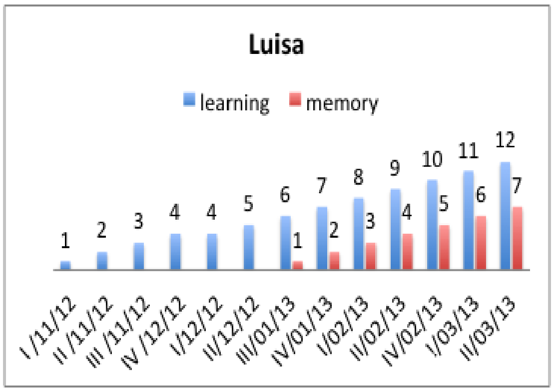

Figure 4.

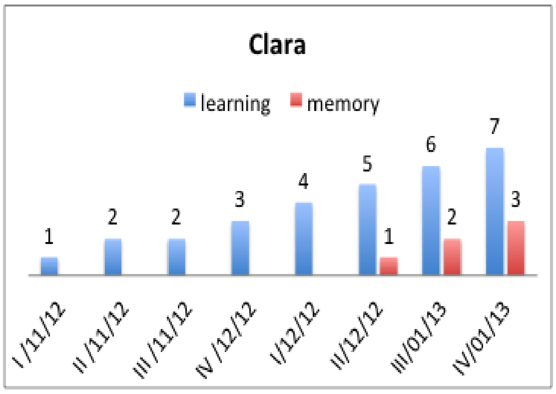

Figure 5.

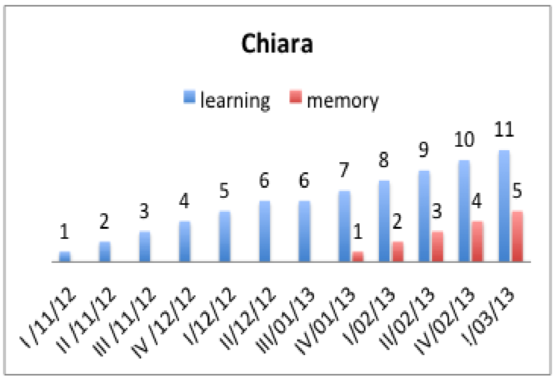

Figure 6.

Concerning the difficulties that the children encountered, the indications given to Chiara had to deal mostly with fingerings (figure 9), which were the object of observations during four lessons, on phrasing (2 lessons) and on rhythmic imprecision (1 lesson). The indications given to Clara (figure 8) have had to deal mainly rhythmic precision for at least two lessons. In Luisa's case the difficulties showed themselves at a more advanced level of study (figure 7), closer to the date of performance, and regarded tone quality, the use of pedal, the dynamics, and precision in the performance of the rhythmic pattern recurring throughout the entire piece.

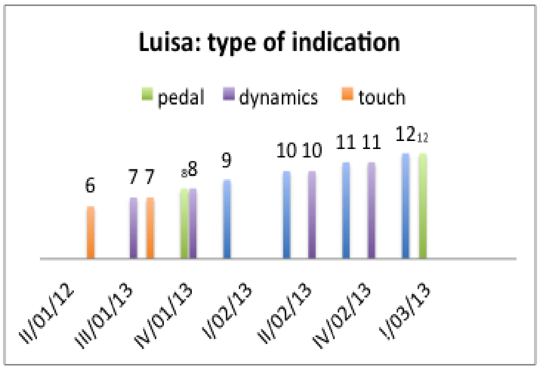

Figure 7.

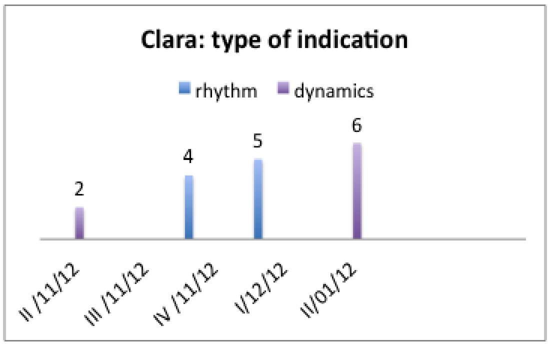

Figure 8.

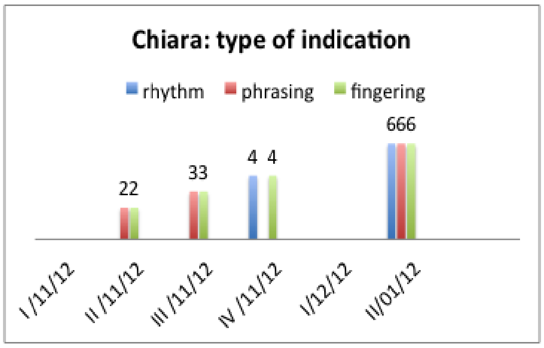

Figure 9.

Reading the diary, we can learn important details to understand the path through which expressive performance has matured, in that they represent authentic autonomous reactions and thoughts of the children. In particular, in the case of Luisa, the child continued to sustain that she did not like her assigned piece until March 2, when she spontaneously said "Now I'm starting to like it…". The fact that she did not like the piece probably caused fatigue and slow learning, contrarily to the case of Clara, who as early as November 16 told the teacher that she had discovered that by making a great difference in dynamics between the two hands she could make the dissonances throughout the piece much more pleasing due of the intervals created by the chromatism.

5. Conclusions

The presence of important evidence in proximity of the conjunction points between the principal parts which define the structure of the pieces performed, mistakes, omissions, an acceleration, a memory lapse, a rubato - all induce one to think that in the absence of analytic training and of awareness of form, the performance of the three children pivoted on the fundamental musical structures of the piece. The same gestures of the body and of the hands is strongly connected to relevant musical events, like the dialogue between parts, the separation of musical phrases or the handling of a long sound which preludes a new formal section. The choice of having the children study pieces whose titles do not refer to the extra-musical language world, and the fact that the language and structures of the pieces excluded immediate associations to other musical or non-musical ideas has effectively enclosed the children's affective experience within the pure musical experience, making it possible to get a significant reading of their behaviors, of their reactions and their patterns in learning. This study can be developed and deepened from the point of view of the methods of investigation and certainly has need of evidence from a larger sample of young musicians, but the indications which it will be able to give to instrumental teaching are of great relevance since these could give added guidance to the field of teaching expressiveness.

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MUSIC IN GAMBLING CONTEXTS: WHAT ARE INDIVIDUALS' PERCEPTIONS OF MUSIC EXPERIENCED IN GAMBLING CONTEXTS & WHY DO INDIVIDUALS SELF-SELECT MUSIC TO ACCOMPANY GAMBLING?

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Abstract

Music influences behaviours in everyday contexts (North & Hargreaves, 2008) and is a factor which can influence gambling behaviour (Griffiths & Parke, 2005; 2003). Experimenter-selected background music has been found to influence indices of gambling behaviour in laboratory gambling experiments (e.g. Spenwyn, Barrett & Griffiths, 2010; Noseworthy & Finlay, 2009; Dixon, Trigg & Griffiths, 2007; Marmurek et al., 2007). However, less is known about gamblers' experience of music in real-life gambling contexts. To date research has considered music's utilisation in gambling environments where fruit machines are located (Griffiths & Parke, 2005). Therefore further research is required to determine gamblers' responses to music in different gambling environments and when playing other gambling activities. Opportunities for individuals to gamble have increased; gambling activities can be accessed in both traditional (e.g. casinos, bookmakers) and remote gambling environments. Remote gambling permits individuals to gamble using technological devices and the same can be observed for music, as listeners access music using sophisticated electronic equipment. It is therefore feasible that individuals self-select music to accompany gambling. In the present study an online questionnaire was administered to examine gamblers' responses to music in traditional and remote gambling environments; the perceived functions and influences of music on gambling behaviour. This is the first study to examine gamblers' motivations for self-selecting music to accompany gambling. Our findings will be presented at the conference, where we will discuss the implications of music listening for gamblers and consider how future research could further the understanding of why music influences gambling behaviour.

Keywords: functions of music, self-selected music, gambling

1. Background & Aims of the Present Study

Gambling is a suitable paradigm in which to explore music's influence on behaviour because gambling requires individuals to use a range of psychological processes including attention, risk-taking, decision-making and memory. Research conducted within the field of music psychology has demonstrated that music can influence cognitive processes (North & Hargreaves, 2008), individuals' behaviour (Kämpfe, Sedlmeier & Renkewitz, 2011) and elicit emotional responses (De Nora, 2000) in listeners in everyday situations. It is possible that background music can influence gambling behaviour and as gambling is potentially addictive (Orford, 2011) it is important to determine how and why music can effect gambling behaviour.

The marketing methods employed by gambling operators to encourage and maintain gambling can be classified into two categories: situational characteristics and structural characteristics (Griffiths, 2003). Background music is a factor within the two marketing methods which can be utilised by gambling operators. As a situational characteristic music can attract individuals to gambling activities and can initiate gambling (Griffiths & Parke, 2003). Music can also maintain or reinforce gambling as a structural characteristic (Parke & Griffiths 2006). Recently researchers have begun to investigate background music's influence on gambling behaviour in laboratory studies and have found that music can influence the likelihood of individuals gambling beyond planned levels (Marmurek et al., 2007; Finlay et al., 2007), individuals' ability to estimate the time spent gambling (Noseworthy & Finlay, 2009) and fast tempo music can lead to faster betting in virtual roulette (Spenwyn et al., 2010; Dixon et al., 2007; Bramley, Dibben & Rowe, in press). These studies show that within laboratory environments background music can influence aspects of gambling behaviour, however, less is known about whether background music can effect gambling behaviour in real-life gambling situations.

Gambling is a leisure activity which can be undertaken in traditional gambling environments such as amusement arcades, casinos, bookmakers, pubs and clubs. Anecdotal evidence suggests that background music can be present in traditional gambling environments, however, we do not have comprehensive knowledge of how gambling-operators utilise music in these environments or gamblers' responses to the music. A study conducted in an amusement arcade indicated that the gambling operators played background music with the aim of appealing to gamblers' musical preferences: different music genres were played according to the customers' age and gender as well as which machine they were playing (Griffiths & Parke, 2005). However, it is unknown whether the utilisation of music in this manner in the amusement arcade (Griffiths & Parke, 2005) represents the ways that music is presented to gamblers in other gambling environments.

Hypotheses have been proposed to suggest how the music heard in an amusement arcade may influence gamblers (Griffiths & Parke, 2005). The suggested effects of background music on fruit machine gamblers include increasing their confidence, arousal, aiding relaxation, helping gamblers' to disregard previous losses and inducing a "romantic" affective state leading gamblers to believe that their chances of winning are better than in reality (Griffiths & Parke, 2005; 2003). It is acknowledged by Griffiths and Parke (2005) that background music heard in other gambling environments may exert different effects on gamblers, however, to date, these hypotheses have not been tested. Therefore, an aim of the present study is to determine gamblers' responses to music, which will provide an insight into whether music is perceived to influence gambling behaviour.

The structural and situational characteristics associated with remote gambling are different to when gambling in traditional gambling environments. For example, remote gambling affords increased accessibility, anonymity, convenience, disinhibition, event-frequency (shorter length of time between each gamble), asociability (reduced social interaction), interactivity (increased personal control) and stimulation (Griffiths et al., 2005). Therefore, background music may provide other functions for remote gamblers and elicit different responses from them. The present study therefore also investigates remote gamblers' responses to music which will enable comparisons to be made between responses obtained within other gambling environments.

To date, studies which have investigated gamblers' experience of background music have considered their responses to either gambling-operator selected (Griffiths & Parke, 2005) or experimenter-selected music (e.g. Spenwyn et al., 2010). Given that the portability and miniaturisation of technological devices have led to both music listening and gambling participation being more accessible, it may be that gamblers' self-select music to listen to when gambling similar to the practice of self-selecting music to accompany activities such as travelling or driving (North, Hargreaves & Hargreaves, 2004). In the present study we therefore compare individuals' responses to gambling-operator selected and self-selected music.

Studies have identified four recurring functions of self-selected music – distraction, energising, entrainment and meaning enhancement (Sloboda, Lamont & Greasley, 2009). In a gambling situation it may be that self-selected music may maintain or exacerbate individuals' gambling behaviour as the music matches gamblers' musical preferences (Griffiths & Parke, 2003). Given that music can be self-selected to support psychological processes such as attention (De Nora, 2000), memory (North et al., 2004), for affective reasons (e.g. Dibben & Williamson, 2007), to achieve a specific physiological state (Laukka & Quick, 2011) and there are behavioural, cognitive and emotional aspects to gambling (Orford, 2011), it appears that research is needed to establish the reasons why gamblers' self-select music. It may be that music fulfils unique functions for gamblers and may use music for behavioural, cognitive or emotional reasons in order to meet their needs, goals and desires in gambling situations. We therefore explore gamblers' motivations for listening to music, any benefits that music listening may afford and the perceived influences of self-selected music on gambling behaviour.

Our study builds upon existing research conducted within laboratory and traditional gambling environments to consider gamblers' perceptions of the music heard when gambling in a range of contexts. For example, we extend the gambling situations previously considered within other research (e.g. Griffiths & Parke, 2005) to include remote gambling, thereby recognising that the different features of remote gambling may influence gamblers' experience of music.

We also consider that gamblers may self-select music to listen to and this may elicit different responses from them compared to gambling-operator selected music. An insight is also obtained into gamblers' music listening habits – the technology used to listen to music, the music genres listened to, perceived functions, effects of music on gambling behaviour and the motivations for self-selecting music to listen to when gambling. We suggest that gamblers' responses to music may differ according to the environment in which it is experienced and whether gamblers' have control over the music that is present. Furthermore we suggest that the reasons given for why certain music is chosen to accompany gambling will differ according to gamblers' goals and the gambling context. We therefore consider whether the reciprocal feedback of musical response model (Hargreaves, MacDonald & Miell, 2005), which states that there are personal, musical and situational variables to take into account when explaining individuals' responses to music can apply to understanding the experience of music in gambling situations.

2. Method

An online questionnaire was designed to investigate the aims of the present study. The questionnaire consisted of 26 items and skip-logic was employed to ensure that respondents were asked only relevant questions about the gambling environments (traditional versus remote) in which they gambled.

The questionnaire collected demographic information, asked respondents about their gambling habits, their perceptions of the music heard when gambling and the extent that they self-selected music to listen to when gambling. The questionnaire probed music's potential to influence aspects of gambling behaviour by asking respondents' to rate their agreement with a number of statements (e.g. "The music that I hear when gambling remotely aids my concentration"). Respondents indicated their agreement using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Descriptive and inferential statistics will be referred to at the conference in order to present the findings obtained from the quantitative data.

Qualitative data were collected via a question which probed the reasons why respondents' self-selected music to listen to whilst gambling. Responses to this question were analysed using Thematic Analysis (Braun & Clarke, 2006). The findings of the present study will be presented at the conference.

3. Implications & Future Research

This exploratory study is the first to consider gamblers' responses to self-selected music and to gambling-operator selected music in traditional and remote gambling situations. One implication of this research is that more knowledge has been gathered about why music is an important factor to consider when identifying why certain gambling activities or environments are fun, engaging, exciting, addictive and commercially successful. This knowledge could improve the understanding of why factors, such as music, promote gambling participation and why gambling is appealing (Cornish, 1978; Griffiths, 1993; Parke & Griffiths, 2007). Furthermore, this research may contribute to the promotion of responsible gambling, development of harm-minimisation strategies and gamblers themselves could modify their behaviour (Gainsbury & Blaszczynski, 2012). This study has also provided a basis for future research to explore the possibility of a relationship between gamblers' beliefs about music's effects and whether music actually influences their gambling behaviour.

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INVESTIGATING RELATIONSHIPS BETWEEN MUSIC, EMOTIONS, PERSONALITY, AND MUSIC-INDUCED MOVEMENT

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Abstract

Listening to music makes us to move in various ways. The characteristics of these movements can be affected by several aspects, such as individual factors, musical features, or the emotional content of the music. In a study in which we presented 60 individuals with 30 musical stimuli representing different genres of popular music and recorded their movement with an optical motion capture system, we found significant correlations 1) between musical characteristics and the exhibited movement, 2) between the perceived emotional content of the music and the movement, and 3) between personality traits of the dancers and the movement. However, such separate analyses are incapable of investigating possible relationships between the different aspects. We describe two multivariate analysis approaches – mediation and moderation – that enable the simultaneous analysis of relationships between more than two variables. The results of these analyses suggest mediation effects of the perceived emotional content of music on the relationships between different features of music and movement. It can therefore be assumed that musical emotions can (partly) account for the effect of music on movements. However, using personality as moderator between music and movement failed to show a moderation effect in most cases, suggesting that personality does not generally affect existing relationships between music and movement. Hence it can be assumed that musical characteristics and personality are independent factors in relation to music-induced movement.

Keywords: music-induced movement, multivariate statistics, emotion

1. Introduction

Music makes us move. While listening to music, we often spontaneously move our bodies. Keller and Rieger (2009), for example, stated that simply listening to music can induce movement, and Lesaffre et al. (2008) conducted a self-report study, in which most participants reported moving when listening to music. Janata, Tomic, and Haberman (2012) asked participants to tap to music and found that participants not only moved the finger/hand, but also other body parts, such as feet and head. In general, people tend to move to music in an organized way by, for example, rhythmically synchronizing with the pulse of the music by tapping their foot, nodding their head, moving their whole body, or mimicking instrumentalists' gestures (Godøy, Haga, & Jensenius, 2006; Leman & Godøy, 2010). Moreover, Leman (2007:96) suggests, "Spontaneous movements [to music] may be closely related to predictions of local bursts of energy in the musical audio stream, in particular to the beat and the rhythm patterns". Such utilization of the body is the core concept of embodied cognition, which claims that the body is involved in or even required for cognitive processes (e.g., Lakoff & Johnson, 1980, 1999; Varela, Thompson, & Rosch, 1991). Human cognition is thus highly influenced by the interaction between mind/brain, sensorimotor capabilities, body, and environment. Following this, we can approach musical engagement by linking our perception of it to our body movement (Leman, 2007). One could postulate that our bodily movements reflect, imitate, or help understanding the structure and content of music. Leman suggests that corporeal involvement could be influenced by three (coexisting) components or concepts: "Synchronization", "Embodied Attuning", and "Empathy", which differ in the degree of musical involvement and in the kind of action-perception couplings. "Synchronization" constitutes the fundamental component: synchronizing to a beat, the basic musical element. The second component, "Embodied Attuning", concerns the linkage of body movement to musical features, such as melody, harmony, rhythm, or timbre. Following this idea, movement could be used to reflect, parse, and navigate within the musical structure. Finally, "Empathy" links musical features to expressivity and emotions, so the listener would feel the emotions expressed in the music and reflect them by using body movement.

A few studies have investigated music-induced movement and suggested several factors to affect the characteristics of such movements: Relationships have been found with individual factors, such as personality (Luck, Saarikallio, Burger, Thompson, & Toiviainen, 2010) or mood (Saarikallio, Luck, Burger, Thompson, & Toiviainen, 2013), as well as with musical features, such as pulse clarity and rhythmic strength (Burger, Thompson, Luck, Saarikallio, & Toiviainen, 2012; Burger, Thompson, Saarikallio, Luck, & Toiviainen, 2013) or the presence of the bass drum (Van Dyck et al., 2013). Besides such factors, the emotional content of the music was found to be related to music-induced movement as well (Burger, Saarikallio, Luck, Thompson, & Toiviainen, 2013).

So far, these different aspects have only been studied separately. However, among them there might be relationships that separate analyses would be incapable of revealing. One variable, the emotional content of the music, for example, could account for the relationship between music and movement, in other words the music would have an indirect relationship with the movement by influencing the emotional expression, which then influences the movement. In this case, the emotional content would act as a so-called mediator variable (Baron & Kenny, 1986; Hayes, 2009; Preacher, Rucker, & Hayes, 2007). Besides or in addition to such an association, another variable, the personality of the dancer for example, could change the effect of the music on the movement. Personality would then act as a so-called moderator variable (Baron & Kenny, 1986; Preacher et al., 2007).

To explore possible relationships between musical features, perceived emotions in music, personality, and music-induced movement, we conducted a motion capture study to connect the different aspects chosen earlier (separate analyses described in Burger, Saarikallio, et al., 2013; Burger, Thompson, et al., 2013; Luck et al., 2010). Therefore, we reviewed recent statistical approaches in the field of multivariate statistics and found mediation and moderation analysis an interesting and potentially useful approach for our inquiry. This paper will first describe the design of the study and then focus on the proposed analysis methods.

2. Method

2.1. Participants

A total of 60 participants took part in this experiment (43 females; average age: 24, SD: 3.3). They were recruited based on a database of 952 individuals containing their scores of the Big Five Inventory (John, Naumann, & Soto, 2008), a 44-item instrument measuring the five primary personality dimensions (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism). We aimed at high- and low-scoring individuals for each of the five dimensions to participate in this study. Participants were rewarded with a movie ticket.

2.2. Stimuli

Participants were presented with 30 randomly ordered musical stimuli representing the following popular music genres: Techno, Pop, Rock, Latin, Funk, and Jazz. All stimuli were 30 seconds long, non-vocal, and in 4/4 time, but differed in their rhythmic complexity, pulse clarity, and tempo, and in their perceived emotional content. The emotional content was assessed in a perceptual experiment, in which 34 participants rated the emotions expressed in the music on scales for happiness, anger, sadness, tenderness, arousal, and valence (for a detailed description of this experiment, see Burger, Saarikallio, et al., 2013).

2.3. Apparatus

Participants' movements were recorded using an eight-camera optical motion capture system (Qualisys ProReflex) tracking, at a frame rate of 120 Hz, the three-dimensional positions of 28 reflective markers attached to each participant. The locations of the markers are shown in Figure 1a, and can be described as follows (L = left, R = right, F = front, B = back): 1: LF head; 2: RF head; 3: LB head; 4: RB head; 5: L shoulder; 6: R shoulder; 7: sternum; 8: spine (T5); 9: LF hip; 10: RF hip; 11: LB hip; 12: RB hip; 13: L elbow; 14: R elbow; 15: L wrist/radius; 16: L wrist/ulna; 17: R wrist/radius; 18: R wrist/ulna; 19: L middle finger; 20: R middle finger; 21: L knee; 22: R knee; 23: L ankle; 24: R ankle; 25: L heel; 26: R heel; 27: L big toe; 28: R big toe. The musical stimuli were played back via a pair of Genelec 8030A loudspeakers using a Max/MSP patch running on an Apple computer.

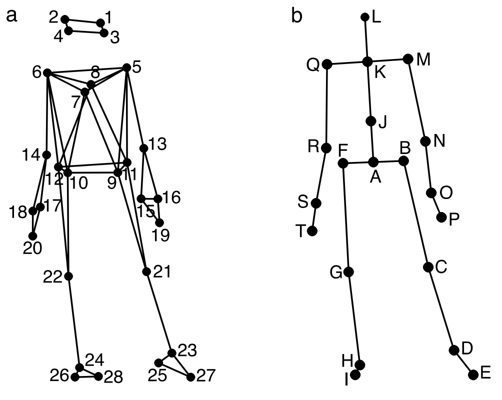

Figure 1. (a) Anterior view of the location of the markers attached to the participants' bodies; (b) Anterior view of the locations of the secondary markers/joints used in the analysis.

2.4. Procedure

Participants were recorded individually and were asked to move to the stimuli in a way that felt natural. Additionally, they were encouraged to dance if they wanted to, but were requested to remain in the center of the capture space indicated by a 115 x 200 cm carpet.

2.5. Movement feature extraction

In order to extract various kinematic features, the MATLAB Motion Capture (MoCap) Toolbox (Toiviainen & Burger, 2013) was used to first trim the data to the duration of each stimulus. Following this, a set of 20 secondary markers was derived – subsequently referred to as joints – from the original 28 markers to reduce marker redundancy. The locations of these 20 joints are depicted in Figure 1b. The locations of joints C, D, E, G, H, I, M, N, P, Q, R, and T are identical to the locations of one of the original markers, while the locations of the remaining joints were obtained by averaging the locations of two or more markers; joint A: midpoint of the four hip markers; B: midpoint of markers 9 and 11 (left hip); F: midpoint of markers 10 and 12 (right hip); J: midpoint of sternum, spine, and the hip markers (midtorso); K: midpoint of shoulder markers (manubrium), L: midpoint of the four head markers (head); O: midpoint of the two left wrist markers (left wrist); S: midpoint of the two right wrist markers (right wrist). From the three-dimensional joint position data, instantaneous velocity and acceleration were estimated using numerical differentiation based on the Savitzky-Golay smoothing FIR filter (Savitzky & Golay, 1964) with a window length of seven samples and a polynomial order of two. These values were found to provide an optimal combination of precision and smoothness in the time derivatives. Subsequently, the data was transformed into a local coordinate system, in which joint A was located at the origin, and segment BF had zero azimuth. From these data, various movement features were extracted, with six being used in the present analysis:

- Magnitude of Head Speed (Joints L).
- Magnitude of Hand Speed (Joints P & T).
- Magnitude of Head Acceleration (Joint L).
- Magnitude of Hand Acceleration (Joints P & T).
- Fluidity: overall movement fluidity (smoothness) measure based on the ratio of velocity to acceleration. The combina-

tion of high velocity and low acceleration reflects fluid movement, whereas the combination of low velocity and high acceleration reflects non-fluid movement.
- Rotation Range: amount of rotation of the body (Joints M & Q) around the vertical axis.

2.6. Musical feature extraction

In order to quantitatively describe the musical content of our stimuli, we performed computational feature extraction analysis of the stimuli used in the experiment. To this end, various musical features were extracted from the stimuli using the MATLAB MIRToolbox (version 1.4) (Lartillot & Toiviainen, 2007), with six being used in the present analysis.

- Spectral Flux of Sub-band 2: indicates the extent to which the spectrum of the frequency band between 50 and 100 Hz changes over time. This feature thus measures the flux in the low frequencies, usually produced by kick drum and bass guitar. For the calculation see Alluri and Toiviainen (2010) and Burger, Saarikallio, et al. (2013).
- Spectral Flux of Sub-band 9: based on the same calculation as spectral flux of sub-band 2, except for the frequency band ranging from 6400 to 12800 Hz. Thus, this feature measures the flux of the high frequencies, usually produced by hihats or cymbals.
- Attack Time: time of the attack at note onsets. The shorter the time, the sharper and more percussive the sound.
- Number of Onsets: sum of note onsets detected in the stimulus. A high number of onsets is related to a high sound density.
- Low Energy: the proportion of time during which the sound (RMS) energy is below the average RMS energy. Vocal music with silences, for instance, will have high values, whereas continuous strings have low values of low energy (Tzanetakis & Cook, 2002).
- Spectral Centroid: geometric center of the amplitude spectrum. It is commonly associated with musical timbre, in particular with brightness (McAdams, Winsberg, Donnadieu, Soete, & Krimphoff, 1995).

All features apart from the number of onsets resulted in time-series, subsequently being averaged to obtain one value per stimulus.

3. Results

3.1. Emotion as mediator

In Figure 2, two models of relationships between variables are depicted: the total-effect model and the mediation model. The total effect is the effect of an independent variable on a dependent variable, whereas a mediator is a variable that accounts for the effect of an independent variable on a dependent variable (Baron & Kenny, 1986; Hayes, 2009; Preacher et al., 2007). Mediation occurs if the effect of the independent variable on the dependent variable is reduced when the mediator is included (i.e., the regression coefficient is smaller for *c′* than for *c*, preferably *c′* being non-significant). Furthermore for mediation to occur, the indirect effect needs to be estimated, which can be assessed by computing confidence intervals for the indirect effect using bootstrap methods: Confidence intervals in which both lower and upper bound are either positive or negative (i.e., the confidence interval does not contain zero) are considered significant (Hayes, 2009). The effect size of the indirect effect can be assessed by calculating kappa-squared (κ^2): a small effect would be around .01, a medium effect around .09, and a large effect around .25 (Preacher & Kelley, 2011).

We hypothesized that the emotional content accounts for the relationship between music and movements, since musical features and emotional content are related with each other and both of them might have influenced participants' movements.

Although it is possible that an indirect effect exists between two variables even if these two variables are not associated when the mediator variable is absent (Hayes, 2009), we will concentrate for the time being on the combinations, in which all the three variables show at least moderately high mutual correlation with each other. Therefore, as the first step of the analysis, correlations between movement, emotions, and musical features were assessed,

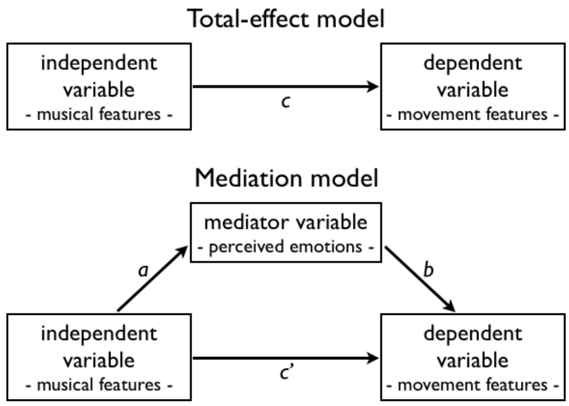

Figure 2. Total-effect model and mediation model. A mediator model decomposes the total effect, *c*, into the indirect effect, *ab* (product of the indirect paths *a* and *b*) and the direct effect, *c*' (with the effect of the mediator removed). The total effect can be describes as $c = c' + ab$, and hence the indirect effect as $ab = c - c'$.

of which the significant ones ($p < .05$) are presented in Table 1.

Table 1. Correlations (*n*=30) between emotions, movement features, and musical features. Asterisks indicate the significance level of the lowest coefficient of the three pairwise correlations.

		SHe	SHa	AHe	AHa	Fl	Rot
Aro	Ons	*		**	**	**	
	SBF2	**	**	**	**	**	
	SBF9	**	**	**	**		
	AT			*	**	**	
Val	LE						*
	Ons					*	
	SBF2					*	
Hap	SC						*
Ang	LE						*
	Ons					**	
	SBF2					*	
Sad	AT				*	*	
Ten	LE						*
	Ons	*		**	*	**	
	SBF2	**		**	**	*	
	SBF9	*		*	*		

* $p < .05$, ** $p < .01$

Abbreviations: Emotions: *Aro*: Arousal; *Val*: Valence; *Hap*: Happiness, *Ang*: Anger; *Sad*: Sadness; *Ten*: Tenderness – Musical features: *SBF2*: Spectral flux of sub-band no. 2; *SFB9*: Spectral flux of sub-band no.9; *AT*: Attack time; *Ons*: no of onsets; *LE*: Low Energy; *SC*: Spectral Centroid – Movement features: *SHe*: Head speed; *SHa*: Hand speed; *AHe*: Head acceleration; *AHa*: Hand acceleration; *Fl*: Fluid; *Rot*: Rotation Range

Subsequently, we performed mediation analysis using PROCESS, a tool developed for conditional process modeling in SPSS[1] (Hayes, 2013). In all analyses presented below, the significance of the indirect effect was obtained by computing 95% confidence intervals using 10 000 bootstrap samples.

Testing all significant correlations listed in Table 1 would go beyond the scope of this paper. Thus for Arousal and Tenderness, we will only report relationships involving the two Spectral Flux features, since they were found to significantly contribute to shaping music-induced movement (Burger, Thompson, et al., 2013) and neglect the musical features Low Energy, Number of Onsets, Attack Time, and Spectral Centroid. For the other emotions (Valence, Happiness, Anger, and Sadness), all feature combinations as indicated in Table 1 are analyzed.

Arousal was found to mediate the effect of Spectral Flux of Sub-band 2 on Hand Speed, Hand Acceleration, and Fluidity, and the effect of Spectral Flux of Sub-band 9 on Head Acceleration and Hand Acceleration. For all, there were significant total effects, and including the mediator caused the direct effects to become insignificant, while the indirect effects were significant, with the indirect paths being as well significant (cf., Fig. 2) The confidence intervals did not contain zero, and the κ^2-values indicated large effect sizes. Thus, Arousal could successfully mediate the relationship between these variables. The remaining combinations showed mediation effects as well, although the effect of the direct paths remained significant when including the mediator. The statistical results are presented in Table 2.

Valence was found to mediate the relationship between Low Energy and Rotation Range. However, Valence failed to mediate the effect of Spectral Flux of Sub-band 2 on Fluidity and the effect of No of Onsets on Fluidity, as the respective confidence intervals contained zero. The statistical results can be found in Table 2.

Furthermore, Happiness was found to mediate the effect of Spectral Centroid on Rotation Range (results in Table 2).

[1] www.ibm.com/software/analytics/spss/

With Anger we failed to determine any significant mediation effects, as in all three cases the respective confidence intervals contained zero (see Table 2).

Sadness also failed to act as a mediator between Attack Time and both Hand Acceleration and Fluidity, as both indirect effects were shown insignificant (see Table 2).

Table 2. Non-standardized regression coefficients and model significance of total effect *c*, direct effect *c'*, and both indirect paths *a* and *b*, as well as non-standardized and standardized regression coefficients of indirect effect *ab* with 95% bootstrap confidence interval, and effect size κ^2 with 95% bootstrap confidence interval. Insignificant direct effects are indicated in bold. Insignificant models are shaded in grey.

	model	*b(c)*, *p*	*b(c')*, *p*	*b(a)*, *p*	*b(b)*, *p*	*b(ab)*, [CI]	*β(ab)*, [CI]	κ^2, [CI]
Aro	**SBF2/SHe**	1.05, .00	.80, .0004	.05, .003	5.11, .02	.25, [.03, .60]	.17, [.002, .04]	.22, [.05, .44]
	SBF2/SHa	2.84, .01	1.41, **.21**	.05, .003	29.06, .02	1.42, [.28, 3.50]	.23, [.05, .53]	.23, [.05, .45]
	SBF2/AHe	15.73, .00	9.71, .001	.05, .003	122.86, .0002	6.02, [2.49, 11.87]	.27, [.12, .47]	.33, [.15, .51]
	SBF2/AHa	39.17, .003	13.38, **.22**	.05, .003	526.39, .0001	25.79, [10.03, 50.06]	.35, [.15, .60]	.36, [.15, .57]
	SBF2/Flu	-.0003, .02	.00, **.79**	.05, .003	-.01, .00	-.0003, [-.0006, -.0002]	-.45, [-.66, -.22]	.50, [.28, .66]
	SBF9/SHe	3.22, .0001	2.25, .01	.15, .01	6.42, .01	.98, [.25, 2.19]	.19, [.05, .44]	.22, [.06, .44]
	SBF9/SHa	13.90, .0001	10.51, .003	.15, .01	22.32, .03	3.39, [.64, 8.16]	.16, [.03, .38]	.18, [.04, .38]
	SBF9/AHe	43.08, .002	20.66, **.06**	.15, .01	147.59, .0001	22.42, [7.64, 45.28]	.29, [.10, .55]	.32, [.10, .55]
	SBF9/AHa	138.91, .003	60.47, **.10**	.15, .01	516.37, .00	78.44, [25.50, 151.89]	.30, [.10, .54]	.33, [.09, .54]
Val	**LE/Rot**	1.56, .03	.63, **.39**	5.30, .006	.17, 0.1	.93, [.25, 1.95]	.23, [.06, .52]	.22, [.05, .48]
	SBF2/Fl	-.0003, .02	-.0002, **.30**	-.05, .0004	.003, .14	-.0001, [-.0004, 0001]	-.19, [-.46, .07]	.16, [.01, .38]
	Ons/Fl	-.0001, .003	-.0001, **.06**	-.01, .0003	.002, .34	.00, [-.0001, .00]	-.12, [-.40, 10]	.11, [.005, .33]
Hap	**SC/Rot**	.0001, .046	.0001, **.31**	.0003, .03	.17, .01	.0001, [.0000, .0001]	.19, [.06, .40]	.19, [.05, .38]
Ang	LE/Rot	1.56, .03	1.01, **.16**	-4.77, .05	-.11, .04	.55, [-.03, 1.44]	.14, [-.01, .35]	.13, [.01, .35]
	Ons/Fl	-.0001, .003	-.0001, .04	.01, .004	-.002, .16	.00, [-.0001, 0.00]	-.14, [-.34, .06]	.14, .01, .31]
	SBF2/Fl	-.0003, .02	-.0002, **.22**	.04, .01	-.003, .08	-.0001, [-.0003, .00]	-.17, [-.36, .07]	.17, [.01, 33]
Sad	AT/AHa	-39629.34, .01	-31772.85, .03	25.56, .05	-307.33, .15	-7856.47, [-29489.44, 1839.10]	-.10, [-.33, .02]	.10, [.01, .30]
	AT/Fl	.40, .01	.32, .04	25.56, .05	.003, .17	.08, [-.06, .39]	.09, [-.08, .43]	.10, [.002, .36]
Ten	SBF2/SHe	1.05, .00	.89, .001	-.05, .00	-2.95, .35	.16, [-.24, .57]	.11, [-.17, .39]	.12, [.003, .35]
	SBF2/AHe	15.73, .00	11.70, .01	-.05, .00	-73.63, .14	4.03, [-2.28, 10.88]	.18, [-.11, .47]	.19, [.01, .45]
	SBF2/AHa	39.17, .003	28.83, .09	-.05, .00	-189.04, .36	10.33, [-12.05, 33.46]	.14, [-.17, .42]	.12, [.003, .32]
	SBF2/Flu	-.0003, .02	.0001, **.73**	-.05, .00	.01, .001	-.0004, [-.0007, -.0001]	-.48, [-.76, -.18]	.41, [.12, .64]
	SBF9/SHe	3.22, .0001	2.45, .002	-.11, .04	-7.20, .01	.77, [.15, 1.82]	.15, [.03, .34]	.18, [.04, .37]
	SBF9/AHe	43.08, .002	28.79, .02	-.11, .04	-133.82, .002	14.29, [3.25, 32.35	.18, [.05, .38]	.21, [.05,.41]
	SBF9/AHa	138.91, .003	108.21, .02	-.11, .04	-287.56, .07	30.71, [2.56, 85.76]	.12, [.01, .30]	.13, [.02, .30]

Abbreviations: see Table 1

Tenderness acted as mediator in the relationship between Spectral Flux of Sub-band 2 and Fluidity. Tenderness also mediated the effect of Spectral Flux of Sub-band 9 on Head Acceleration (direct path still significant), as well as on Head Speed (direct path significant) and on Hand Acceleration (direct path significant and *b*-path non-significant). The results for the models for Spectral Flux of Sub-band no 2 with Head Speed, Head Acceleration, and Hand Acceleration did not show any mediation effect of Tenderness. The statistical results are presented in Table 2.

3.2. Personality as moderator

If the strength of a relationship between two variables is dependent on the level of a third variable, this third variable is said to act as a moderator (Baron & Kenny, 1986; Preacher et al., 2007). Moderation effects are usually understood as an interaction between the independent variable and the moderator variable in predicting the dependent variable, where the effect of the independent variable depends on the level of the moderator. Figure 3 depicts the conceptual and the statistical model for moderation analysis.

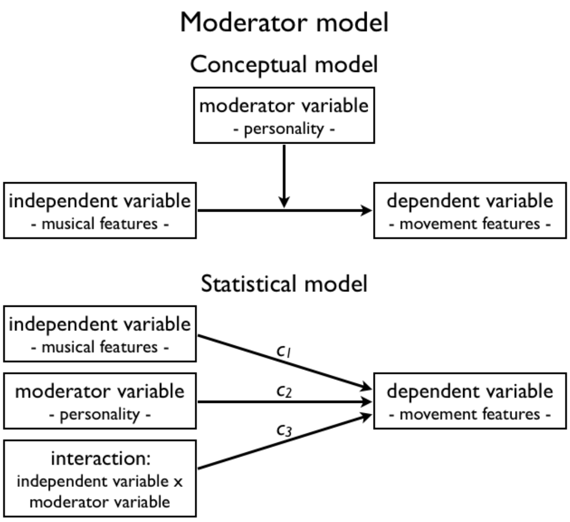

Figure 3. Conceptual and statistical model for moderation.

We hypothesized that personality of the dancers would act as a moderator. Thus, the level of personality trait would affect the relationship between musical features and movement characteristics. For instance, extrovert participants would make use of a certain movement feature to a higher extent than non-extrovert participants given a specific musical characteristic.

For analyzing the effect of personality, we first divided the 60 participants into three groups of 20 high-scorers, 20 mid-scorers, and 20 low-scorers for each personality trait separately and removed the mid-scorers from the analysis. The remaining two groups of participants were coded binary (instead of keeping the original scores). A similar approach was used in Luck et al. (2010).

For moderation to occur, we assume a relationship between the independent and the dependent variables, in our case the musical and movement features respectively. Therefore, we correlated the musical features with the movement features and present the result in Table 3.

Table 3. Correlations (n=30) between musical features and movement features.

	SHe	SHa	AHe	AHa	Fl	Rot
LE						*
Ons	*		**	*	**	
SBF2	***	*	***	**	*	
SBF9	***	***	**	**		
AT			*	**	**	
SC						*

* $p < .05$, ** $p < .01$, *** $p < .001$

Abbreviations: see Table 1

Subsequently, we performed moderation analysis employing the SPSS modeling tool PROCESS (Hayes, 2013)[2]. The results indicate that only two combinations showed moderation effect: we found significant interactions between Extroversion and Spectral Flux of Sub-band no 2 on Head Acceleration and between Conscientiousness and Number of Onsets on Fluidity. The results of both regression models are reported in Table 4.

[2] In moderation analysis, it is common to transform the predictors using grand mean centering before analysis, so that we obtain the effect of one predictor when the other predictor is its mean value (and not zero).

Table 4. Regression results of the moderation models with significant interactions.

Extroversion/SBF2/Head Acceleration, R^2 = .13

	β	*SE*	*t*	*p*
Extr	.28	25.29	10.25	.00
SBF2	.21	2.69	6.92	.00
Extr x SBF2	.07	2.69	2.32	.02

Conscientiousness /Ons/Fluidity, R^2 = .04

	β	*SE*	*t*	*p*
Cons	.03	.0007	1.22	.22
Ons	-.18	.0000	-6.42	.00
Cons x Ons	-.06	.0000	-2.00	.045

4. Discussion

We described two analysis approaches of multivariate nature – mediation and moderation – to enable the simultaneous inclusion of several variables into one analysis to investigate underlying relationships among them.

The results of the analysis suggest that such analyses serve as insightful ways of looking at relationships between different variables. We found the perceived emotional content of the music to mediate the effect of musical features on movement features in case of Arousal, Valence, Happiness, and Tenderness, which suggests to assume that the emotional content could account for the relationship between musical features and participants' movements. Thus, participants might have taken the emotions expressed in the music into consideration when moving to it. This could serve as support for Leman's theory of corporeal articulations (Leman, 2007), in particular for the concepts of "Embodied Attuning" and "Empathy". Participants' movements reflected both musical features and emotions perceived in the music, suggesting that participants have even tried to integrate them into a coherent outcome. This could also indicate that music and emotions are interconnected and co-existing, so "Empathy" could be maybe seen as an abstraction of "Embodied Attuning".

As regards personality as moderator, we found only two instances where moderation occurred, whereas in the remaining 88 combinations, no moderation occurred. This result, especially taken the low R^2 values of both models, would suggest that generally the level of personality did not change the relation between music and movement. In other words, if a relationship between a musical feature and a movement feature exists, it remains unaffected by the personality. One might even propose that an existing relationship between musical features and movement features can suppress the influence of personality. Furthermore, this result could indicate that musical characteristics and personality are independent factors that are related to music-induced movement in different, non-interactive, ways.

Interesting to note is that individual differences, such as personality, do not appear as a concept in the theory of corporeal involvement proposed by Leman (2007). However, if, for instance, movements are seen as being gestural expressions of a certain emotion expressed in the music (as in the concept of "Empathy"), then it seems likely to assume that movements can be seen as gestural expressions related to individual factors of a performer/listener/dancer. Thus, the integration of individual factors into approaches of body-related musical behavior might be a fruitful strategy to formulate a holistic theory of music-related and -induced corporeal articulations.

Further analysis attempts will include additional and more complex model configurations, in particular having several independent, dependent, and intervening variables. Using, for instance, more than one musical and more than one movement feature simultaneously in the analysis would provide a more holistic view on our data and might reveal more general results than with the present approach. Another attempt will combine both emotion and personality into one analysis – for example, in an approach called moderated mediation (Preacher et al., 2007) – to test if the magnitude of the indirect effect (emotions) is dependent on the moderator (personality). The method of path modeling (Schumacker & Lomax, 2010) might provide further opportunities for integrating both aspects into the same analysis. Moreover, structural equation modeling, an approach for testing and estimating causal relations between factors and/or observed variables (Schumacker & Lomax, 2010), will be tested. It offers the possibility to build latent factors from the observed variables, so higher-order relationships – in our case, "music" versus "movement" with intervening factors, such as "emotions" and "personality", might be testable as one comprehensive model. However, one issue regarding the latter approach is the small sample size of our data, as for structural equation modeling, a large sample size is a prerequisite for incorporation of latent variables.

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OH HAPPY DANCE: EMOTION RECOGNITION IN DANCE MOVEMENTS

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Abstract

Movements are capable of conveying emotions, as shown for instance in studies on both non-verbal gestures and music-specific movements performed by instrumentalists or professional dancers. Since dancing/moving to music is a common human activity, this study aims at investigating whether quasi-spontaneous music-induced movements of non-professional dancers can convey emotional qualities as well. From a movement data pool of 60 individuals dancing to 30 musical stimuli, the performances of four dancers that moved most notably, and four stimuli representing happiness, anger, sadness, and tenderness were chosen to create a set of stimuli containing the four audio excerpts, 16 video excerpts (without audio), and 64 audio-video excerpts (16 congruent music-movement combination and 48 incongruent combinations). Subsequently, 80 participants were asked to rate the emotional content perceived in the excerpts according to happiness, anger, sadness, and tenderness. The results showed that target emotions could be perceived in all conditions, although systematic mismatches occurred, especially with examples related to tenderness. The audio-only condition was most effective in conveying emotions, followed by the audio-video condition. Furthermore in the audio-video condition, the auditory modality dominated the visual modality, though the two modalities appeared additive and self-similar.

Keywords: music-induced movement, emotion, perception

1. Introduction

On a daily basis, humans use body movements as an important means of nonverbal communication. Body postures and movements can convey different kinds of information, for instance related to the mental or physical state or personality traits, or to accompany and emphasize speech. It has been argued that speech and movement/gestures are tightly connected and co-occur, as they underlie the same cognitive processes (Iverson & Thelen, 1999; McNeill, 1992). Furthermore, body movements can convey emotions. Various studies have investigated the capability of movement to express emotions and have shown that distinct features of human movement are related to emotion categories. De Meijer (1989), for example, asked observers to attribute emotional characteristics to movements of actors who performed several movement patterns differing in general features, such as trunk or arm movement, velocity, and spatial direction and found that different emotion categories were associated with different movement characteristics. Wallbott (1998) conducted a study in which he used a scenario-based approach with professional actors performing certain emotions. He found movement features characteristic for different emotion categories and computed a discriminant analysis that could, significantly above chance level, classify the emotions correctly. Atkinson, Dittrich, Gemmell, and Young (2004) compared static vs. dynamic whole body expressions and full-light vs. point-light displays and found that all of them could communicate emotions, though the recognition rate and misclassification patterns differed for individual emotions. Pollick, Paterson, Bruderlin, and Sanford (2001) investigated visual perception of emotions in simple arm movements shown as point-light displays, such as drinking and knocking. They found that arm movements could communicate emotions, though observers tended to confuse similar emotions. Gross, Crane, and Fredrickson (2010) studied the perception of knocking movements performed by actors who were subjected to an emotion induction task. The results indicated a limited recognition rate, especially for positive emotions, and systematic confusions between several emotions. Besides in acted emotion approaches, emotion recognition has been studied in other contexts as well, such as in gait. Montepare, Goldstein, and Clausen (1987), for instance, showed that happiness, anger, and sadness could be successfully recognized in walking patterns. Research in linguistics has investigated integration of auditory and visual information in emotion perception using face-voice stimuli. Such studies showed that usually the visual information dominates (Collignon et al., 2008), and that bimodal stimuli can be integrated even if they display incongruent combinations of emotions (De Gelder & Vroomen, 2000; Massaro & Egan, 1996).

Emotions are an essential component of musical expression (e.g., Gabrielsson & Lindström, 2010) and have been investigated in a large number of music-related studies. According to Krumhansl (2002), people report that their primary motivation for listening to music is its emotional impact. Various rating experiments have shown that listeners are able to perceive emotional content in music in a consistent fashion (e.g., Balkwill & Thompson, 1999; Eerola & Vuoskoski, 2011; Gabrielsson & Juslin, 1996; Schubert, 1999; Zentner, Grandjean, & Scherer, 2008).

Musical emotions are conveyed not only by the music itself, but also through movement. While movements are required, for example, to produce sounds when playing a musical instrument, studies have shown that there are certain additional movements that are not used for the actual sound production, but for conveying emotions and expressivity (e.g., Wanderley, Vines, Middleton, McKay, & Hatch, 2005). Davidson (1993) conducted a study in which observers rated expressive movements of violinists and pianists. Results indicate that visual information more clearly communicated the expressive manner of the musician than sound alone and sound and vision presented together. Vines, Krumhansl, Wanderley, and Levitin (2006) examined clarinetists' abilities of communicating tension to observers and found that auditory and visual signals evoked different perceptions of tension, with the sound dominating the judgments. Additionally, their results indicated that the audiovisual presentation increased the perceived tension compared to the audio-only and video-only conditions, suggesting that participants integrated both signals. Dahl and Friberg (2007) studied marimba, saxophone, and bassoon players performing with different emotional intentions and presented observers with only the visual elements of the performances. Observers could detect the happy, angry, and sad performances successfully, but failed with the fearful ones. Sörgjerd (2000) investigated a clarinetist and a violinist who performed a piece of music with different emotional intentions, and reported that happiness, anger, sadness, and fear were better identified than tenderness and solemnity. However, no significant differences for the presentation condition (audio-only, movement-only, audio+movement) were found. Petrini, McAleer, and Pollick (2010) found that in audiovisual presentations of musicians playing with different emotional characteristics the sound dominated the visual signal, both in emotionally matching and mismatching stimuli. Furthermore, when participants were asked to focus on the visual information of the audiovisual stimuli, their ability to correctly identify the emotion decreased in case of emotionally incongruent stimuli, whereas it was unaffected by the video information, when participants were asked to focus on the audio information.

More direct links between music and emotion-specific movement have been investigated in research on dance, in which movement is the only way to convey expressivity and emotion. Several studies showed that dance movement could successfully communicate emotions to observers, both in regular video and in stick-figure animations (Boone & Cunningham, 1998; Dittrich, Troscianko, Lea, & Morgan, 1996; Lagerlöf & Djerf, 2009; Walk & Homan, 1984). Common to these studies was that they used professional dancers (or actors) who were explicitly asked to express the emotions while dancing.

Listening to music make people move spontaneously, for example by rhythmically synchronizing with the pulse of the music by tapping the foot, nodding the head, moving the whole body in various manners, or mimicking instrumentalists' gestures (Leman & Godøy, 2010; Leman, 2007). Studies investigating music-induced movement have suggested such movements to be related to personality (Luck, Saarikallio, Burger, Thompson, & Toiviainen, 2010), mood (Saarikallio, Luck, Burger, Thompson, & Toiviainen, 2013), or musical features (Burger, Thompson, Saarikallio, Luck, & Toiviainen, 2013; van Dyck et al., 2013). In a recent study (Burger, Saarikallio, Luck, Thompson, & Toiviainen, 2013), we could also establish links between movements and the emotional content of the music to which the participants were dancing. In that experiment, we asked 60 participants to move to different pop music stimuli and recorded their movements with an optical motion capture system. The computational analysis of the movement data coupled with a perceptual evaluation of the emotions expressed in the music revealed characteristic movement features for the emotions happiness, anger, sadness, and tenderness.

While there appears to be correlations between perceived emotions in music and movement characteristics, it is neither clear whether music-induced movement can convey emotional content to observers and which emotions can be communicated, nor how auditory and visual information would interact in this process. Therefore, we designed a perceptual experiment using a subset of the movement data collected in the previous experiment and asked observers to rate various stick figure clips regarding the emotions conveyed by these clips. We restricted this study to the use of perceived emotions as opposed to felt emotions, since previous literature has mostly focused on the former (about the importance to distinguish between perceived and felt emotions, see Evans & Schubert, 2008; Gabrielsson, 2002), and we used perceived emotions in the previous study. We decided to include three presentation conditions: audio-only, video-only, and audio and video combined, as was done in studies about musician's movements (Davidson, 1993; Petrini et al., 2010; Sörgjerd, 2000; Vines et al., 2006) and in research on face-voice stimuli (Collignon et al., 2008; De Gelder & Vroomen, 2000; Massaro & Egan, 1996). Besides including the correct combinations of music and movement (i.e., the movements actually performed to that music during the previous experiment), we wanted to further examine the audiovisual integration and generated a set of incongruent stimuli (i.e., combining the movements with another song used in the experiment expressing a different emotion), as was done in Petrini et al. (2010), for instance. Previous studies suggest different scenarios regarding the influence of music and movement on the judgments. However, in line with the results by Petrini et al. (2010) and Vines et al. (2006), we hypothesize that the audio-video condition will receive higher recognition rates than the two unimodal conditions (at least for the congruent stimuli), and audio will dominate the perception of both the congruent and the incongruent audio-video examples.

2. Method

2.1. Participants

Eighty university students, aged 19-36, participated in this study (53 females, average age: 24.7, SD of age: 3.4). Fifty-two participants took some kind of dance lessons and 75 participants reported to like movement-related activities, such as dance and sports. Thirty-seven participants reported to go out dancing more than once a month.

2.2. Stimuli

The stimuli used in this experiment were selected from a motion capture data pool of 60 participants dancing to 30 different musical excerpts that was collected in a previous study (Burger, Saarikallio, et al., 2013). Based on results of a rating experiment conducted within this previous study, four musical excerpts were determined that most clearly conveyed one of the following (target) emotions happiness, anger, sadness, and tenderness. Subsequently, two female and two male participants (from now referred to as "dancers"), were chosen based on their movement characteristics (i.e., participants whose performances received highest values regarding several movement features, such as speed, acceleration, area covered, or complexity). This yielded 16 (4x4) combinations of stick figure dance performances.

The four musical stimuli were of different tempi (100 bpm, 105 bpm, 113 bpm, 121 bpm), so we adjusted their tempi to 113 bpm by time-stretching three of them using the Audacity software[1], to eliminate the effect of tempo on the perceived emotions. Likewise, the movement data was resampled by the appropriate ratio using the Matlab Mocap Toolbox (Toiviainen & Burger, 2013). Besides this, the movement data were rotated to be visible from the front with respect to the average locations of the hip markers (for more information on the marker locations see Burger et al., 2013). In all videos, the stick figures were plotted in black on white background. QuickTime Player 7 (Pro version) was used to combine the time-shifted audio and video material in all possible combinations yielding 16 congruent stimuli and 48 incongruent stimuli. It was checked that the combination appeared synchronized. All stimuli used in the experiment were trimmed to 20 seconds.

2.3. Apparatus

To gather perceptual ratings, a special patch was created in Max/MSP 5, a graphical programming environment, running on Max OS X. The patch used QuickTime Player 7 to play back the video material. The setup enabled the participants to repeat excerpts as often as they wished, to move forward at their own speed, and to take breaks at any moment of the experiment. The stimuli were played back through studio quality headphones (AKG K141 Studio). The participants could themselves adjust the volume to a preferred level.

2.4. Procedure

In the beginning of the experiment, a short questionnaire was filled in to gather information about participants' gender, age, dance training, and movement and dance activities. The experiment was divided into three sections: one section containing the four (time-stretched) audio clips, a second section containing the 16 silent (and time-shifted) video clips (four dancers moving to the four different musical stimuli), and a third section containing the 64 (time-shifted) audio-video clips (16 congruent and 48 incongruent combinations). To avoid any effect of order, the three sections were presented in random order to the participants. Within each section, the clips were randomized as well. Participants were accomplishing the experiment individually. They were instructed to rate the emotions expressed in the clips (perceived emotions) on seven-step scales for Happiness, Anger, Sadness, and Tenderness. Preceding each section, there was a practice part of one example to get familiar with the interface, the type of stimuli, and the rating scales used. In the beginning of the experiment, participants were explicitly told to rate according to the emotions expressed in the clips (as opposed to felt emotions). The participants were also advised to take breaks in between if they felt like it. The total duration of the experiment was between 45 and 90 minutes. After completing the experiment participants were rewarded with a movie ticket.

3. Results

Outlier detection was performed as the first step of the analysis by calculating the mean inter-subject correlation for each participant (taking all ratings of the three conditions) and each rating scale (happiness, anger, sadness, and tenderness) separately. This yielded a measure of how similarly the participants were rating in relation to each other on each scale.

[1] http://www.audacity.sourceforge.net

We obtained overall positive correlations, apart from one participant who correlated negatively on two scales (happiness and tenderness) with the other participants. We therefore decided to eliminate this participant from further analysis.

Next, we checked for rating consistency between participants by calculating intraclass correlations (cf., Shrout & Fleiss, 1979) for each rating scale separately. All six correlations coefficients were highly significant (between $r = .95$ and $r = .97$, $p < .001$), suggesting that participants' ratings for each scale were similar enough to average across them for any further analysis.

Subsequently, this section will present the analysis regarding which emotions were perceived in the different conditions, which condition was most effective in conveying the target emotion, and whether the perception of the audio-video clips was higher influenced by the auditory or by the visual modality of the clips.

3.1. Emotions perceived

In order to investigate which emotions were perceived in the different conditions and if the target emotions could be perceived, we displayed the ratings of the participants for the four musical stimuli (target emotion) as error bar plots (see Figure 1) and additionally conducted repeated measures ANOVAs (including subsequent post hoc tests) with the four ratings scales per stimulus to assess the significance of the differences between the ratings. The significance level of the post hoc tests (as indicated in Figure 1) was adjusted using Bonferroni correction to account for multiple comparisons.

Figure 1A shows the results for the four stimuli / target emotions of the audio condition. For the stimulus with Happiness as target emotion, the happiness scale received the highest average rating of the four scales/concepts, and the repeated measures ANOVA showed a significant main effect, $F(2.34, 182.67) = 194.04$, $p < .001$ (degrees of freedom adjusted using Greenhouse-Geissner correction as the sphericity assumption was violated – applied to all repeated measures ANOVA results, if not indicated differently). The subsequent post hoc test revealed a highly significant difference ($p < .001$) between happiness and tenderness, the second highest average, thus the target emotion Happiness

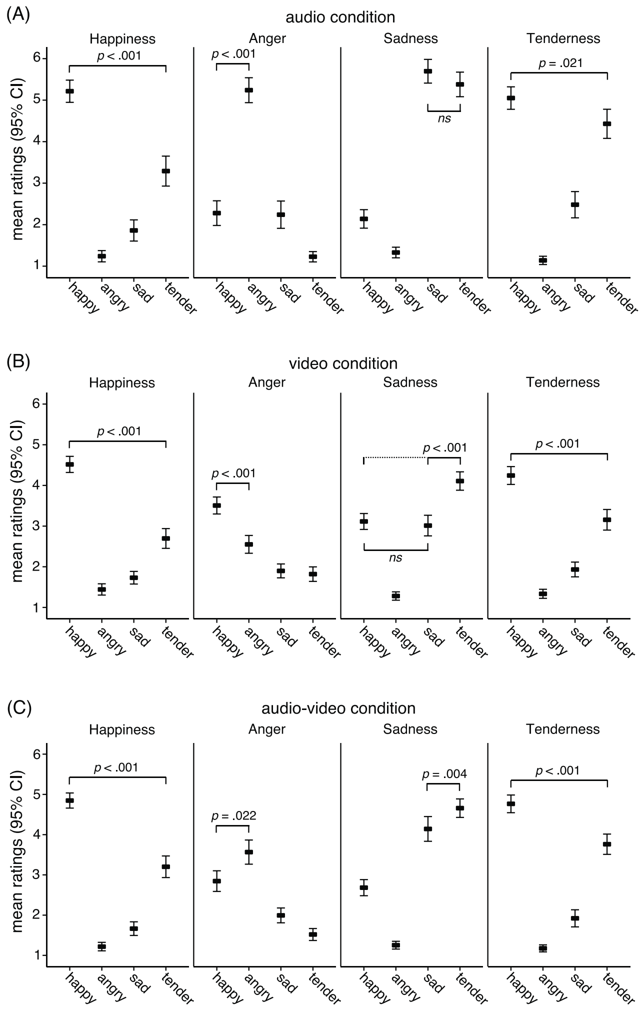

Figure 1. Error bar plots displaying average ratings and 95% confidence intervals for the four target emotion stimuli of the three conditions. (A) Audio condition. (B) Video condition, averaged across dancers. (C) Congruent audio-video condition, averaged across dancers.

could be successfully perceived in the audio condition. For the stimulus with the target emotion Anger, anger received the highest average rating of the four scales/concepts, the repeated measures ANOVA resulted in a significant main effect, $F(2.07, 160.47) = 156.74$, $p < .001$, and the post hoc test showed a significant difference ($p < .001$) between anger and happiness, the second highest average. Thus, the target emotion Anger could be successfully communicated as well. For the stimulus with Sadness as target emotion, sadness obtained highest ratings with a significant main effect revealed by the repeated measures ANOVA, $F(2.35, 183.27) = 310.84$, $p < .001$. The post hoc test, however, indicated that the difference between sadness and the second highest average, tenderness, was non-significant ($p = .68$), so there two emotions were slightly confused in case of the target emotion Sadness. For the stimulus with the target emotion Tenderness, happiness received the highest average rating of the four concepts, followed by tenderness. The repeated measures ANOVA exhibited a significant main effect, $F(2.40, 187.29) = 171.86$, $p < .001$, and the post hoc test resulted in a significant difference between both emotion concepts ($p = .021$), so participants tended to confuse Tenderness with Happiness.

Figure 1B shows the results for the video condition. The ratings for the 16 clips presented in the experiment were averaged across the four dancers to obtain one rating per participant for each target emotion stimulus. For the target emotion Happiness, the happiness scale received the highest average rating of the four concepts, and the repeated measures ANOVA showed a significant main effect, $F(2.36, 183.77) = 254.10$, $p < .001$. The subsequent post hoc test revealed a highly significant difference between happiness and the second highest average, tenderness, ($p < .001$), thus the target emotion Happiness could be communicated successfully in the video condition as well. For the target emotion Anger, happiness received the highest average rating of the four concepts, followed by anger. The repeated measures ANOVA indicated a significant main effect, $F(2.21, 172.36) = 73.19$, $p < .001$, and the post hoc test resulted in a significant difference between both concepts ($p < .001$), so the movements performed to the stimulus rated as angry could not efficiently communicate anger. For the target emotion Sadness, tenderness received the highest average rating, followed by happiness and sadness. The repeated measures ANOVA revealed a significant main effect, $F(2.33, 181.40) = 147.69$, $p < .001$, and the post hoc comparison between sadness and tenderness as well as between tenderness and happiness exhibited significant differences ($p < .001$), whereas the difference between sadness and happiness was shown to be non-significant ($p = 1.00$). From this it can be concluded that the movements failed to communicate the intended emotion. For the target emotion Tenderness, happiness obtained the highest averaged rating, followed by tenderness. The repeated measures ANOVA resulted in a significant main effect, $F(2.33, 181.63) = 198.98$, $p < .001$, while the post hoc test indicated a significant difference between both concepts ($p < .001$), so confusion alike to the audio condition occurred in the video condition as well.

Figure 1C displays the results for the congruent stimuli of audio-video condition. The ratings from the 16 congruent clips presented in the experiment were averaged across the four dancers to obtain one rating per participant for each target emotion stimulus. For the target emotion Happiness, happiness received the highest average rating of the four concepts, and the repeated measures ANOVA exhibited a significant main effect, $F(2.38, 185.44) = 359.41$, $p < .001$. The subsequent post hoc test revealed a significant difference between happiness and tenderness, the second highest average, ($p < .001$), thus the target emotion Happiness could be communicated successfully in the audio-video condition. For the target emotion Anger, anger received the highest average rating of the four concepts. The repeated measures ANOVA resulted in a significant main effect, $F(1.67, 130.41) = 60.76$, $p < .001$, and the post hoc comparison between the two concepts showed a (moderately) significant difference ($p = .022$), so the combination of auditory and visual components could fairly successfully communicate the target emotion Anger. For the target emotion Sadness, tenderness received the highest average rating, followed by sadness. The repeated measures ANOVA showed a significant main effect, $F(1.88, 146.30) = 202.75$, $p < .001$, and the post hoc test exhibited a significant difference between both concepts ($p = .004$), which suggests that there occurred some confusion between the two. For the target emotion Tenderness, happiness obtained the highest average rating, followed by tenderness. The repeated measures ANOVA results revealed a significant main effect, $F(2.18, 169.74) = 317.93$, $p < .001$, and the post hoc comparison indicated a significant difference between the two concepts ($p < .001$), so clips intended to convey tenderness communicated happiness instead. Thus, the same confusion as in the audio and video conditions described above happened in the audio-video condition.

3.2. Conveyance of target emotion

Next, we examined which experiment condition was most effective in conveying the four target emotions. Figure 2 illustrates the differences between the three conditions in conveying the four target emotions. For all target emotions, audio was most effective (highest average ratings), followed by the audio-video condition. The video condition was least effective in conveying the target emotions, especially in the case of anger and sadness. Repeated measures ANOVA results including post hoc tests (adjusted significance level using Bonferroni correction) revealed significant main effects (see Table 1) and differences between the three conditions in all target emotions (significance of the differences indicated in Figure 2).

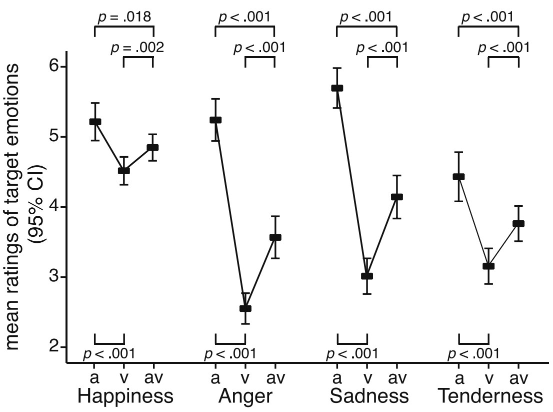

Figure 2. Error bar plot showing the differences in mean ratings for the three experiment conditions with respect to conveying the four target emotions (a: audio condition; v: video condition; av: audio-video condition).

Table 1. Repeated measure ANOVA results for each target emotion.

	F statistics	significance
Happiness	$F(1.49, 116.13) = 14.03$	$p < .001$
Anger	$F(2, 156)^{\#} = 166.63$	$p < .001$
Sadness	$F(2, 156)^{\#} = 164.94$	$p < .001$
Tenderness	$F(1.54, 119.82) = 30.99$	$p < .001$

no Greenhouse-Geissner correction applied (sphericity assumption holds)

3.3. Influence of modalities in audio-video condition

In order to investigate whether the perception of the audio-video clips was more strongly influenced by the auditory or by the visual modality, we conducted a series of linear regression analyses for each of the target emotions: 1) the audio ratings predicting the (congruent and incongruent) audio-video ratings, 2) the video ratings predicting the (congruent and incongruent) audio-video ratings, and 3) both the video and audio ratings predicting the (congruent and incongruent) audio-video ratings. The variances explained by each of the models (R^2 values) are displayed in Table 2.

Table 2. Variances explained by each of the three regression models for each of the target emotions. The asterisks indicate the significance level of the regression models.

	R^2(audio)	R^2(video)	R^2(audio + video)	
Happiness	.54 ***	.39 ***	.93 ***	
Anger		.82 ***	.14 **	.96 ***
Sadness		.62 ***	.33 ***	.94 ***
Tenderness		.51 ***	.39 ***	.91 ***

*** $p < .001$, ** $p < .01$

For all four target emotions, the ratings for the audio condition could explain a larger amount of variance than the video ratings. We therefore assume that the participants paid more attention to the auditory part of the stimulus than to the visual part when rating the (partly incongruent) audio-video stimuli. Furthermore, audio and video ratings were additive, as adding both R^2 values resulted in a value very close to the R^2 value of the third (audio + video) regression model. Including both audio and video ratings in the (third) regression model, between 91 and 96 % of the total variance could be explained, which means that audio-video ratings could almost perfectly be predicted from both the ratings of the audio and the video conditions.

The final step of the analysis consisted of investigating the distribution and alignment of the ratings of the audio-video condition. To do so, we first reduced the dimensionality of the rating data for the audio-video condition using principal components analysis (PCA). Applying Kaiser's criterion, we retained two components that could account for 77.8% of the total variance (PC 1: 41.25% and PC 2: 36.55%). Subsequently, the components were rotated using varimax rotation and then averaged across dancers and participants yielding one value per audio/video combination resulting in 16 values per PC. Figure 3 displays these results as coordinates in a two-dimensional space. To show the influences of the auditory and visual modality on the audio-video ratings, the figure contains two subfigures: subfigure (A) shows the solution with the same audio stimuli being connected with lines, whereas subfigure (B) shows the same solution, but now with the same movement stimuli connected. The dotted line in each subfigure connects the congruent stimuli. Figure 3 shows that the stimuli having the same audio grouped closer together than the stimuli having the same movements. The happiness and tenderness cluster are overlapping in the same-audio-connected case (Figure 3A), which is in line with the previous results related to the confusion of the two emotion concepts. If we consider the two concepts as one cluster, we can see that there is no overlap between the happiness/tenderness cluster, the anger cluster, and the sadness cluster. In the same-movement case (Figure 3B) however, all clusters overlap, thus it seemed that the auditory domain was indeed dominating the visual domain in the audio-video condition. Furthermore, it is interesting to note that the clusters have self-similar structures with themselves and with the connectors of the congruent stimuli (dotted lines). This suggests that the ratings for the audio-video condition were very consistent and coherent, despite the contradictory information contained in the stimuli. This also accords with the additivity of the audio-only and video-only ratings in the regression models.

4. Discussion

This study investigated whether quasi-spontaneous music-induced movements of non-professional dancers can convey emotional qualities. Participants were asked to rate audio, video, and audio-video clips according to the emotions expressed by music, movement, and combinations of both. The results showed that in general the target emotions could be perceived in the three experiment conditions, although systematic mismatches occurred, especially examples related to ten-

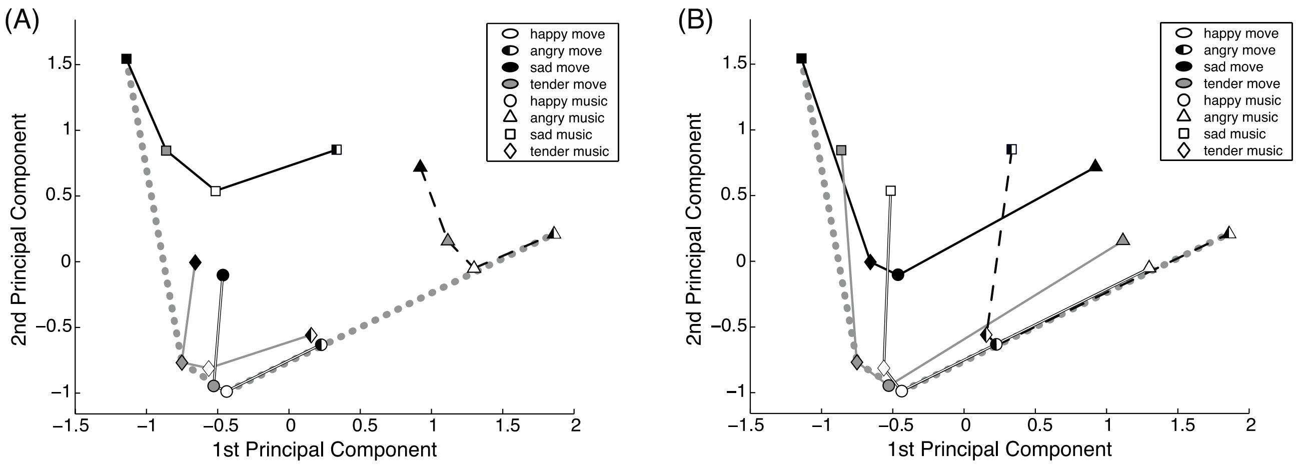

Figure 3. Principal component solution averaged across dancers and participants plotted against each other in two dimensions. (A) Solution with the same audio stimuli being connected with lines. (B) Solution with the same movement stimuli being connected. The dotted line in each subfigure is connecting the congruent stimuli.

derness. Such confusions have been reported in the literature, both in music- and in movement-related research (e.g., Eerola & Vuoskoski, 2011; Gross et al., 2010; Pollick et al., 2001). Eerola and Vuoskoski (2011) reported that for the moderate examples used in their study on emotions perception in music happiness and tenderness as well as tenderness and sadness were confused, while Gross et al. (2010) found in investigating movements of emotional knocking that tenderness was confused with happiness. These findings suggest that it requires very stereotypical examples to communicate emotions, and more specifically to communicate a single emotion with one stimulus. The nature of the stimuli could serve as an explanation for the confusions related to tenderness. The prerequisite for our musical stimuli was to contain some kind of beat to induce and stimulate movement. However, it is difficult (if not impossible) to find musical stimuli that genuinely express tenderness and as well have a perceivable beat structure. Stimuli with a tender character, but possessing a beat are most likely to be rated as happy, as the activity/arousal level would increase due to the beat. Consequently, if the music communicated similar emotional qualities, it is likely that the movement exhibited to such music do so as well.

For the video condition, an interesting finding is that the movements performed to the angry stimulus could not communicate the same emotion. An explanation for this finding could be that dance movements are commonly understood as positive and pleasant (leisure activity, fun), so they might appear and thus be rated (more) positively as well. This explanation would connect the discrete emotions approach with the dimensional model of emotions (Russell, 1980), in which happiness is commonly described as active positive/pleasant, anger as active negative, sadness as inactive negative, and tenderness as inactive positive, so the shift from anger to happiness could be explained in terms of the valence/pleasantness dimension of that model. Additionally, the movements might contain less stereotypical hints to emotional qualities than the music, at least to negative emotions. Thus, it could be that negative emotions can only be communicated in dance movements, if the dancers are asked to move according to the emotional character of the music (and not "just" to the music, as it was in this case). Similar results were also found in studies on dance and on acted emotions (Atkinson et al., 2004; Dittrich et al., 1996), although they would disagree with Walk and Homan's (1984) 'alarm hypothesis': expressions of negative emotions are easier and better recognized than positive emotions. The tendency towards more positive judgments (related to the dimensional model of emotions) can also be found in the case of Sadness as target emotion. The sad examples were rated being high in expressing tenderness, so the observers rated them more positive and pleasant, like they did with the examples expressing anger. A similar shift might have occurred in the ratings for the target emotion Tenderness when being confused with happiness, though it would be rather related to the activity level than to pleasantness in terms of the dimensional model of emotions.

We observed similar shifts in the congruent audio-video condition for the Sadness and Tenderness as target emotions – sad examples being perceived as more positive (cf., dimensional model) and tender examples being perceived as more active – though the results for the target emotion anger were different: anger could be successfully communicated when audio and video was presented together. Thus, it seems that the auditory domain dominates such ratings compared to the visual domain.

A closer investigation of the question which condition was most effective in conveying emotions revealed that the audio condition received the highest average ratings for the four target emotions, followed by the audio-video condition. For all target emotions, the same pattern emerged. Thus, we failed to find support to our initial hypothesis that the audio-video condition would receive highest recognition. We could neither confirm the results obtained in previous research (Collignon et al., 2008; Davidson, 1993; Petrini et al., 2010; Sörgjerd, 2000; Vines et al., 2006). It could be that music is the most powerful carrier of emotions, at least in relation to spontaneous dance movements. As mentioned already, dance movement might rather express pleasure, sensuality, and aesthetics, so they might lack stereotypical and stylized emotion-related qualities.

Earlier studies usually employed professional actors or dancers, whose task was to portray specific emotions. Such an approach leads to rather stylized movements that might successfully express emotions, but may lack naturalism. Our stimuli, on the other hand, were derived from quasi-spontaneous movements to music, so they might lack emotion-specific qualities, as the dancers were not instructed to express emotions with their movements. However, although the dancers were unaware of any implications to emotions, they still moved in a way that observers perceived as expressive of emotions.

The three experiment conditions showed a noteworthy relationship, as the auditory and visual modalities appeared to be additive with regards to the audio-video presentation of the stimuli. The audio-video ratings could be almost perfectly predicted from both the ratings for the audio condition and the video condition, whereas the ratings of either the audio condition or the video condition could only partly predict the audio-video ratings. This would suggest that both domains influence the perception of audio-video stimuli, and that participants tried to integrate both channels, as has already been shown in research on music (Petrini et al., 2010; Vines et al., 2006) and on voice-face integration (De Gelder & Vroomen, 2000; Massaro & Egan, 1996).

Furthermore, we found that in the audio-video condition, the auditory modality dominated the visual modality. Thus, regardless of the combination of the stimuli (i.e., for both congruent and incongruent combinations of music and movements), participants seemed to rather rate according to the music than to the movement. This result supports our initial hypothesis as well as previous studies in music research (Petrini et al., 2010; Vines et al., 2006), but contradicts with results from research on voice-face stimuli (Collignon et al., 2008) – a finding that would suggest that differences exist in musical and linguistic processing with regards to emotion perception. The domination of the auditory domain could mean that the music was more expressive of a certain emotion than was the movement, so it was guiding the ratings of the participants – especially in cases of incongruent combinations. This issue will be investigated further in the future, as data was gathered about the participants' own perception of their rating behavior: the participants were asked after completion of the audio-video part to indicate whether they paid more attention to the music, to the movement, or if they tried to integrate both. These results might give us more insight into the participants' integration of auditory and visual stimulus information.

An interesting finding within the results of the audio-video condition is that the alignment of the ratings showed a self-similar structure. We plotted the principal component solution of the basic emotion ratings in a two-dimensional space and connected the stimuli in two ways: related to the examples containing the same music and related to the examples containing the same movements. The resulting clusters supported the already mentioned finding about the auditory domain having higher influence on the ratings, as the same-music clusters are non-overlapping and smaller than the same-movement clusters. It seems that the music or/and the congruent stimulus combination "attracted" the other movements to cluster close together. Furthermore, the clusters exhibited self-similar structures with each other and with the cluster of the congruent stimuli. This suggests that, despite the contradictory information of the stimuli, the ratings were very consistent and coherent. It could be assumed that both the congruent stimulus combinations and the music were somehow guiding the perception of the incongruent stimulus combinations, so the participants followed a homogeneous rating scheme throughout the experiment.

The result that the movements failed to communicate anger in the video condition would deserve further investigation. In a future experiment, participants could be asked – differently from the present study – to express, while dancing, the emotion expressed in the music. It would be of interest to investigate how the movements (and their perception) change and if participants are able to maintain dance movement characteristics while successfully communicating emotions.

The selection of the musical stimuli in this experiment was somewhat restricted, insofar as they were derived/adopted from a previous study. Therefore, the stimuli might not have as clearly expressed an emotion as stimuli selected purely based on their emotional characteristics. However, a follow-up study could address this issue with a fresh set of stimuli of more clearly expressing an emotion, though being potentially less danceable than the recent selection.

The presented study gave revealing insights into multimodal perception of dance movement stimuli showing that participants could attribute emotions to dance movements. They were furthermore able to meaningfully integrate audio and video signals, even in case of incongruent combinations. This investigation was a follow-up study to a motion capture study (Burger, Saarikallio, et al., 2013), in which we could establish links between movement features and the emotional characteristics of music. The results of both studies can serve as support for each other: we could show in both studies that music-induced movements can express emotional characteristics, with the computational analysis showing in particular that there are relationships between movement features and the emotional content of music, and the perceptual experiment showing that humans can perceive and recognize emotions in music-induced movements.

Acknowledgments

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ASPECTS OF EMOTION AND CONSTRUCTION IN THE MUSIC OF NIGHTWISH

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Abstract

The compositions of NIGHTWISH are one of the most exciting examples of symphonic heavy metal. Tuomas Holopainen composes songs full of emotion and poetry and uses many strategies in order to accompany them musically. The songs of NIGHTWISH are a successful fusion of lyrical emotion and musical construction.
How is NIGHTWISH's popularity explained? What musical features characterize this band? Can the music of this group be analyzed from a music scientific point of view? The aim of this article is, on the one hand, to give sound answers to these questions and, on the other hand, to describe from a music analytical point of view the sound of this band in terms of how emotionality influences the musical construction.

Keywords: symphonic heavy metal, emotion and construction, music analysis

NIGHTWISH is one of the most well-known heavy metal bands of the 21st century. Tuomas Holopainen, founder, keyboard player and composer of most of the band's songs, created around the turn of the century a new heavy metal sound, which led the way for countless new heavy metal bands of the new generation. No later than the completion of their third album (Wishmaster, 2000), NIGHTWISH reached a global and still enduring popularity.

No one could suspect that the vision of a young Finnish musician, which was conceived around a camp fire by the Finnish lake *Pyhäjärvi*, would so significantly change the heavy metal sound of the 21st century. All began in 1996 in the Finnish town of Kitee, where three young talented musicians met to found a band, which would play emotional music with keyboards, acoustic guitars and a female singer (Ollila, 2007, p. 29).

Tuomas's intention was neither to create a heavy metal sound nor to pursue a career which includes several months of international tours. Rather, his first demo tape was a spontaneous result of three young musicians who wanted to follow their inner voice (Ollila, 2007, p. 46).

The three founding members of NIGHTWISH all have a background which was very untypical for a heavy metal or hard rock musician. Tuomas Holopainen, founder, keyboarder and composer of most of the band's songs enjoyed a completely normal childhood and was raised by educated parents completely normally.

As a child, Emppu Vuorinen, the band's guitarist, did not intend to become a rock star. His free time activities were in the field of sports (Judo) and he was a member of the local boy scouts team. (Ollila, 2007, p. 29)

Likewise untypical is the also the early biography of Tarja Turunen. Tarja's aim was primarily to become a classical opera singer and not to conquer the most famous rock festivals of the world. (Ollila, 2007, p. 30)

How is NIGHTWISH's popularity explained? What musical features characterize this band? Can the music of this group be analyzed from a music scientific point of view? The aim of this article is, on the one hand, to give sound answers to these questions and, on the other hand, to describe from a music analytical point of view the sound of this band in terms of how emotionality influences the musical construction.

An important aspect of the NIGHTWISH phenomenon is the very emotional lyrics. The band's founder manages to interpret his complex texts with a wealth of musical means. Tarja describes the ability of Tuomas to express his feelings and emotions musically:

"The melodic power of music – and the fact that music can be beautiful even at its heaviest – has always meant an awful lot to Thuomas. He´s able to show all his emotions and feelings in his music. I think Tuomas is very brave, because not so many people can do the same. He may not look like a macho man, but when it comes to music, it´s all or nothing for him". (Ollila, 2007, p. 112)

In order to understand the compositional language of NIGHTWISH, it is important to briefly look at the course heavy metal music in the 70s. The somber sound and the occult themes of the songs by BLACK SABBATH (Phillips, 2009, p. 35) combined with the new guitar playing techniques the raspy singing and the sophistication of instrumentation of DEEP PURPLE (Phillips, 2009, p. 63-65) were, among others, the most important features for the New Wave of British Heavy Metal (from 1979).

This new exciting, virtuosic and louder sound was now the starting point for diverse heavy metal styles like Thrash Metal, Black Metal, Death Metal and Power Metal. While it was relatively easy during the 70s and 80s to have an overview of the different bands and styles, from 1990 and on, the situation was completely different. Almost every famous band played a self-created style and every famous guitarist had his own special sound. NIGHTWISH placed themselves in the same frame of mind and managed, no later than 2004 with their fifth album (Once, 2004) not only an international breakthrough, but also to develop their own sound.

The following musical characteristics are visible if we consider the entire compositional creation of NIGHTWISH, from Angels Fall First (1997) to Imaginaeurm (2011) from a music analytical point of view and from a general perspective:

There is often a change between the female (until 2005: Tarja Turunen, 2005-2012: Anette Olzon, since 2012 Floor Jansen) and the male (until 2000: mainly Tapio Vilska, since 2002: Marco Hietala) vocal parts. The combination of the operatic female singing of Tarja Turunen with the raw death metal-kind of Tapio Vilska's voice was seldom in the heavy metal scene. During the last 14 years there were different combinations between men and women as singers of NIGHTWISH (Tapio Vilska with Tarja Turunen / Tarja Turunen with Marco Hietala / Marco Hietala with Anette Olazon). The musical parameters of the interaction between the two voices, however, always remained constant. The Swedish band THERION was already known for its use of female operatic singers in combination with heavier sounding male voices. THERION's use of this, however, is completely different from NIGHTWISH's.

The keyboard parts were very differently composed by Tuomas than those in most bands during the 80s (for example: IRON MAIDEN in *7th Son of a 7th Son* or HELLOWEEN in *Keeper of the Seven Keys*). The keyboard's function changes quite often (for example: in the background with long-lasting chords, doubling the guitar part, leading melody voice while all other instruments play the accompaniment) during a song. Tuomas also uses the instrument's ability to produce many different sounds in order to enrich the entirety of the tone colors of the songs. Since 2002 a live orchestra (specifically since 2007 the *London Philharmonic Orchestra*) plays many of the keyboard's parts, with the aim to make the overall sound richer in overtones and more powerful.

Similarly with the keyboard parts, the instrumentation changes as often as possible during a song. It often happens that it changes so fast (for example *Wish I had an Angel*, *Amaranth*) that the listener gains the impression of a constantly changing sound.

Tuomas tries during the repetition of characteristic motifs (*Nemo*: opening melody, *Bless the Child*: strong rhythmic string melody in the introduction) to avoid identically sounding combinations.

Figure 1. *Dead Boy's Poem* (Wishmaster, 2000). Development of instrumentation

The musical features just mentioned are part of NIGHTWISH's music and can be found in almost any song. In this study, six songs will be presented. Each of these songs has highly emotional lyrics and is also musically strictly thought-out. The aim of this study is then, to demonstrate the behavior of emotionality and structure of these songs.

Dead Boy's Poem (Wishmaster, 2000) is for Tuomas, a "deeply personal song" (Ollila, 2007, p. 111). The text has strong autobiographical references and talk about his emotions about his parents and the world in general, which he can express only through music.

This song functions both lyrically and musically as a through composed *crescendo*. The text is complex and is both sung by Tarja and recited by a young boy with the Nama Sam Hardwick (Ollila, 2007, p. 111-112) Tarja opens *Dead Boy's Poem* with an *a capella* melody (A1: Fig. 1). From the silence (Born from silence) emerge many feelings and emotions (*So much to live for, so much to die for, If only my heart had a home*), which are partly connected with Tuomas's music life as a member of NIGHTWISH (*A perfect concert my best friend, Every thought the music I write, Wrote for the eclipse, wrote for the virgin*). The mood of the poem is rather little positive (*My love letter to nobody*) and in time becomes even more negative (*Failed in becoming a god, Never sigh for better world*). The poem reaches its climax towards the end (*A lonely soul... An ocean soul*). These last lines are sung many times by Tarja and express the emotional state of the song's author. At the same time, the recitation of the lines by Sam Hardwick adds a layer to the text which is full of poetry and emotions.

Fig. 1 describes the development of instrumentation from Tarja's *a capella* singing (A) to the climax of the entire composition (E2). Time references are additionally added to each part of the score in order to make the clarity of Fig. 1 higher. Template is the studio version of the song (NIGHTWISH: Wishmaster, Drakkar, Witten 2000).

The increase of the author's emotions is musically supported by a through composed crescendo. At first, Tarja sings a capella (A). The quiet singing in the lower register is supported by an acoustic guitar and the keyboard which play subtle long-lasting chords (B1), while later (B2) it is also supported by subtle playing drums. The sound of the distorted guitar (C1 and later (C2) with melody-playing keyboards) adds extra tension to the music. The guitar then takes on the action with a lyrical solo (D). The climax of the composition is reached at the moment where Tarja sings the most emotional lyrics (*A lonely soul... An ocean soul*). There Tuomas takes over the main voice (??) of the music (E1 and E2). While up to this point, he only accompanied the band with long-lasting tones and stayed mainly in the background, now the entire sound of the composition is dominated by his instrument. He is the lonely soul of the poem and the transition of his instrument (keyboard) from the background to the foreground supports his feelings.

Tuomas considers the song *Ever Dream* (Century Child, 2002) as "a personal confession and pouring out of feelings". (Ollila, 2007, p. 171) This explosion of emotion is musically expressed in a similar manner as in *Dead Boy's Poem*. In only three minutes, the instrumentation changes more than twice. All ten instrumentation dispositions differ, additionally, in tone color. Fig. 2 demonstrates the high art of instrumentation by Tuomas Holopainen. (Studio Version: Century Child, Drakkar, Witten 2002) This song has:

- Piano with vocals (A)
- Piano with vocals and strings (B)
- Band (with acoustic guitars) with strings without vocals (C)
- As in C but also with vocals (D)
- Bans (with distorted guitars) with strings and vocals (E)
- As in E but with extra keyboard voices (F)
- Band with solo guitar (overdubbing, G)
- Keyboard (not piano) with vocals (H)
- Band (with double base drums) with female (Tarja) and male (Marco) vocals (I)

Figure 2. *Ever Dream* (Century Child, 2002), all instrumentation dispositions

The introduction of a second voice and the pulsating rhythm are used by Tuomas intentionally at the end of the composition, in order to give the music extra energy and excitement.The strong tone-color contrast between the operatic voice of Tarja Turunen and the raw death-metal kind of voice by Marco Hietala is intentionally used in many songs by Tuomas, in order to musically express the emotional character of the lyrics. An example for this is *Slaying the Dreamer* (Century Child, 2002).

Tensions existed for a long time between the band members and Tarja, before their final separation in 2005. A friend of Tarja's accused Tuomas of being, among others, a ruthless person. Tuomas Holopainen must indeed be a very sensitive person, since these false accusations brought him to such an emotional state, that he stayed up all that night writing the lyrics to *Slaying the Dreamer*. It was the most aggressive text written by Tuomas at that time. These lyrics also provided the ground for the most aggressive song composed by Tuomas at that time. (Ollila, 2007, p. 172)

While in *Dead Boy's Poem* the emotions that appear are negative and at the same time introverted, in *Slaying the Dreamer*, aggressiveness, anger and outrage are the ones that prevail. In the chorus, Tuomas describes the verbal abuse by Tarja's friend (*Put a stake through my heart and drag me into sunlight, so awake for your greed as you're slaying the dreamer*) and the subsequent effects on his mental state (*God it hurts, give a name to the pain, Our primrose path to hell is growing weed*). This part of the composition is brought forth by alternating between Tarja and instrumental interludes. Towards the end of the song, though, we have an explosion of emotions (*You bastards tainted my soul, raped my words, played me a fool, Gather your precious glitter and leave me be, The great ones are all dead and I'm tired, too, I truly hate you all*). This explosion of negative feelings is sung by Marco.

Fig. 3 shows the compositional strategy used by Tuomas in order to musically express his emotions. He divides the sound of the composition in four tone-color categories:

Bright / Middle-bright / Middle-dark / Dark.

For each of these four categories, he uses instruments which remain constant during the song. Fig. 3 shows an overview of the diverse tone-colors and the instruments, which build these tone-colors. It shows that:

- When Tarja sings, instruments with brighter tone-colors appear in the background (for example bells).
- When Marco sings, the band plays with more distortion in the lower register of their instruments.
- There is a constant change of the four tone-colors.

Voice	Tone-color	Dominant Instruments
Female	Bright	Keyboards with Orchestra (Tutti) (00:57-01:09,01:39-01:48,02:15-02:33)
Instrumental	Middle-bright	Guitar with distortion and Bells (00:28-00:56,01:22-01:38,02:02-02:14)
Male	Middle-dark	Guitar with distortion (lower register) (00:00-00:28,01:10-01:21,01:49-02:01,02:34-03:01.)
Male	Dark	Guitar with distortion (lower register) (more aggressive) (03:02-04:32)

Figure 3. Slaying the Dreamer (Century Child, 2002)

The song *Eva* (Dark Passion Play, 2007) could hardly be any more different in both lyrical and musical content than *Slaying the Dreamer*. It is a sensitive girl who is bullied at school by other student. The song's singer, Anette Olzon, was instrumental in the creation of *Eva*, since she was herself in a similar situation during the school years. (Metal Hammer, Oktober 2007, p. 30-37)

There are significant musical differences between *Eva* and *Slaying the Dreamer*. In *Eva*, the orchestra instruments are dominant, while the band plays a minor role and the male vocals are missing completely. But only the musical factors just mentioned, are not enough in order to distinguish the tone-colors that appear in *Eva* from the rest of the songs in this album. The choice of the key G-sharp minor is owed to the strong lyrical character in *Eva*. In the entire compositional work by NIGHTWISH, this is the only song composed in such a key or any neighboring keys.

In fact, Tuomas goes a step further and composes every part of *Eva* in a different key, something which guarantees tone-color variety.

Formal section	Intro, Verse 1-2	Chorus A1	Verse 3-4	Solo	Chorus A2
Tonality	G#-m	B	E	B-m	C-m

Figure 4. *Eva* (Dark Passion Play, 2007), harmonic disposition

Eva (Dark Passion Play, 2007)

Figure 5a. Introduction and Verse 1-2 (00:00-00:56, 02:12-02:50)

Figure 5b. Refrain A1 (00:00-00:56, 02:12-02:50)

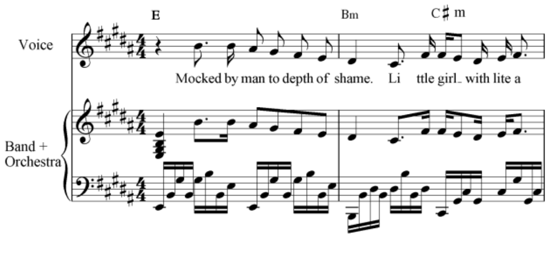

Figure 5c. Verse 3-4 (01:35-01:36-02:11)

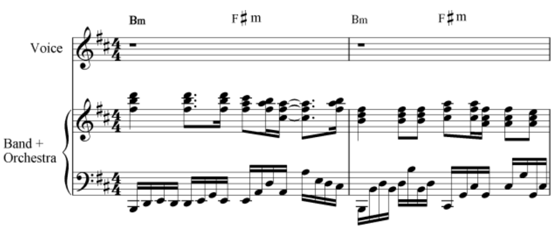

Figure 5d. Solo (02:51-03:27)

Figure 5e. Refrain A2 (03:28-04:26)

Fig. 4 provides an overview of all formal sections of *Eva* and the tonalities in which each section is composed.

Fig. 5 lists, in form of a *Particel* with vocals, the first to bars of every part of the score in *Eva*. (Dark Passion Play, Nuklear Blast, Donzdorf 2007)

Although the schema melody plus accompaniment remains constant, the harmonic progression is constantly changing.

The termination of the band's cooperation with Tarja Turunen after the final concert of the Once tour (2004 – 2005) marcs a turning point in the history of NIGHTWISH. It was both for Tarja and Tuomas and the rest of the band's members, a traumatical experience, which was processed by each one of them in a different way. Tuomas expressed his anger about Tarja's husband in the song *Master Passion Greed*. For Tarja, he composed the song *Bye Bye Beautiful*. Both of these songs are the most emotional songs of the next album (without Tarja Turunen, Dark Passion, Play, 2007).

Master Passion Greed is a song filled with anger, doubt and aggression against Marcelo Cabuli, Tarja Turunen's husband. Tuomas blames him that he deceived and manipulated Tarja (*Seek her, Seduce her, Tame her, Blame her, Have her, Kill her*). He does indeed pose some serious allegations against Marcelo Cabuli. The song was never performed live.

For such an emotional text, the founder of NIGHTWISH, chose an accordingly unusual musical form. Tuomas composed this song almost entirely on the guitar (Hard Rock, Oktober 2007, p. 22-26) and became the hardest sounding song of the band. (Metal Hammer, August 2007, p. 22) *Master Passion Greed* builds on the tradition of the 80's thrash metal.

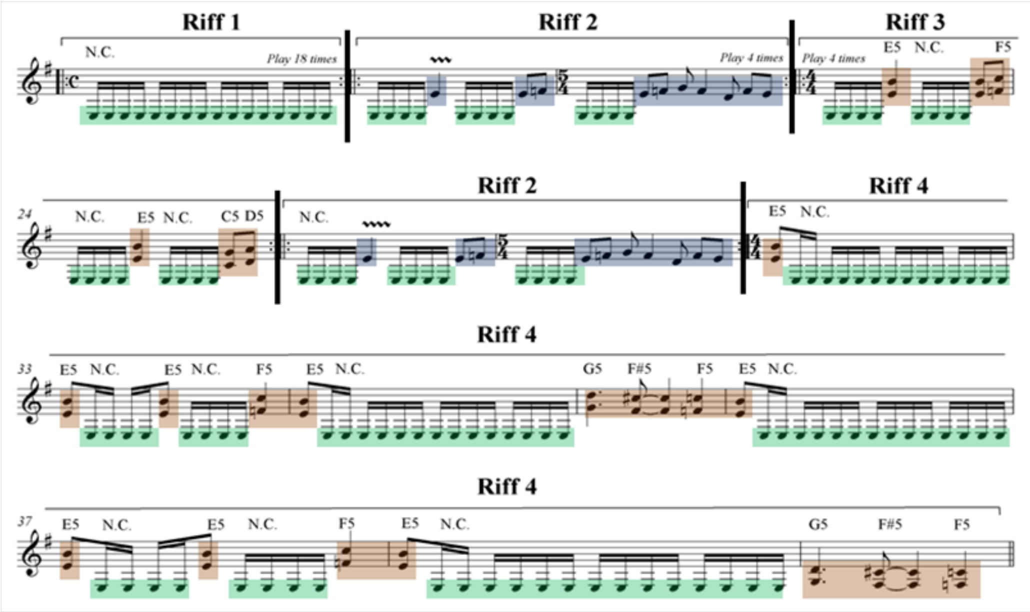

Figure 6. SLAYER: introduction of Black Magic, Show No Mercy (1983)

Fig. 6 demonstrates, from a music analytical point of view, how a typical thrash-metal song is built. Different riffs are put together in an extremely high tempo. Diverse colors are introduced in order to make the constant changing of the tone-colors more clear. The following tone-colors are used n *Black Magic*:

Fast repetitions of an open string, damped with the lower part of the hand (palm mute). This results in a muffled sound with very few overtones (section A / green colour).

Power chords, not damped. Due to the enormous distortion, the impression that the guitarist plays no double stops is given. The sound is rich and full (section B / light brown colour).

Monophonic melody, neither plentiful nor damped in terms of timbre (section C / blue colour).

Although there are more than 25 years between SLAYER's *Black Magic* and NIGHTWISH's *Master Passion Greed* (Fig. 7), there are surpisingly many similarities between the two compositions. Tuomas uses the same tone-color on the guitar. He composes many riffs before the singer's entrance and tries to vary the tone-colors of the different riffs as much as possible.

Despite the massive aggression against Marcelo Cabuli, Tuomas shows a certain fairness and waives the female voice of the successor of Tarja Turunen (Anette Olzon). Upon reaching the climax of *Master Passion Greed* (*Seek her, Seduce her, Tame her, Blame her, Have her, Kill her*), the Chorus is sung by the entire band. This song psychologically exceeds the limits of expression of emotions and feelings and is considered by the members of NIGHTWISH as a kind of dealing with the past.

There is another song in this album with the same background as *Master Passion Greed*. *Bye Bye Beautiful* themes the behavior of Tarja not only during the painful break up from the band, but also long before this happened. The tone-color contrast between the male and female voices (musical level) in intelligibly combined with the reproachful text by Tuomas. It was a challenge to keep the fairness (Anette had to stay out of this story) and still not give up on the tone-color of the female voice.

Tuomas manages this balancing act through intelligent introduction of different textual levels. At the beginning of Bye Bye Beautiful Anette sings poetic, yet extremely abstract lyrics (Finally the hills are without eyes, they are tired of painting. A dead man's face red with their own blood. They used to love having so much to lose. Blink your eyes just once and see everything in ruins). (00:31-00:57 and 01:48-02:15)

The meaning of these lyrics remains unclear, something which was probably intentional by Tuomas.

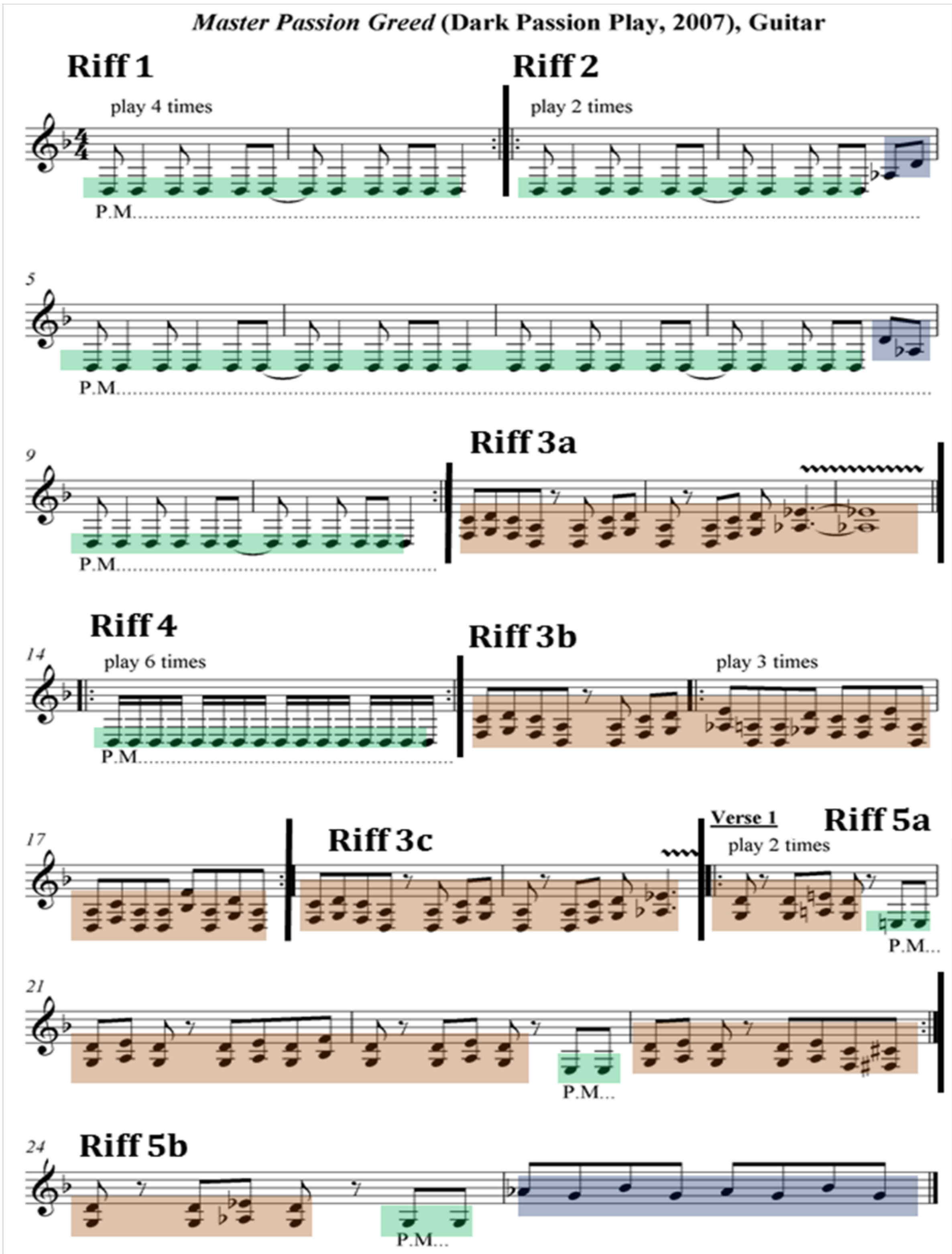

Figure 7. *Master Passion Greed* (Dark Passion Play, 2007), Introduction and Verse 1 (guitar)

This includes some strong musical characteristics of pop music. On the official video clip by NIGHTWISH (released on September 27 2007) the music is not played by the band, but from young attractive girls. In many interviews, Tuomas describes the connection of models as band members with the expulsion of Tarja.

Text level A, Anette Olzon (00:31-00:57)
Finally the hills are without eyes, they are tired of painting. A dead man's face red with their own blood. They used to love having so much to lose. Blink your eyes just once and see everything in ruins
Text level B, Marco Hietala (1:00-1:31)
Did you ever hear what I told you? Did you ever read what I wrote you? Did you ever listen to what we played? Did you ever let in what the world said? Did we get this far just to feel your hate? Did we play to become only pawns in the game? How blind can you be, don't you see? You chose the long road but we'll be waiting? Bye, bye beautiful. Bye, bye beautiful

Figure 8. *Bye Bye Beautiful* (Dark Passion Play, 2007), Text levels A and B

The subsequent use of Marco's voice could not be more contrasting. His raw voice supports the concrete and reproachful lyrics (*Did you ever hear what I told you? Did you ever read what I wrote you? Did you ever listen to what we played?)*, the music is dominated by the sound of distorted guitars and in the video clip, the young girls are replaced by the band's members. Fig. 8 shows the first verses by Anette and Marco.

The genius of this song is that the symmetry between the layers A and B is broken in the last quarter of composition (Fig. 9:03:18-03:31). Anette whispers the melody of Marco, but sings the abstract lyrics (**B**). Such hidden symmetry perforations demonstrate exactly how well thought out the music of NIGHTWISH is.

Anette:	**Text**	A		A		A	
	Music	A		A		**B**	
Marco:	**Text**		**B**		**B**		**B**
	Music		**B**		**B**		**B**

Figure 9. *Bye Bye Beautiful* (Dark Passion Play, 2007), formal disposition

The compositions of NIGHTWISH are one of the most exciting examples of symphonic heavy metal. Tuomas Holopainen composes songs full of emotion and poetry and uses many strategies in order to accompany them musically. The songs of NIGHTWISH are a successful fusion of lyrical emotion and musical construction.

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LIVE MUSIC IN THE TOURIST INDUSTRY: A COMPARATIVE STUDY BETWEEN THE FINNISH HOTEL CRUISE LINES AND SHARM EL SHEIKH'S RESORTS ENTERTAINMENT

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Abstract

The primary aim of this study is to focus on the tourists, singer-musicians' and hotel managers' experiences with live music in Finnish hotel cruise lines and Sharm EL Sheikh's seaside resorts. The tourist, singer-musician and hotel manager relations --although an integral part of the tourist experience--have received little attention in past tourism and music studies. Thus, the purpose of this research will be to show that by observing these different informants performance rituals, interactions, and attitudes towards local entertainment in the tourist industry, we could offer insightful guidelines to better understand the cultural significance of live music in the tourist experience, often produced by a complex nexus of socio- political factors. The research will furthermore, try to encompass new grounds by focusing on the sociocultural and aesthetic meanings of live (popular, folk and world) music performances, from a tourist rather than popular music perspective. Themes, such as *liminality*, the *flow*, and *imagined communities* will thus be crucial in assessing the socio-culturally different or similar performer-audience meanings and experiences with live music in the two "worlds apart" entertainment settings. The multi-sited ethnographic framework in this research, will compare the host-guest experiences for the two *world apart* sites, and study the future impacts of world systems on changes in local music production and on attitudes towards live music performances. While Cohen (2002) asks, what can popular music tell us about cities the purpose of this paper is to ask what does the hotel industry tell us about popular music?

Keywords: hotel industry, performance, popular music

1. Introduction

The complex relationship between *tourism, performance—identity* has received its share of light in the works of Turner (1979), Smith (1989), Urry, (1990), Aldskogius (1993), Matheson (2008), MacCannell (1999), Carson (2004) and Cohen (2007). But while, the focus has rested on the performing arts and cultural tourism, it has mainly been inspired by works on festivals and concerts, the profane breath taking music spectacles of the post-modern Disney theme parks, or even on the sacred pilgrims of sightseeing, and the religious rituals. As a result, many local entertainment forms, in the everyday lives of the tourists have gone unnoticed.

It is the role of this paper to focus with the help of these past papers, on two particular forms of local entertainment practices, prevalent in the everyday lives of the Finnish cruise lines and Egyptian hotel industries. Even though the works of Urry (1990) and Hughes (2000) reflected upon the decrease in the quality and quantity of live music performances in worldwide seaside resorts after the mid twentieth- century, the performances and interactions between the musicians, tourists and hotel managers, and the theme of popular music have still remained in the shadow. It is with the study of two research questions, a) *What is the cultural significance of live music performances, and b) What are the social, cultural, aesthetic criteria for evaluations of live music performances*, that this paper will aim to reveal a new full inspection of the set of meanings behind the *hotel industry, performance, and popular music* connection.

The professional and amateur everyday life entertainment practices of the two world's apart hotel-resort settings used in this research, will hopefully uncover interesting thoughts on the similarities and differences in the Finnish hotel cruise lines and Sharm EL-Sheikh's seaside resorts local entertainment practices. In other words, on the popular, folk and world music entertainment practices in these two distinctive tourist settings.

The core of this paper derives its purpose from, the performance, symbolic interactionism, structuralism, distinction, cultural imperialism and world system theories. The main approach here will be to use these theories in such a format that rituals, drama, and symbols connected to performances are explored as strategic outcomes of different touristic functions and not simply as mere products of western popular entertainment. Goffman's (1959), Adorno's (1970,1997), Turner's (1979), Fabbri's (1982), Frith's (1996), MacCannell's (1999) ,Hughes,(2000),Cohen's(2007), Bennet's (2005), Whiteley's (2004), and Finnegan's (1989) works will help me in this.

Bennett's (2005) and Finnegan's (1989) studies, with their focus on the local and everyday life entertainment practices, will work as tools in observing the Finnish cruise lines and Sharm EL Sheikh's hotel-resorts tourists', performers' and hotel managers' everyday life entertainment rituals, interactions, and attitudes towards different musical worlds. Most importantly, unlike many past studies this paper will confine its focus on the local entertainment practices of both the professional music practitioners as well as on the more amateur musicians performances. Both whose social practices involve a whole group of hosts other than just performers (e.g. hotel managers), and whose performance efforts have implications for national culture (Finnegan, 1989).

Furthermore, by integrating these scholars world views on the front and back stage performances rituals, drama, and symbols this paper will be able to answer the two research questions respectively.

a) The Performance and Symbolic interactionism Theory: A set of rituals and drama

First of all, this research will follow in the footsteps of Frith's (1996), Fabbri's (1982), Finnegan's (1989), Abercrombie's (1998), Adorno's (1970, 1997), Cohen's (2007) and Whiteley's (2004) analyzes on the performance rituals of different musical worlds, and their categorizations of different musical worlds and audience rituals into good or bad, authentic or inauthentic, professional or amateur, serious or fun, folk or popular, simple or mass diffusive, and black or white. While Frith (1996), Fabbri (1982), Adorno (1970,1997), Whiteley (2004), and Cohen (2007) look at the performance rituals of different genres of music, Abercrombie (1998), on the other hand, examines in particular the distinct types of audience rituals. In other words, for Abercrombie (1998) the western idea of physical separation between the performer and audience depends not as much on the musical world, the audience belongs to, but rather on the audience type, and on whether the audience is simple or mass-diffusive. For the mass-diffusive, art performances exist usually as a secondary interest. However, popular music can consist of both types of audiences.

Hughes (2000) brings out a similar argument to his study on arts, performance and tourism as Abercrombie. However, he takes the argument a step further, as he links audience rituals with particular categories of tourists e.g. core arts or peripheral arts tourists. Hughes (2000), believes that for the core art tourists (festival and concert oriented audiences), there are a clear set of behavior rules, rituals and an ongoing ceremony open to the public, whereas, for the art-peripheral tourists (more hotel- popular entertainment oriented audiences) performances are more about tedious rituals, less ceremonial and the distance between the audience and performer for the art-peripheral tourists performances tends to be greater.

While, King's (1995) study is purely on social rituals in the tourist industry, she illustrates exactly the way performance and social rituals in tourism actually create a greater distance between the audience and the performers (i.e. guests and hosts).

Hughes interpretation makes a unique connection in itself between tourism, performance and identity. However, the purpose of my paper will be to explore whether this dichotomy that Hughes proposes of a high culture and more popular entertainment, in other words, core art- and art peripheral tourists can also be applied to the hotel industries such as the Finnish hotel cruise line and Egyptian seaside resort- hotels local everyday life entertainment practices. This question will be among others answered, with the help of Finnegan's (1989) study on the distinction between the amateur and professional local performers, and which revealed some ambiguities in the divide between the professional and the amateur or the high culture and more popular forms of entertainment.

Back to the performance rituals, MacCannell (1999), whose ideas are largely shaped by Turner's (1979) concepts of pilgrims and sacred performances of tourist and religious rituals, will add a tourist dimension along with Turner's approach to the interpretations of the musical world's performance rituals in the front and back stages of the Finnish and Egyptian tourist settings. MacCannell (1999) examines the sacralization of natural or cultural objects in modern tourist settings and the way this sacralization is nurtured with the performance rituals of the guests and hosts. Thus, in this sense, MacCannell's theory will be valuable as it will determine the role of sacralization in the Finnish and Egyptian tourist settings performance rituals that might influence the performer's, tourist's and hotel manager's experiences and attitudes towards popular music and local entertainment. For example, markers of the tourist settings MacCannell (1999) mentions are one of the producers of this sacralization, also an important link between the tourist and the site. Moreover, according to Abercrombie (1998), because mass diffusive (art –peripheral) settings are more about work rituals, they lack markers such as proper advertisement of the musical events unlike it is the case for the simple and core-art audiences **Figure 1.**

Goffman's (1959), MacCannell's (1999), Turner's (1979) and Finnegan's (1989) studies will also be useful in the study of the connections between the front and back stages performance rituals on the one hand, and drama on the other. Studying drama in the front and back stage of performances will offer useful techniques to explore the everyday life entertainment of the two diverse tourist settings and of course the connection between hotel industry, performance—and popular music in the Finnish cruise line hotels and Sharm EL Sheikh's seaside hotel-resorts.

These famous authors reflect upon the performance ritual practices which might lead to drama between the performer and audience. For example, if the audience or performer is careless about his self presentation or the self of the other drama might occur. Drama might also rise when an audience breaks the rule and enters the back stage intentionally or accidentally. Edensor (2001) reveals the dangers in crossing the front and back stage boundaries. In Cheshire, tourists were excessively pressured to participate on the front stage with the real actors rehearsals, and many were thus disappointed.

The breach of the performance rituals and the rise of drama as a result of the breach can be portrayed with a conflict that occurred between Johnny, one of my M.A. field work musician informants working in a four star hotel in Hurghada, and a Russian tourist. The Russian tourist entered Johnny's sacred front stage. And when Johnny refused to play Russian music for the tourist, the Russian man shook Johnny's elbow, and in turn Johnny twisted the man's arm, lightly.

In short, the performance and symbolic interactionism theories that have been founded by Margaret Mead and Herbert Blumer, will assist me in looking at the front and back stage performances, audience rituals and at drama occurring in these two types of stages. By integrating this micro approach, the research will thus be able to examine the similarities and differences in the social practices and interactions between the performer-audience, performer-performer, audience-audience, and performer-hotel manager, in the Finnish hotel cruise line and Sharm El Sheikh's seaside resorts local/national entertainment industries.

Most importantly, the research will then be able to answer the two primary research questions: a) what is the cultural significance of live music? b) What are the social, cultural, and aesthetic criteria for the evaluations of live music performances? Lastly, it will hopefully be able to bridge the gap in the present literature on the hotel industry, performance—popular music and with the comparative study on local entertainment in the Finnish cruise line and Egyptian hotel industries it will thus reveal the role of popular music in the two world apart hotel industries.

b) The structuralism and distinction theories: Systems of signs and Distinction

This paper has tried so far, to present shortly the benefits of exploring the performance and audience rituals, and drama, and studying the cruise line and hotel industries that shape popular music and local entertainment practices. The structuralism and distinction theories likewise will provide a more in depth study of the hotel industry, performance --and popular music connection. This section of the paper is perhaps the most important one, as it tries to deconstruct more fully the many meanings of popular music and local entertainment in the hotel industry, as different systems of signs.

Influenced by the famous French sociologists Claude Levi Strauss (1908-2009) and Bourdieu's (1984) ideologies of Distinction, the two theories will aim to shed light on the complex set of larger structures and systems of symbols in the front and back stage performances such as the different musical worlds, liminality, cultural imperialism, the flow, and imagined communities, all which shape the tourists, musicians and hotel managers local entertainment practices similarly or differently for the Finnish cruise lines and Egyptian seaside hotel- resorts. Naturally, these different symbols will distinctively shed light on the cultural significance of live music performances and on the social, cultural and aesthetic criteria for the evaluations of live music performances.

Fabbri (1982) breaks the different musical worlds into traditional, pop, rock, sophisticated Italian canzone d'autore, political and children's music. He illustrates the way music carries different meanings, symbols for different people that define the music genre itself. For example, in Britain and America popular music would consist of rock or pop genres, in other countries such as in Italy (even in Egypt), folk or traditional music could be considered also as popular music. One example, of this Fabbri (1982) says, is the "canzone d'autore or the "author's song" which crosses in Italy the boundaries between the traditional and the pop song because of its highly unique vocal and pronunciation style, for instance. Traditional songs have an another distinction, while they focus mainly on drama in their lyrics, and the tone of the song is rather serious, on the other hand for more dreamy and fantasy related pop songs the listener is more likely to identify with the character of the song (Fabbri, 1982).

Finnegan (1989), Cohen (2007), and Frith (1996) also examine some of the symbols behind different musical worlds. Like Fabbri (1982), their works respectively shed light to the frontier problems of different genres of music for separate musical world audiences and cultures. Their research projects set apart clearly the symbols describing the different musical world performances and settings, different music expressions of the professional and amateur performers, values and practices of the audience, set of instruments, and the social networks typical to the particular style of music.

However, the main argument in Finnegan's work is that whilst distinct musical worlds have their own symbols separating the audiences or performers from one another, the boundaries between the professional and amateur musicians are often ambiguous. For example, for participants in the classical world, the beauty, good coordination and high standard of local amateur group performances, are often as good as those of the more national professional performances. Likewise, for the folk world, Finnegan states (1989) the local amateur folk performances are not pure imitations of professional folk bands but exist in their own right producing a high sense of identity and romanticism for the highly educated professional folk audience. Therefore, as Finnegan puts it: 'What was classified as within this classical tradition depended not so much on an objective set of criteria as on cultural conventions about the appropriate forms and contexts of music'.

In other words, in Finnegan's world view about local amateurs in Milton Keynes the distinction between the high culture and the more popular forms of entertainment dissolves. Proof of its ambiguity, becomes apparent in the manner in which most of the high standard amateur musicians are self taught and have little institutional schooling in music apart from the classical performers.

While, Finnegan (1989) questions the objectives of a set of criteria or the relevancy of any proper distinction between the high culture (national professional musicians) and more popular forms of entertainment for the Milton Keynes local amateur music settings, her work seems to somewhat resonate on Adorno's (1970, 1997) values of the ever changing society from high culture to mass popular, in which there are no real distinctions in criteria only in the social and cultural aspects of the musical worlds. Bourdieu's (1984) ,Frith's (1996) and Cohen's (2007) works on the other hand, stand closer to Hughes (2000) world view, and reflect upon the symbols and boundaries between the high culture and the more popular types of entertainment. These authors illustrate, the way there exists some set of criteria for performances, often related to class hierarchies or pure lifestyle.

However, looking back at the tourist-hotel industry we can see that it has its own systems of signs and symbols that influence the type of local popular music entertainment in a tourist setting. It becomes extremely useful then to integrate Turner's (1979) concept or symbol of liminality in this paper. Applying "liminality" in this study might reveal on how in the hotel industries audiences and performers might experience popular music and entertainment, the musical worlds or even the boundaries between the high culture and popular culture very differently than at home. In other words, in the different hotel settings, liminality can have a direct impact on performance rituals, popular music, and identity.

Turner (1979) describes liminality as a rite of passage in tourism with three phases: separation, transition and incorporation. The transition phase is the most important one, as it can consist of a lot of ambiguity and insecurity in the tourists or performers, on the one hand, and of high peak flow experiences, on the other. Most performance rituals in the hotel experiences thus are driven by liminality. Liminality is also partly the driver for what MacCannell (1999) refers to as the sacralization of performance rituals or to Csikszenmihalyi's (2000) the flow of experiences.

Some of the challenges in liminality are that it easily blurs the boundaries between work and play or ritual and theatre. Smith (1989), for example, pinpoints that the leisure-work distinction in liminality often decreases the hosts and guests into mere objects in interaction. The hosts of course, continuously being at the service of the guests and especially in the Third World are at a disadvantaged status. Hence, liminality in the hotel experience might actually produce totally different experiences with popular music and widen the gap between the audience and performer when ceremonial performances, and local entertainment tends to become more about rituals or touristic encounters than about theatre or spectacles. However, this distance may vary from one culture, performance, and hotel setting to another. Therefore, it is interesting to compare the Finnish cruise line experiences with rituals and ceremonies with those of the Egyptian seaside hotel-resorts.

c) Cultural Imperialism and World System Theories

The cultural imperialism and world- system theories are connected to the theme of liminality. Bennett (2005), Adorno (1970, 1997) and

Wallerstein (2004) all shed light to the core-nations exploitation of the periphery nations and their local production of arts. This exploitation often occurs in the social relations between the different employers in the hotel industry and in the leisure-work distinction, objectification of the performers and audiences, but also in what Adorno (1970.1997) has called the over productivity of western mass culture commodities. The result as Hall (1994) mentions is that "we are no longer moved by the experiences arts have to offer, we consume them."

While, Hall (1994) and Featherstone (2002) also have looked at the larger structures, symbols of consumer cultures and their effects on arts, Urry (1990) also believes that resorts and entertainment have increasingly become less about profane high culture music spectacles and more about other type of entertainment with the tourist gaze.

During my MA fieldwork in Hurghada I followed a conversation between an Egyptian musician and his Egyptian music manager. According to the musician and music manager, the days of the high culture and golden era were over in the Egyptian hotel industry. I sensed nostalgia in their voices.

Edouard, the musician, commented: "There is no respectable place to work in anymore." "No, there are still a few places" said, the manager. Edouard continued, "A few, where are these? Most places are now doing it for money". The manager replied, "True, the musicians of today are living the last days of the golden age. It is the management in the hotels which has gone bad."

Cohen (2007) and Bennett (2005) look at how developments in global capitalism have affected the relationship between popular music and the city, and thus on the global in the local. While the global in the local will be apparent also in this paper, however, the focus here instead will be on the manner in which liminality and developments in the global capitalism, cultural imperialism and the world systems are reshaping popular music entertainment in the local hotel industries.

Appadurai (1986) states the "politics mediate the level between a commodity being exchanged and its value." Thus, what also must be looked at are the different socio-politic effects in the cruise and hotel industries, and how they similarly or differently are shaping the value of arts for the Finnish Cruise lines and Sharm EL Sheikh's entertainment practices with popular music.

d) Liminality and the flow

We have already grasped the way certain features of liminality can widen the gap between the performer and audience, such as with the leisure/work distinction or even with the exploitation of the hosts local culture productions in the tourism-hotel industries.

Nevertheless, regardless of the challenges that liminality produces, most importantly, the transitional stage, often encourages the flow experience with positive feelings towards local popular entertainment, and may thus blur further any common objective set of criteria of "high culture" and "more popular form of entertainment" as the distance between the performer and the audience gets smaller. Csikszentmihalyi (2000) states that for the flow to happen between different individuals they both have to be action oriented like the performer and the audience and the social and cultural expectations of the performer have to match those of the audience. However, in liminality and in the tourist experience, the flow can often have a different impact on the audience's social practices and many people can enjoy different genres of music, cross the boundaries of the musical worlds that they usually wouldn't necessarily enjoy listening to at home. Moreover, as **Figure 2.** reveals tourists in flow during music performances might be influenced by cultural stereotypes or imagined communities very differently than when back home.

As Harrison (2003) mentions, during the flow in the transition stage of travel most tourists are in a state of loss of consciousness over their bodies and minds, they can forget the most painful experiences of travel or let go more easily of their social cultural expectations and self discipline mainly because of the leisure-work division in liminality and because of the tourists role as players in the tourist settings. In other words, the flow of experience in liminality can turn the art peripheral tourist into the core- art tourist. Furthermore, a heavy metal fan, or a Finnish tourist seeking some high culture entertainment in the Finnish cruise lines can suddenly enjoy a local musician's interpretation of Bryan Adams song Heaven in Sharm EL Sheikh's hotels. In this sense then, tourism and hotel industries install a new set of meanings to performances and popular music and the usual boundaries between the simple audience and mass diffusive or the core art and art-peripheral audience become vague.

e) Liminality and the imagined communities

Focusing on larger structures, the symbols of liminality, and on the imagined communities will have its own advantage for exploring the similarities and differences in local entertainment practices and attitudes towards popular music in the Finnish Cruise Lines and Sharm EL Sheikh's hotels resorts. Anderson (1991) believes that somewhere in this imagined world resides a profound comradeship among the same nation's citizens. Turner's (1979) concept of communitas is rather similar. He believes that persons actively relate to one another through the social, historical and cultural factors. This on the other hand, as Dunaway (2003) mentions with the modern world-system might produce contradictory feelings as the world -system often places people into different race categories, and produces clashes in imagined communities.

Tourism and the hotel industry are products of the world- system in which the clashes in imagined communities often become apparent in popular music and local entertainment. Liminality as we have seen with the flow can alter the imagined communities and thus change its shape. Nevertheless, liminality is strongly connected to the imagined communities and the cultural memories and myths of popular, folk or world music. Furthermore, it is because of the imagined communities, in the first place, that the Global becomes apparent in the local (Cohen, 2007).

Although the world system might also have its negative effects on the imagined communities and thus on the local production of music, on the other hand, the imagined community is also a source of productivity and creativity for popular music in the hotel industry. One example, of this can be portrayed with the popular Egyptian music and the Spanish Tinge, in which flamenco guitar sounds are interwoven with traditional Egyptian musical styles in the local amateur/professional performances in Sharm EL Sheikh's hotel industry.

2. Images

Figure 1. National, local, highly advertised Finnish cruise line entertainment.

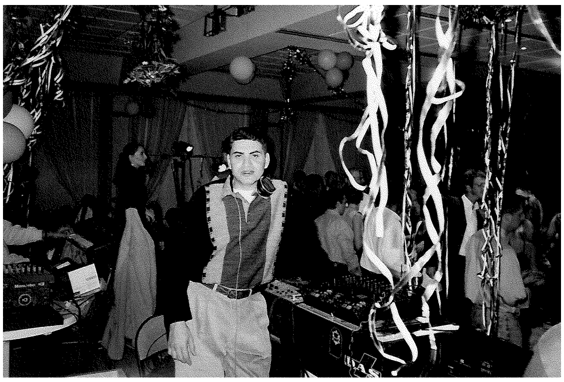

Figure 2. Local, little advertised entertainment. Ghazala Hotel, Sharm EL Sheikh,1997. Liminality in action-a highly celebrative art-peripheral audience.

3. Research Methods and Conclusions

This research will use multi-sited ethnographic fieldwork as its method. Even though a model of mixed methods would have been useful, however, because the main aim is to focus on the larger systems of signs (i.e. symbols), which will cover the biggest part of the paper, I came to the conclusion that relying fully on the ethnographic method would be more practical.

The multi-sited ethnographic fieldwork approach will be relevant for several reasons. First and foremost, as it studies the world systems impacts on changes in local cultural production and compares *world apart* sites (Marcus, 1995). Furthermore, while comparing these two *world apart* the Finnish cruise lines and Sharm EL Sheikh's seaside resort-hotels at the same time the study will hopefully be able to support the opportunity for an exchange of knowledge for the distinct cultural fields of arts in the Finnish and Egyptian *world apart* tourist sites.

The ethnographic method will consist of participant observation, semi structured and unstructured interviews. Moreover, it will contain self-reflexive and narrative dialogue techniques, visual and sound techniques, in other words, photography and video recording to capture and then later interpret the smallest of details in the performances. Moreover, whereas there will be no questionnaire to generalize the informants responses into nationality, age, gender, social class and level of education categories, these variables will still be included and analyzed with the rest of the data.

The participants from the Finnish Cruise lines (Viking Grace and Baltic Princess) and Egyptian five and four star hotel-resorts in Sharm EL Sheikh (Ghazala Hotel, Marriott hotel, Fayrouz Hotel, Four Seasons Resort, Hyatt Regency Sharm EL Sheikh) will be selected by convenience sampling. The Finnish respondents I will be interviewing in the Viking Grace and Baltic Princess cruise lines will consist of five men and five women entertainers, five men and five women tourists, and of two cruise line managers for each of the cruise line companies. Likewise, the respondents I will be interviewing in Sharm EL Sheikh's five and four star hotels will consist of five men and five women entertainers, five men and five woman tourists, and of two hotel managers in each of the five resort-hotels.

The interviews and fieldwork in both of the Finnish Cruise lines will take place on two separate occasions, each occasion lasting for a maximum of two nights. Whereas the interviews in Sharm EL Sheikh will take place on one occasion only but over a longer span of time. Moreover, the respondents will be chosen according to different age groups: a)15-25, b) 25-34, c) 35-44, d) 45-54, e) 55-64, f) 65-74, and g) 75+ to get a complete picture of the local popular music entertainment practices in the cruise lines and the hotels. Studying the educational background will also be important and this will include the following categories a) Secondary School b) Graduate c) Post Graduate d) Other.

Even though, the primary aim in this research is to study local entertainment practices in the cruise line-hotels, it will also be beneficial for me to explore the other forms of performance and entertainment in the cruise lines and hotels which are connected to the live music entertainment performances and attracting people. These consist of the food and drinks, advertisements, the sea and exotic environment.

While I will be analyzing the data by using coding techniques, I will be careful not to break the code of ethics, and thus make sure that by coding the photographs and recordings, I will be able to protect the confidentiality of my informants.

Furthermore, whereas the challenges in getting the consent of informants for interviews might be more applicable to Sharm EL Sheikh's hotels, there are still many questions I will have to ask myself before entering the field. For example, to what extent must I hold to the ideology of free consent and is being a researcher at times more important than being ethical? What if I have trouble accessing tourists in some of the hotels? Should I still continue doing informal interviews in the hotels without the consent of the management? Being prepared to meet these challenges might save me from many difficult situations later in the field.

Finally, for my concluding remarks, I would like to add that this paper has tried to grasp the different directions, in other words, the different theories and the way these theories should help me answer the two research questions. Most importantly, this paper has tried to argue that the main goal is to study live entertainment in two world apart tourist destinations and to study the cruise line's and hotel's relationships to popular music.

While the intention here has not been to shed excessive light on the division between high culture and the more popular forms of entertainment in the hotel industry, however, by observing the connection between *hotel industry, performance, and popular music*, the work will naturally reveal whether a distinction exists between the high culture and more popular forms of entertainment, in the Finnish cruise line and Egyptian hotel settings. One thing for sure, while the Finnish cruise lines offer national and local professional entertainment, the entertainment in Sharm EL Sheikh consists primarily of local amateur and professionals musicians to whom popular music is more about cover songs than original and nationally played artworks.

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THE ROLE OF INSPIRATION IN THE PERFORMANCE OF PROGRAMME MUSIC: THE CASE OF "VIAGENS NA MINHA TERRA" BY FERNANDO LOPES-GRAÇA

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Abstract

"Viagens na minha Terra" (Travels in my Homeland) is a piano cycle in nineteen movements by Portuguese composer Fernando Lopes-Graça (1906-1994). The work relates to Portuguese culture in many ways: the title of the work is from a novel by Almeida Garrett and each movement is based on a traditional folk song. The music also refers to traditional dances, musical instruments and religious festivities, all of which are associated with small villages or regional traditions. By tracing the composer's original sources of inspiration, this paper examines how these extra-musical ideas can influence the way the piece is performed. It gives examples of how these ideas are incorporated into the piece and transcribed into the score. It also shows how analysing sound recordings of the traditional folk songs used in "Viagens na minha Terra" can determine the performer's approach to the work in terms of tempo, rhythm, dynamics and sound.

Keywords: Fernando Lopes-Graça, programme music, performance studies

1. Introduction

Fernando Lopes-Graça (1906 - 1994) is without doubt one of the most important figures of Portuguese musical culture. Apart from being a prolific composer, with works for different instruments, his interest in Portuguese traditional music was crucial in the establishment of his identity as a composer. In a very personal way, he incorporated references to Portuguese folk music in almost all of his works. "Viagens na Minha Terra" is a very clear example of this and it represents an interesting challenge for the performer who is faced with many external references.

In the 1960s of the XXth century, Lopes-Graça accompanied the Corsican ethnomusicologist Michel Giacometti in his collecting of traditional music. Concerned with the authenticity of the collections made *in loco*, the composer said: "I think one of the main problems, if not the main problem, the main difficulty that faces the collector of folk music, especially the one who wants to record it, is to find it live, that is, as a functional part of activities or moments that express it or are the purpose for it: the work songs during the agricultural labour or similar, the religious songs during the cult, the lullabies near the cradle, the songs of Pilgrimages in the Shrine or on the way to the Shrine, etc.." (Lopes-Graça, 1953). Being responsible for the transcription of the melodies, Lopes-Graça remarked that it wasn't a confortable task: "Many style particularities, certain accentuations, certain voice inflexions, like the attacks and characteristic *portamenti* are difficult to notate. The rhythm can constitute, sometimes, a real problem" (Lopes-Graça, 1953).

The relationship of Lopes-Graça with traditional music had two sides: its collection/transcription for ethnographical purposes and its incorporation in his music.

2. The work: movements and comments

The piano cycle "Viagens na Minha Terra" (Travels in my Homeland) was composed between 1953 and 1954 and is dedicated to the Brazilian pianist Arnaldo Estrela who, like Lopes-Graça, was, politically, a left-winger. Lopes-Graça annotated the score with the following comments: «The little pieces that constitute "Viagens na Minha Terra" evoke mores, legends, the physiognomy of Portugal not in picturesque and flashy way, but more in a way of showing the soul [unreadable], simple and [unreadable], perhaps even rude, but profoundly spiritual of the people, its gravity. Intention: to preserve a certain number of melodies. "Viagens na Minha Terra" is a homage to Almeida Garrett on the occasion of the 1st century. The titles don't imply necessarily descriptive intentions. It's not only a simple harmonization. It wouldn't be worth for a composer to do so if in the process he didn't intervene with his personality» (Cascudo, 2012). The title of the work is the same of one of the most famous Portuguese novels, which is authored by Almeida Garrett (1799-1854). The novel combines two layers: the description of a real journey between Lisbon and Santarém and the fictional narration of a love story. The idea of wandering is also present in the subtitle of the piano work: "Nineteen piano pieces based on traditional portuguese melodies." In the autograph of the work the composer even added a small comment next to the title of each movement (Cascudo, 2012).

Here are the titles of each movement, followed by the comment of the composer (the composer didn't add comments to every movement):

1 - Procissão de Penitência em S. Gens de Calvos | Penitence Procession in S. Gens de Calvos
Comment: Dramatic piety;

2 - Na Romaria do Senhor da Serra de Semide | Pilgrimage to the Shrine of Senhor da Serra in Semide
Comment: Primitive material / simple rhythmic tetrachordal formula obsessively repeated / variation of the harmonic colour;

3 - Noutros Tempos a Figueira da Foz dançava o Lundum | In the olden days Figueira da Foz would dance the Lundum
Comment: Naturally, the syncope represents the main element of the rhythmic structure;

4 - Um Natal no Ribatejo | Christmas in Ribatejo
Comment: Misticism;

5 - Em Alcobaça, dançando um velho fandango | In Alcobaça, dancing an old fandango
Comment: Choreographic vivacity. Of Spanish origin or not, the fandango is one of the most vulgar dances in Portugal: various types. This one is very Portuguese;

6 - Em Ourique do Alentejo, durante o S. João | In Ourique from Alentejo during the S. João
Comment: Melody in an old style; ancestral rites suggested by the special idiosyncrasy of the people from Alentejo;

7 - Acampando no Marão | Camping on the Marão
Comment: Simplicity; bonhomie of the rustic people;

8 - Em S. Miguel d'Acha, durante as trovoadas, mulheres e homens cantam o Bendito | In S. Miguel d'Acha, during the storms, women and men sing the Bendito
Comments: A song with two voices; old song for exorcisms assimilated by the Catholicism, returning to its primitive magical function;

9 - Em terras do Douro | In the Douro valley

10 - Nas faldas da Serra da Estrela | At the foot of Serra da Estrela

11 - Em Silves já não há moiras encantadas | In Silves there are no more enchanted moorish maidens
Comment: It involves a certain irony (ó minha caninha verde; banal corridinho;

12 - Cantando os Reis em Rezende | Singing the Reis in Rezende

13 - Em Pegarinhos, uma velhinha canta uma antiga canção de roca | In Pegarinhos, an old woman sings an ancient spinning song
Comments: A region of patriarchal habits;

14 - Na Citânia de Briteiros. | In Citânia de Briteiros

15 - Em Monsanto da Beira, apanhando a margaça | Gathering the margaça in Monsanto da Beira
Comments: Brightness, the brightness of the songs of Monsanto;

16 - Na Ria de Aveiro | On the estuary of Aveiro

17 - Em Setúbal, comendo a bela laranja | In Setúbal, eating the lovely orange

18 - Em Vinhais, escutando um velho romance | In Vinhais, listening to an old romance;

19 - Os adufes troam na romaria da Senhora da Póvoa de Val-de-Lobo | The adufes thunder at the pilgrimage of Senhora da Póvoa of Val-de-Lobo.
Comments: Pilgrimages of Beira Baixa / adufes / modal hexachord that proves the antiquity of the song.

3. Extra-musical references

Each movement of "Viagens na Minha Terra" is *per se* a vehicle for the Portuguese culture, not only because of the sonorities but also due to other references present in the titles. The most emblematic ones can be divided into the following categories:

a) religious festivities (nº 1, 2, 4, 6, 12, 18)
b) traditional dances (nº3, 5)
c) rural places (nº 7, 9, 10, 13, 16)
d) folk tales (nº 11, 18)
e) regional traditions (nº 8, 15)
f) traditional cries/tunes (nº 14, 17)
g) musical instruments (nº 19)

Considering the composer's writings on the work and analysing the titles and categories into which they fit, the question emerges: what effect can it have in the performance?

By tracing the composer's original sources of inspiration, one can find a considerable amount of information that can have an impact in the understanding and, consequently, in the performance of the work. For now we will concentrate on the analysis of the information contained in the titles of each movement.

Regarding the following movements the composer seems to only draw attention on different locations in Portugal, probably relating the origin of the traditional melodies to the places identified in the titles. In some cases "the place" referred to is not a village or a parish but a region, which makes it difficult to trace the original songs. "In the Douro valley" and "At the foot of Serra da Estrela", ninth and tenth movements respectively, are those where the composer focuses on two Portuguese landmarks: the Douro valley, whose *vinhateiro* region has been classified as a World Heritage Site by UNESCO, and the Serra da Estrela (Estrela Mountains), the highest mountain range in Continental Portugal. The same happens to the pieces "In Citânia de Briteiros" and "On the estuary of Aveiro", the fourteenth and sixteenth movements. Citânia de Briteiros is an important archaeological site of Castro Culture in the North of Portugal. It was there that, in 1932, the English diplomat Rodney Gallop collected the tune of stonemasons used by Lopes-Graça in "Viagens na Minha Terra" (Giacometti, 1981). The estuary of Aveiro is located in the North of Portugal, on the Atlantic coast. It stands as one of Europe's last remaining untouched coastal marshland. "Singing the Reis in Rezende", the twelfth movement, refers to the religious Portuguese tradition of singing the Reis (Maji) on the 6th January. Lopes-Graça probably used a melody from the region of Resende (a parish located in the Central Inland of Portugal). The seventeenth movement "In Setúbal, eating the lovely orange" is based on a traditional cry for selling oranges collected by Jaime Cortesão in 1942 in Setúbal (Giacometti, 1981), a

Portuguese village known of its very sweet oranges.

The first movement, "Penitence Procession in S. Gens de Calvos" is based on a melody collected by Gonçalo Sampaio in S. Gens de Calvos, a small parish in the Minho region (Sampaio, 1986). The mood of this movement is "Solemn", the same of "Alerta, Alerta", the song in which it is based. The solemnity is related to the penitence procession, a Christian ritual that is part of the Lent, the preparation for Easter: "During Easter, those impressive, sometimes even terrifying, the Commendations of the Souls or the Pray for the Souls, night chants sung in the crossroads, in front of the chapels of the "alminhas" [little souls], a clear reminiscence of the ancestral cult of the dead that perhaps constitute one of the aspects more curious of our religious folklore" (Giacometti, 1981).

Although the second movement is related to a religious pilgrimage, "Pilgrimage to the Shrine of Senhor da Serra in Semide", it portrays the pagan feast associated with this shrine: "There mustn't be many pilgrimages in Portugal that are able to gather, regularly, for so few days, such a great number of pilgrims, as the Pilgrimage to the Shrine of Senhor da Serra" (Campos Neves, 1920). Lopes-Graça certainly testified the vivacity of this feast because he went of vacation to Senhor da Serra at least in the summers of 1940, 1942, 1944 and 1945 (Museu da Música Portuguesa, 1998).

Some titles are strongly connected with the traditional melody in which the movement is based. The original melody of the third movement is called "Lundu da Figueira" (Lundu from Figueira). The Lundu (or Lundum), which rhythmic specificities are the "habanera ostinato" and the syncope, is a traditional song and dance of African-Brazilian origin brought to Europe around the 18th century. Although nowadays it is a very lively dance, it used to have a more discreet and slightly insinuating character - the piece by Lopes-Graça even contains the expression "languid" (Figure 1). Figueira (an abbreviation of Figueira da Foz, a seashore village in Centre of Portugal) is the place where the original melody (Figure 1.1) was collected (Tomás, 1934). In this case, the original melody is clearly presented in the piece by Lopes-Graça.

Figure 1. "Noutros Tempos a Figueira da Foz dançava o Lundum" (bars 1 to 5).

Figure 1.1. "Lundu da Figueira" (bars 1 to 3).

The same happens in the case of the fifth movement: "In Alcobaça, dancing an old Fandango". M. N. Cruz and J. D. Ribeiro collected some fandango songs around 1917 in the Alcobaça area, in the Portuguese Extremadura province (Giacometti, 1981). The fandango is a lively dance that, as one of the main folk dances in Portugal, is still present in the pilgrimages around the country.

"Christmas in Ribatejo" is the fourth movement, to which the composer connects the idea of *mysticism*. The Ribatejo is a Portuguese province, a referential place in the history of the Order of the Templars in Portugal associated with the Convent of Christ (that is located in Tomar, the town where Lopes-Graça was born).

The title of the sixth movement only refers to the religious/pagan feast of São João (St. John) that takes place in Ourique do Alentejo (in the Alentejo province, South of Portugal). It is a very slow piece that is related to the "Cante Alentejano", the traditional musical genre of the Alentejo that is characterized by the repetitive nature of the strophes in a very slow tempo with some moments of silence.

Other titles require a more poetic interpretation as it is the case of the seventh movement called "Camping at Marão". The title may suggest a panoramic view of the Marão Mountains (Serra do Marão) that are located in the North of Portugal and have an altitude of 1415 m.

Figure 2. Serra do Marão in the 60s

"Bendito «das trovoadas»", the melody that appears in the eighth movement was collected by Lopes-Graça who considered it a "precious song" (Lopes-Graça, 1953). In the transcription of the collection, the melody is sung antiphonally by men and women (Figure 3). The structure of "In S. Miguel d'Acha, during the storms, women and men sing the Bendito" follows closely the structure of the original melody, clearly divided in two groups as seen in Figure 3.1. To clearly divide the phrases, both examples contain a *fermata* in the end of each phrase, which is followed by a breath mark in Figure 3 and the indication "corta" (cut) in the piece by Lopes-Graça.

Figure 3. Bendito «das trovoadas»

Figure 3.1. "Em S. Miguel d'Acha, durante as trovoadas, mulheres e homens cantam o Bendito" (bars 1 to 17).

The eleventh movement contains different Portuguese references. In the title "In Silves there are no more enchanted moorish maidens" and in the comments of the composer we can find many interesting layers. This movement refers to the Algarve region (South of Portugal), specifically the village of Silves that used to be the Moorish capital during the Muslim occupation in Portugal. It is mainly from XIIIth century that the legends around the enchanted moorish maidens, supernatural beings, date back. Contrasting with this oneiric ambience suggest by these "characters", the composer constructs the music based on the song "Ó minha caninha verde", an example of the *corridinho*, the fast songs and dances from the Algarve that implicate and exquisite and rhythmic footwork. The title of this movement may be inspired in the book "The enchanted Moorish maidens and the enchantments of the Argarve", that contains a chapter called "The Moorish maiden of Silves" (Athaíde d'Oliveira, 1898).

Some examples may suggest the composer's personal experiences as in the thirteenth movement called "In Pegarinhos, an old woman sings an ancient spinning song". With the purpose of collecting folk music, Lopes-Graça was in Pegarinhos (a small parish situated in Trás-os-Montes, a Portuguese province in the Northeastern corner of the country) in 1953. Apart from being based in a melody collected in Pegarinhos, which is also cited in the fifth movement of the Rustic Suite nº 1 for orchestra by Lopes-Graça, this movement may relate to an encounter between the composer and an old woman that was especially kept in his memory.

In the eighteenth movement we are still in Trás-os-Montes, this time in the municipality of Vinhais. The title of the piece "In Vinhais, listening to an old romance" refers to the song "The Romance of the captive girl" collected by Kurt Schindler, a German-born American composer and conductor, in 1941 (Weffort, 2006).

In the fifteenth movement of "Viagens na Minha Terra" we are taken to Monsanto, a small village that was once considered *The most Portuguese village of Portugal* in a competition organized in 1938 by the Secretariado de Propaganda Nacional (Secretariat of National Propaganda), during the dictatorship of Salazar. "Gathering margaça in Monsanto da Beira" is based on a melody collected by Ernesto Veiga de Oliveira and Benjamim Pereira between 1960 and 1963 (Viana, 1947). The original melody is called "Margaça", which is a plant from the same family as the camomile. It is accompanied by the *adufe*, a traditional Portuguese instrument of Moorish origin. The *adufe* is a traditional square tambourine only played by women used mainly in the provinces of Beira and Trás-os-Montes. Figure 4 shows the *adufe* played by Catarina Chitas (1913 - 2003), a shepherdess from Penha Garcia, who was one the most important players of the instrument.

Figure 4. The *adufe* played by Catarina Chitas (1970)

In "The adufes thunder at the pilgrimage of Senhora da Póvoa of Val-de-Lobo", the last movement of "Viagens na Minha Terra", the *adufe* has also an important role. The piece is based on a song called "Senhora da Póvoa", the name of the shrine and the pilgrimage that takes place in Vale de Lobo, a small parish located in the municipality of Penamacor, very close to the Spanish border. The song was primarily collected by Rodney Gallop and published in 1937 (Giacometti, 1981) and a recording of this song, collected by Giacometti and Lopes-Graça, will be referred to in the following chapter.

By analysing the information contained in the titles of each movement we were able to trace the sources that could influence each piece's performance. By connecting the pieces to religious/solemn rituals, to traditional dances, to the landscape, the pianist may feel more involved with the piece and therefore especially inspired in performance. These external references can influence the sound (the attack, the kind of sonority), dynamics and tempo (obviously taking into account the indications in the score of "Viagens na Minha Terra" but connecting these indications to the original pieces).

4. Original musical sources

To fully understand the characteristics of each song, one can listen to field recordings. Concerning rhythm, some interesting aspects were found when analysing the recordings of three folk songs that correspond to three movements of "Viagens na Minha Terra".

The nineteenth movement starts with an introduction played in the left hand (Figure 5). It is only when listening to the two field recordings of "Senhora da Póvoa" collected by Giacometti and Lopes-Graça that we fully understand "what it means".

Figure 5. "Os adufes troam na romaria da Senhora da Póvoa de Val-de-Lobo" (bars 1 to 5).

In these recordings, the introduction sets the character of the piece: "the tremulous rhythm of the *adufes* transport us, in a sense, to an "African" ritual or dance." (Giacometti, Lopes-Graça, 1991). The song starts with the sound of the *adufes* played vigorously by a group of women, whose voices come in later. It is clear that in Lopes-Graça's piece the *adufes* correspond to the accompaniment (left hand) and the voices to the melody (right hand). The indication in the score *PP lontano*, an approach considerably different from the recording, seems to suggest a reminiscence of the original song, as if the *adufes* are sounding far away and we can only hear them vaguely. Considering the timbre of the *adufes* and the amateur approach towards the instrument, the sound of the left hand must be somewhat "tarnished" and the rhythm mustn't be taken too strictly.

The song "Margaça" or "A margaça é má erva" ("The margaça is a bad weed") is the original song for the fifteenth movement. Due to geographic proximity of the places where the songs were collected, in the a recording made in the 1960s, the *adufe* is also present, this time giving the pulse through the repetition of the rhythm of ♩ ♪ (crotchet, quaver). However not all performers strictly follow this rhythmic motif, which creates small variations that ornament the accompaniment. Although the motif is not present in Lopes-Graça's piece, by listening to the recording, the performer should feel that repetitive cell when performing this movement. Concerning the rhythm of this piece we found another relevant detail: if we compare one of the oldest transcriptions of the song, published in "Cancioneiro Monsantino" in 1947 (Figure 6) and the recording in question, we find that the rhythm of bars 2, 4, 6 and 8 is different. In the recording, the rhythm of these bars is ♩♩♩ (three crotchets), which creates a very interesting moment of ternary subdivision (opposed to the binary subdivision of the song). This rhythm is probably the most usual rhythm for the referred bars, because it is also followed in a recording made in 2012 by a Folkloric group called "Modas e Adufes" (Portuguese Folk, 2012). It is known that Giacometti recorded this song *in loco* but it is not known if Lopes-Graça was there. What is certain is that the composer didn't follow this transcription because he uses the syncopated rhythm. Another remark can be taken into account when performing the piece by Lopes-Graça: in both recordings, the first crotchet of bars 2, 4 and 6 has a small accent, which makes the crotchet last a little bit more time before ending the phrase in *diminuendo*. When Lopes-Graça referred the "brightness" of the songs of Monsanto was probably thinking about this song: because of its high tessitura the timbre of the voices is very luminous and cheerful. The performer should therefore have this musical image in mind when playing the piece.

Figure 6. First published transcription of " Margaça".

Many recordings can be found of the Portuguese fandango. Fandango is a song without lyrics that is normally accompanied with a dance. Although the steps and movements vary according to the Portuguese regions, the music has always a lively character. "Dancing an old Fandango in Alcobaça" starts as a kind of reminiscence of the original dance: if we look at the left hand of the introduction we see quavers played in *staccato* and piano (Figure 7).

Figure 7. "Em Alcobaça, dançando um velho fandango" (bars 1 to 8)

This is very different from the original accompaniment that can be made by instruments like the bagpipe, the accordion or a traditional snare drum (called *caixa* or *bombo*). The "vivacity" referred to by Lopes-Graça is reached ahead in the piece through the increase of the dynamics and the enrichment of the texture. Figure 8 shows the passage in question: this time the melody is presented in octaves (right hand) and the accompaniment is ornamented with an *appoggiatura* in the second beat (left hand). To set the new ambience this passage has the indications of *forte* (f), *molto ritmado* and *staccato*, which suggest the impetuosity associated with this dance.

Figure 8. "Em Alcobaça, dançando um velho fandango" (bars 39 to46).

"In Citânia de Briteiros" is based on a very expressive stonemasons' tune called "Ó, Ó, Ó, Pedra!" (Oh, Oh, Oh, Stone!). Figures 9 and 9.1 show respectivelly the original tune and the first bars of the piece by Lopes-Graça. Even without listening to a recording of the original piece, it is almost possible to imagine the low voices of the stonemasons singing. It can be very moving to foresee these voices singing a melody with the following particularities: the descending half-tones Ab/G, the *fermatas* in the end of each phrase, the indication of *Adagio*. To reinforce the ambiance, Lopes-Graça included an expressive accompaniment in the left hand: the fifth chords seem to suggest the sound of the hammers hit the floor.

Figure 9. First collection of "Ó, Ó, Ó, Pedra!"

Figure 9.1. " Na Citânia de Briteiros" (bars 1 to 6)

5. Conclusion

Tempo, rhythm, dynamics and sound: in performance, these are the main parameters that can be influenced by taking into consideration the external references of "Viagens na Minha Terra". Even the process of searching for the origin of these references would have pleased Lopes-Graça: during this phase, the pianist establishes a deep contact with many aspects of the Portuguese culture (from Geography to Music) that were evoked by the composer in the piece. Of course that prior the "internet era" it would not be easy to reach the primary sources referred to in this paper: the books where the folk songs were originally published - available not only in public libraries but also in online libraries - or the field recordings - downloadable for free or purchasable online. With the democratization and consequent facilitation of the access to the information, the contact with the external references can truly enlighten a deep knowledge of the piece, through its origin, its meaning and its message. The depth of knowledge of the external references depends, for sure, on the interest of the pianist; but it is easy to conclude that, as long as the skills of research and performance are equally developed, the pianist who knows more about the piece will perform better.

For a pianist, researching about the pieces one is practicing is a way of opening horizons: this process brings to the keyboard not only what it is written in the score (and that is interpreted by the pianist according to the personal and musical experience) but also the images and sounds that influenced the composer during the composition of the piece. In the particular case of "Viagens na Minha Terra", a work full of references that co-exist with the personal style of the composer, the pianist who decides to pursue the clues given by the composer is awarded with never ending material that can greatly inspire and enhance the performance experience.

Nota Bene

The author is responsible for all translations.

The autograph of "Viagens na Minha Terra", as well as the entire estate of the composer, is kept in the Museu da Música Portuguesa (Museum of Portuguese Music) in the city of Cascais.

Figures

Figures 1, 3.1, 5, 7, 8 and 9.1 are taken from the piano score of "Viagens na Minha Terra".

Figure 1.1 - (Weffort, 2006) pp. 256.

Figure 2 - Picture by Eduardo Teixeira Pinto. Retrieved from https://plus.google.com/photos/117117577629872048745/albums/5633265019513703009/%205633286691949499602

Figure 3 - (Lopes-Graça, 1953) pp. 584.

Figure 4 - Still from video. Retrieved from http://www.youtube.com/watch?v=Nlz41dv4cz4.

Figure 6 - (Viana, 1947). "A Margaça".

Figure 9 – (Giacometti, 1981)

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EMOTION, PERSONALITY, USE OF MUSIC IN EVERYDAY LIFE AND MUSICAL PREFERENCES

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Abstract

The use of music in everyday life (UofM) is an area with growing interest. Scales for the measurement can be criticized despite their reliability and validity. Additionally, the association of UofM with personality theories has not been carried out thoroughly. Within an ongoing project, the IAAM (Inventory for the measurement of Activation and Arousal modulation by Music) has been constructed. Within the existing study, the reliability and validity of the IAAM-scales are to be examined. The assignment of the IAAM-scales to the biological based BIS-BAS-model (Gray & McNaughton, 2000) should be proven against the explanation of the IAAM-scales by the personality model of Eysenck (1967). Further hypotheses derived from the IAAM-model and past studies are to be tested. 180 undergraduate students completed the IAAM EPP-D, PANAS, BIS/BAS-Questionnaire and the GWPQ-S. Musical preferences were also recorded. Beside item and scale analyses, explorative orientated hypotheses of the scale-personality association were examined by correlation analyses. Using stepwise hierarchical regression analyses, the assignment of the IAAM-scales to both competing biological personality models were tested. Results show that all Cronbach's alpha coefficients of the IAAM-scales are lying above 0.84. The correlation analyses partially confirm the assumed dependencies between the IAAM-scales, personality and music preferences. Regression analyses do not clearly support the integration of IAAM scales into the BIS-BAS-model. Further analyses due to a general problem in measuring the theoretical supposed structure of the personality space by means of used personality questionnaires. Beside this theoretical problem, the IAAM-scales again seem to be reliable and valid and do have strong personality dependencies. This means that the learned strategies of UofM serve as an action theoretical approach to link the effects of music on the brain emotionally with personality based affect susceptibility and behavior.

Keywords: use of music, personality, music preference

1. Introduction

The use of music in everyday life (UofM) is an area with growing interest. Many studies on this topic show that music is used directly or indirectly for influencing the emotional processing of existing states, modulation of momentary attention and concentration faculties and inducing or sustaining social relations (e.g. DeNora, 1999; Sloboda & O'Neill, 2001; Hargreaves & North, 1999; North & Hargreaves, 2004; Juslin & Laukka, 2004; Vorderer & Schramm, 2004; Hays & Minichiello; 2005, Saarikallio & Erkkilä 2007; Saarikallio, 2008; Schäfer & Sedeleier, 2009). All these and other qualitative and quantitative studies imply the existence of underlying nomothetic UofM dimensions. Furthermore studies due to the possibility that UofM may have a strong personality impact. With respect to existing personality theories and models (Eysenck, 1967; Costa & McCrae, 1992), using the MI, (Uses of Music Inventory) Chamorro-Premuzic et al. (2007, 2009, 2012) significant correlations between neuroticism and UofM for emotion regulation were demonstrated. This means that people with high emotional susceptibility use music more intensively and/or frequently to influence

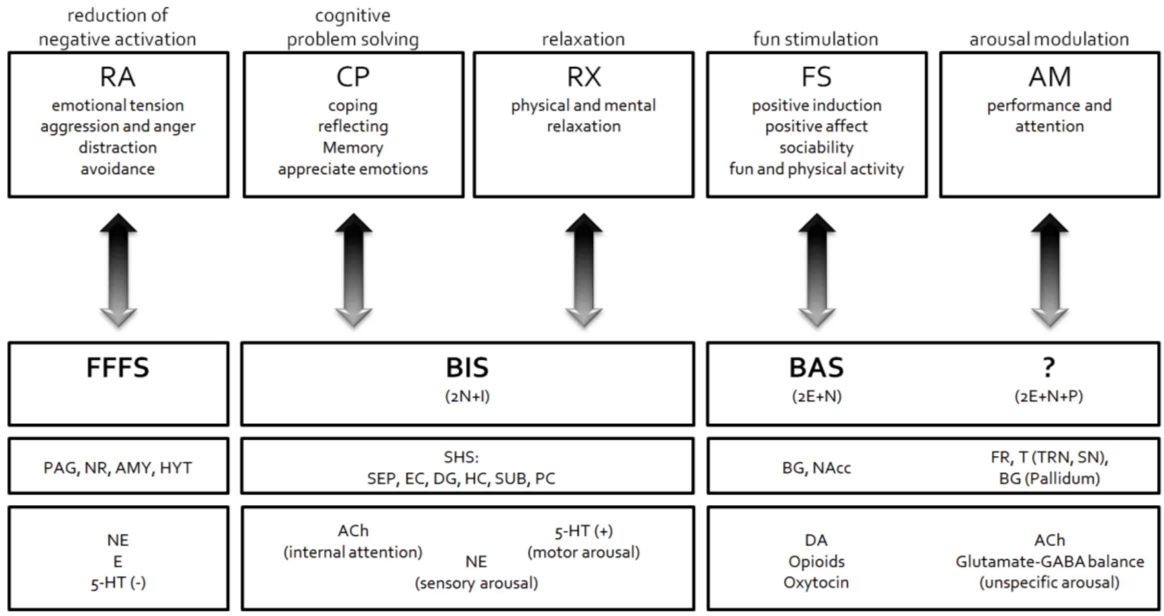

Figure 1. Model of activation and arousal modulation with music (AAM-micromodel) (von Georgi, 2013, in press) (5-HT: 5-hydroxytryptamine; ACh: acetylcholine; AMY: amygdala; BAS: behavioural approach system; BG: basal ganglia; BIS: behavioural inhibition system; DG: dentate gyrus; E: epinephrine; EC: entorhinal cortex; E: extraversion; FFFS: fight-flight-freezing system; FR: reticular formation; GABA: gamma-amino-butyric acid; HC: hippocampus; HYT: hypothalamus; I: introversion; N: neuroticism; NAcc: nucleus accumbens; NE: norepinephrine; NR: raphe nuclei; P: psychoticism; PAG: periaqueductal grey; PC: posterior cingulate; SEP: septum; SUB: subiculum; SHS: septo-hippocampal system; SN: subthalamic nucleus T: thalamus; TRN (thalamic reticular nucleus) (revised model according to von Georgi et al., 2005; 2006b (p.59).

existing emotions and situational affects. Surprisingly the role of extraversion is still unclear. On the basis of the arousal hypothesis, extraversion should be correlated with UofM for background stimulation. This could only be shown in one study. However extraversion seem to be more correlated with a low UofM for emotion regulation. In addition to reliability and validity aspects of the MI, the intercorrelation of extraversion and neuroticism may be additionally responsible for this result. Using the Positive and Negative Affect Schedule (PANAS-state) and the MI, Getz et al. (2012), significant correlations were reported between positive Affect (PA) and UofM for background stimulation as well as between negative Affect (NA) and UofM for emotion regulation. Because of the covariance between the PANAS state and trait scales, these results may also be interpreted in terms of extraversion (PA) and neuroticism (NA) (Watson, 2000).

Contrary to the theoretical framework of Chamorro-Premuzic, the scales of the IAAM (Inventory of Activation and Arousal-Modulation by Music), which is also a questionnaire for the measurement of UofM, are explicitly integrated into the components of the neurophysiological personality model of Gray & McNaughton (2000) (see also: Corr, 2004, 2008). The IAAM does have five scales with ten items per scale and was constructed in 2002 and first presented in 2004 (von Georgi et al., 2004). These five scales measure the UofM for *relaxation* (RX) (e.g. I listen to music when I want to get away from reality, want to find my inner self, need strength not to give in too quickly, want to feel freed of all my burdens), *cognitive problem solving* (CP) (e.g. miss someone, feel hurt by others, need to think about myself, try to solve my problems, want to think about my future), *reduction of negative activation* (RA) (e.g. see no other way out of my problems, want to let out my bottled up anger, when I fear that I could hurt others right now, want to really express my emotions), *fun stimulation* (FS) (e.g. am feeling happy, am in the mood for a good party, want to meet up with my friends, feel like dancing) and *arousal modulation* (AM) (e.g. need to concentrate, have to perform tasks that require my full mental attention, am reading a difficult or exhausting book, need to retain important facts in my memory). All items are answerable on a five-point Likert (0=not at all to 4:very often). An English translation of all IAAM-items is published within von Georgi (2006b, 36-37).

Because of several reasons, which will not be discussed here, the authors do use the term *emotion modulation* instead of *emotion regulation* or *mood regulation* in connection with UofM and the IAAM-scales. The main reason why is because this term emphasizes undirected qualitative aspects of UofM rather than directed quantitative. This means people use music for a qualitative modulation and less for intensifying or attenuating existing affects and emotions (regulation) (von Georgi, in press).

In the assumed theoretical model (Fig. 1), the IAAM scales RX and CP are assigned to the behavioral inhibition system (BIS/Anxiety), RA to the fight-flight-freezing system (FFFS) and FS and AM to the behavioral approach system (BAS/Impulsivity) (see Figure 1 which is the revised version of the original model by von Georgi et al. (2006a, 2006b)). It is assumed that people with high susceptibility in one of these neurophysiological components tend to learn to use music across different situations for the modulation of their frequently and fast arising emotions and affects within situations.

Because of the inconsistent results of the AM scale, this dimension is explained by the Glutamate-GABA-imbalance hypothesis of schizophrenia (Carlsson et al., 1997, 2001): some people are using music as a background stimulus to provoke a constriction of the thalamic filter to enhance concentration processes (von Georgi et al., 2006b; von Georgi, in press). In an unpublished study, people with AM values above the median possess significantly more errors of omissions when completing the d2-Test (Brickenkamp & Zimmer, 1998) without music (n=195) (von Georgi et al., 2008).

Meanwhile there are a sum of studies evaluating the reliability and validity of the IAAM scales with respect to different musicological questions. In all published and unpublished studies, Cronbach's α lies between 0.86 and 0.92 (von Georgi, 2013, in press). Retest reliability (six weeks) lies between 0.85 and 0.91 (von Georgi et al., 2006b) and three of the five scales (RX, RA, FS) are clearly fitting the Rasch model (von Georgi et al., 2006b, 2009b). With respect to the question of the role of UofM for different aspects of everyday life, IAAM scales are additionally correlated with health (von Georgi et al., 2006a, 2006b, 2009a, submitted), psychiatric illness (Gebhardt et al., 2007, in revision), the a possible effect of music therapy (Silina et al., 2012), subjective music chill-sensations (Kunkel et al., 2007) and indeed with personality variables as predicted and musical preferences.

The existing studies mentioned above implicate that RX, CP and RA are related to variables like emotional lability (neuroticism), negative affectivity (NA-trait) and the measurement of the susceptibility of the behavioral inhibition system (BIS/Anxiety) (see fig. 1). RA seems to have an additional aggression/anger aspect, which may be explained by the conjunction with the fight-flight-freezing system (active avoidance). FS is clearly related to extraversion, positive affectivity (PA-trait) and the behavioral approach system (BAS) (see fig. 1). Finally the AM scale goes along with a trait mixture of positive and negative emotions and does have relations with trait constructs like irrational beliefs and strange performance conviction (von Georgi, in press).

However, although these and other studies due to the possibility of the assumed theoretical explanation of the IAAM-dimensions, there is in no study a direct statistical comparison between the model of Gray & McNaughton and another personality model. Within the existing results, all intercorrelations between the IAAM-scales and different personality scales that have been used, can be interpreted alternatively on the basis of the well-known model by Eysenck (1967) and others (e.g. Rammsayer, 2004). This model postulates two basic biological systems which are held responsible for two different personality types: neuroticism (susceptibility of the limbic system) and extraversion (arousal-hypothesis or dopamine-hypothesis). Because of the rotation of the two dimensional personality system of Gray (Anxiety/BIS vs. Impulsivity/BAS) by 30° into the introversion-neuroticism region (see Gray & McNaughton, 2000; Corr, 2007), the majority of the studies with the IAAM show that BIS- and BAS-susceptibility as well as neuroticism and extraversion are correlated with the used criterion variables (e.g. health, music preference).

One method testing the scale-model-assignment is to evaluate the win in prediction by calculating stepwise hierarchical regression analyses (SHR). This is because a factor rotation of 30° is equivalent to a linear combination (Bortz & Schuster, 2010). In terms of regression analysis, this means the first term must be held constant while adding the second term ($Y=b_0 + b_1X_1 + b_2X_2$). For example, the scale RX (see fig. 1) should be best predicted by neuroticism (N) if the Eysenck model is correct for this scale. Otherwise RX may be better predicted by neuroticism (N) adding introversion (negative extraversion): RX=N+(-E). In case of the IAAM-FS-scale a better prediction should be observed by adding neuroticism (FS=E+N) than by extraversion alone (FS=E) (see fig. 1).

2. Method

2.1. Hypotheses

Explorative hypotheses: 1a) do RX, CP and RA correlate with variables indicating an emotional lability or an increased BIS susceptibility? 1b) additionally RA should have additional active avoidance components; 1c) is FS correlated with variables indicating a positive affectivity, sociability and BAS susceptibility? 1d) Is AM correlated with scales measuring aspects of psychoticism; 2) on the basis of existing studies, a musical preference for hard music should be correlated with RA and rhythmic and energetic forms of music with FS.

Hypotheses: Using stepwise hierarchical regression analyses (SHR), the following regression models were tested against each other (p: probability; N: neuroticism; I: introversion (-E); E: extraversion; ⇨: regression on IAAM-scale X).

H1a:	p[N⇨RX]	>	p[(N+I)⇨RX];
H1b:	p[N⇨CP]	>	p[(N+I)⇨CP];
H2:	p[N⇨RA]	>	p[(N+I)⇨RA];
H3:	p[E⇨FS]	>	p[E+N]⇨FS
H4:	p[P⇨AM]	>	[P+(E+N)]⇨AM

H2 and H4 are explorative hypotheses. Especially H4 is derivate from the discussion about the possible rotation of the anxiety- and impulsivity-axis into psychoticism space (e.g. see Zuckerman, 1991, p. 138).

2.2. Procedure

180 undergraduate students of medicine (141 female and 38 male) with a mean age of 20.8 years (SD=3.35; Md=20; min=18; max=40) participated in this study (M_f= 20.6 years (SD=3.59; Md=20; Min=18; Max=40); M_m=21.8 years (SD=1.95; Md=21; Min=19; Max=28). The participants were instructed to complete the following questionnaires: IAAM (von Georgi et al. 2006); EPP-D (Eysenck Personality Profiler - German version: Eysenck et al., 1998); BIS/BAS-Questionnaire (Carver & White, 1994; German version: Strobel et al., 2001); PANAS trait version (Watson et al., 1988; German version: Krohne et al., 1996) and a first German translation of the GWPQ-S (Gray-Wilson Personality Questionnaire - short form by Slobodskaya et al., 2003) which must be reanalyzed by factor and scale analyses because of their low reliability. Additionally the participants were asked about their favorite music preference using the 15 subgenre by Rentfrow & Gosling (2003) as forced choice question (which music do you generally prefer?).

3. Results

3.1. Reliability of the IAAM

Computing Cronbach's α as an indicator of scale reliability (internal consistency) all IAAM-scales are sufficient reliable and above 0.80: RX: α=0.92; CP: α=0.90; RA: α=0.88; FS: α=0.83; AM: α=0.86. With respect to AM, all scales are normally distributed (p>0.05; Kolmogorov-Smirnov-Test).

3.2. Correlation analyses

Table 1 gives the intercorrelations between the IAAM-scales and the personality variables and music preference. As one may see, RX, CP and RA are connected with an emotional instability such as neuroticism and BIS-susceptibility whereas the BIS-scale from the BIS/BAS-Questionnaire shows no intercorrelation with UofM. Moreover RA is correlated with impulsivity-aggression (GWPQ-S-new) and impul-

siveness (EPP-D) and do have a relationship with introversion on one hand and with BAS-susceptibility on the other hand. FS seems to be clearly connected to the scales measuring be clearly connected to the scales measuring extraversion-relevant-behavior or BAS-susceptibility. AM does have connections with the subscales of psychoticism (caution: EPP-D

Table 1. Intercorrelations of the IAAM-scales with personality scales and music preferences

questionnaire	scales	subscales	RX	CP	RA	FS	AM
GWPQ-S-org	BIS	passavoid	,164*	,162*	,201**	,145(*)	,102
		extinction	,116	,088	,071	-,076	,028
	BAS	approach	,066	,090	,207**	,073	,135(*)
		actavoid	,080	,104	,167	-,058	,183*
	FF	flight	-,048	-,042	-,017	,027	,104
		fight	,020	,054	,022	,082	-,090
GWPQ-S	BIS		,113	,117	,119	,071	,007
	BAS		,084	,116	,208**	,052	,212**
	passive reaction control		-,114	-,057	-,062	-,030	-,128(*)
GWPQ-S-new	anxiety		,257***	,230**	,256***	,117	,132(*)
	cognitive behavior control		-,024	,011	,072	-,098	,079
	impulsivity and aggression		,150*	,160*	,231**	,138(*)	,232**
BIS/BAS	BIS		,079	,096	,100	,054	-,002
	BAS		,123	,097	,118	,226**	,132(*)
		drive	,082	,020	,017	,183*	,037
		fun seeking	,116	,105	,151*	,289***	,216**
		reward responsiveness	,140(*)	,135(*)	,150*	,171*	,117
PANAS	positive affectivity (PA)		,155*	,114	,118	,217**	,077
	negative affectivity (NA)		,173*	,225**	,276***	,124	,219**
EPP-D	neuroticism - stability		-,251***	-,320***	-,285***	-,021	-,176*
		inferiority. - self esteem	-,137(*)	-,242***	-,218***	,024	-,074
		unhappy - happy	-,247***	-,346***	-,319***	-,027	-,265***
		hypochondria. - sense of health	-,279***	-,308***	-,297***	-,045	-,163*
		obsessive - casual	-,096	-,058	-,001	-,014	-,012
	extraversion - introversion		,066	,113	,197**	-,110	-,020
		active- inactive	,083	,144(*)	,229**	,028	,051
		sociable - unsociable	,043	-,001	,058	-,248***	-,128(*)
		assertive - submissive	,053	,063	,073	-,111	-,065
		ambitious - unambitious	,012	,115	,192**	,015	,079
	psychoticism		,088	,053	-,054	-,133(*)	-,216**
	(adventure/caution)	impulsive - control	-,181	-,176*	-,231**	-,343***	-,258***
		irresponsible - responsible	,009	-,058	-,103	-,161*	-,254***
		sensation seeking. - unadventure	-,046	,000	-,055	-,141(*)	-,195**
		tough-minded - tender-minded	,120	,153*	,029	,163*	-,073
		practical - reflective	,375***	,256***	,257**	,207**	,226**
music preference	reflexive & complex		,127	,061	-,022	,104	,112
	intense & rebellious		,084	,153*	,222**	,015	,107
	upbeat & conventional		-,066	-,114	-,085	-,187*	-,166
	energetic & rhythmic		-,119	-,094	-,128	,085	-,035

RX: relaxation; CP: cognitive problem solving; RA: reduction of negative activation; FS: positive stimulation; AM: arousal modulation; GWPQ-S-org: original scales of the Gray-Wilson Personality Questionnaire constructed with items of the GWPQ-S (number of items: passavoid (i=2), extinction (i=3), approach (i=6), actavoid (i=4), flight (i=5), fight (i=8)); GWPQ-S : short version of the GWPQ (Slobodskaya et al., 2003); GWPQ-S-new: constructed new scales via factor and scale analyses of the GWPQ-S; BIS/BAS: German version of the BIS/BAS-scale (Strobel et al., 2001); PANAS (trait version) (German version of the Positive and Negative Affect Schedule: Krohne et al., 1996); EPP-D (German version of the Eysenck Personality Profiler: Eysenck et al., 1998). (*): p<0,08; *≤ 0,05; **: p≤0,01; ***: p≤0,001.

extraversion-relevant-behavior or BAS-susceptibility.

Table 1 gives the intercorrelations between the IAAM-scales and the personality variables and music preference. As one may see, RX, CP and RA are connected with an emotional instability such as neuroticism and BIS-susceptibility whereas the BIS-scale from the BIS/BAS-Questionnaire shows no intercorrelation with UofM. Moreover RA is correlated with impulsivity-aggression (GWPQ-S-new) and impulsiveness (EPP-D) and do have a relationship with introversion on one hand and with BAS-susceptibility on the other hand. FS seems to are scales inverted relative to other personality scales).

A preference for hard & rebellious music is conjoint with the UofM for cognitive problem solving (CP) and reduction of negative activation (RA). Contrary to other studies with the IAAM, no correlation between fun stimulation (FS) and a preference for energetic & rhythmic music could be found. However a preference for upbeat & conventional music covaries with a low UofM for fun stimulation. This confirms the results of other IAAM-studies.

3.3. Regression analyses

The best predictor variables for SHR analyses were identified by using correlation and factor analysis of PA, NA, E and N.

Because of the significant intercorrelation of E with N (r=-0.36; p=0,001) and NA with PA (r=0.18 (p=0.014), NA und PA were selected for further analyses because of their lower correlation coefficient and independency from psychoticism. To provide independent predictor variables, the unstandardized residuals of the regression from PA on NA were used (NA_{res}).

SHR analyses do not confirm any of the formulated hypotheses clearly: No additive effect was found with respect to the prediction of RX. In this case adding PA leads to a better prediction of RX. All in all the following statistical results were observed: 1) RX is predicted by NA_{res} (p=0.095) with Δp=0,037 when adding PA (p=0.028); 2) CP and RA are predicted by N_{res} with p_{CP}=0.009 and p_{RA}<0.001. 3) FA is predicted by PA with p=0,004. 4) AM is predicted by P (p=0,004) with no win when adding PA (Δp=0,183) but a significant win when adding NA_{res} as third variable (Δp=0,004) with p<0.001.

4. Discussion

The missing affirmation of the formulated hypotheses at first implies that the model by Eysenck is better for explaining the different forms of UofM measured by the IAAM than the model by Gray could do. But further analyses reverse this interpretation. Predicting the BIS and BAS scales via NA_{res} and PA clearly results in remarkable contrary effects relatively to the theoretical assumptions (p<0.001):

NA_{res}+(-PA)⇨BIS and PA+(-NA_{res})⇨BAS.

The inspection of the geometric relation of the empirical and theoretical personality axis positions are leading to the possibility that especially a BIS-susceptibility is already measured by neuroticism equivalent scales. Because of many studies in personality research which are documenting an intercorrelation of emotional lability and introversion (see also the results of Chamorro-Premuzic et al. (2012) where neuroticism is correlated with extraversion as well), the study at hand does not give an empirical answer to which model better for the explanation of different UofM forms is. This means that an integration of the IAAM-scales into the model of Gray & McNaughton cannot be also rejected. Rather the existing correlation between N and E due to the accuracy of the model of Gray & McNaughton (2000).

Beside this theoretical discussion, the present study shows that UofM for emotion modulation is connected with personality variables and music preference. Further studies to evaluate a possible three way interaction of these variables in connection with additional variables like health, problem behavior or lifestyle should be done.

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BRAIN-ACTIVITY-DRIVEN REAL-TIME MUSIC EMOTIVE CONTROL

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Abstract

Active music listening has emerged as a study field that aims to enable listeners to interactively control music. Most of active music listening systems aim to control music aspects such as playback, equalization, browsing, and retrieval, but few of them aim to control expressive aspects of music to convey emotions. In this study our aim is to enrich the music listening experience by allowing listeners to control expressive parameters in music performances using their perceived emotional state, as detected from their brain activity. We obtain electro-encephalogram (EEG) data using a low-cost EEG device and then map this information into a coordinate in the emotional arousal-valence plane. The resulting coordinate is used to apply expressive transformations to music performances in real time by tuning different performance parameters in the *KTH Director Musices* rule system. Preliminary results show that the emotional state of a person can be used to trigger meaningful expressive music performance transformations.

Keywords: EEG, emotion detection, expressive music performance

1. Introduction

In recent years, active music listening has emerged as a study field that aims to enable listeners to interactively control music. While most of the work in this area has focused on control music aspects such as playback, equalization, browsing and retrieval, there have been few attempts to controlling expressive aspects of music performance.

On the other hand, electroencephalogram (EEG) systems provide useful information about human brain activity and are becoming increasingly available outside the medical domain. Similarly to the information provided by other physiological sensors, Brain-Computer Interfaces (BCI) information can be used as a source for interpreting a person's emotions and intentions.

In this paper we present an approach to enrich the music listening experience by allowing listeners to control expressive parameters in music performances using their perceived emotional state, as detected by a bran-computer interface. We obtain brain activity data using a low-cost EEG device and map this information into a coordinate in the emotional arousal-valence plane. The resulting coordinate is used to apply expressive transformations to music performances in real time by tuning different performance parameters in the KTH Director Musices rule system (Friberg, 2006).

2. Background

The study of users' interaction with multimedia computer systems has increased in recent years. Regarding music, Goto (Goto, 2007) classify systems based on which actions a listener is able to control. He classifies music systems into playback, touch-up (small changes over audio signal, e.g. equalization), retrieval, and browsing. A related research line is the development of systems for automatic expressive accompaniment capable of following the soloist performance expression and/or intention in a real-time basis. Examples of such systems are the ones proposed by Cont et al. (Cont, 2012) and Hidaka et al. (Hidaka, 1995). Both propose systems able to follow the intention of the soloist based on the extraction of intention parameters (excitement, tension, emphasis on chord, chord substitution, and theme reprise). However, none of the above mentioned systems measure the listener/soloist intention/emotion directly from brain activity.

In this paper we propose a system, which allows listeners to control expressive parameters in music performances using their perceived emotional state, as detected from their brain activity. From the listener's EEG data we compute emotional descriptors (i.e. arousal and valence levels), which trigger expressive transformations to music performances in real time. The proposed system is divided in two parts: a real-time system able to detect listeners' emotional state from their EEG data, and a real-time expressive music performance system capable of adapting the expressive parameters of music based on the detected listeners' emotion.

2.1. Emotion detection

Emotion detection studies have explored methods using voice and facial expression information (K. Takahashi, 2004). Other approaches have used skin conductance, heart rate, and pupil dilation (Parala et.al, 2000). However, the quality and availability of brain computer interfaces has increased in recent years, making easier to study emotion using brain activity information. Different methods have been proposed to recognize emotions from EEG signals, e.g. (Chopin, 2000; Takahashi, 2004; Lin, 2010), training classifiers and applying different machine learning techniques and methods. Ramirez and Vamvakuosis (Ramirez, 2012) propose a method based on mapping EEG activity into the bidimensional arousal/valence plane of emotions (Eerola, 2010). By measuring the alpha and beta activity on the prefrontal lobe, they obtain indicators for both arousal and valence. The computed values may be used to classify emotions such as happiness, anger, sadness, and calm.

2.2. Active music listening

Interactive performance systems have been developed in order to make possible for a listener to control music based on the conductor-orchestra paradigm. This is the case of the work of Fabiani (Fabiani, 2011) who use gestures to control performance. Gesture parameters are mapped to performance parameters adapting the four levels of abstraction/complexity proposed by Camurry et al. (Camurry, 2001). This level of abstraction range from low level parameters (physical level) such as audio signal, to high level parameters (semantic descriptors) such as emotions. Thus, gesture analysis is done from low to high level parameters, whereas synthesis is done from high to low level parameters. The control of mid and low level parameters of the performance is carried out using the KTH rule system by Fidberg (Friberg, 2006)

2.3. Expressive music performance

The study of music performance investigates the deviations introduced to the score by a skilled musician in order to add expression and convey emotions. Part of this research consists in finding rules to model these performance modifications that musicians use. Such is the case of the KTH rule system for music performance, which consists of a set of about 30 rules that control different aspects of expressive performance. These set of rules are the result of research initiated by Sundberg (Sundberg, 1983; Friberg, 1991; Sundberg, 1993). The rules affect various parameters (timing, sound level, articulation) and may be used to generate expressive musical performances. The magnitude of each rule is controlled by a parameter *"k"*. Different combinations of k parameters levels model different performance styles, stylistic conventions or emotional intention. The result is a symbolic representation that may be used to control a synthesizer. A real-time based implementation of the KTH system is the pDM (Pure Data implementation of Director Musices Profram) by Friberg (Friberg, 2006). Friberg implements an arousal/valence space control, defining a set of k values for the emotion at each quadrant of the space. Seven rules plus overall tempo and sound level are combined in such a way that they clearly convey the intended expression of each quadrant based on the research by Bresin et al. (Bresin, 2000) and Juslin (Juslin, 2001). Intermediate values for "k" are interpolated when moving across the space.

3. Methodology

Our proposed approach to real-time EEG-based emotional expressive performance control is depicted in Fig. 1. First, we detect EEG activity using the Emotiv Epoch headset. We base the emotion detection on the approach by Ramirez and Vamvakousis (Ramirez, 2012). We measure the EEG signal using electrodes AF3, AF4, F3, and F4, which are located on the prefrontal cortex. We use these electrodes because it has been found that the prefrontal lobe regulates emotion and deals with conscious experience.

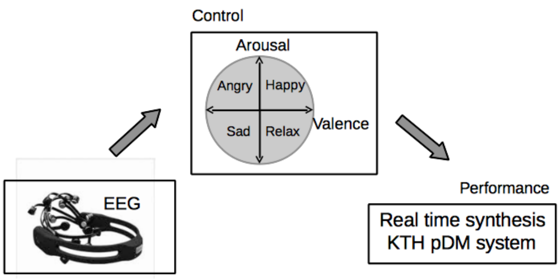

Figure 1. Theoretical frame work for expressive music control based on EEG arousal - valence detection.

We model emotion using the arousal-valence plane, a two dimensional emotion model which proposes that affective states arise from two neurological systems: arousal related to activation and deactivation, and valence related to pleasure and displeasure. In this paper we are interested in characterizing four different emotions: happiness, anger, relaxation, and sadness. As depicted in Figure 1, each studied emotion belongs to a different quadrant in the arousal valence plane: happiness is characterized by high arousal and high valence, anger by high arousal and low valence, relaxation by low arousal and high valence, and finally sadness by low arousal and low valence.

3.1 Signal reprocessing

Alpha and Beta waves are the most often used frequency bands for emotion detection. Alpha waves are dominant in relaxed awake states of mind. Conversely Beta waves are used as an indicator of excited mind states. Thus, the first step in the signal preprocessing is to use a band pass filter in order to split up the signal in order to get the frequencies of interest, which are in the range of 8-12 Hz for alpha waves, and 12-30 Hz for beta waves.

After filtering the signal we calculate the power of each alpha and beta bands using the logarithmic power representation proposed by Aspiras & Asari (Aspiras et al., 2011). The power of each frequency band is computed by:

$$LP_f = 1 + \log(\frac{1}{N}\sum_{n=1}^{N}(x_{nf})^2)$$

Where x_{nf} is the magnitude of the frequency band *f (alpha or beta)*, and N is the number of samples inside a certain window. Hence, we are computing the mean of the power of a group of N samples in a window and then compressing it by calculating the logarithm of the summation.

3.2 Arousal and valence calculation

After the band power calculation, the arousal value is computed from the beta/alpha ratio. Valence is calculated based on the asymmetric frontal activity hypothesis, where left frontal inactivation is linked to a negative emotion, whereas right frontal inactivation may be associated to positive emotions. Thus arousal and valence are calculated as follows:

$$arousal = \frac{b_{F3} + b_{F4}}{a_{F3} + a_{F4}}$$

$$valence = \frac{a_{F4}}{b_{F4}} - \frac{a_{F3}}{b_{F3}}$$

where b_{F3}, b_{F4}, a_{F3} and a_{F4} are respectively the beta and alpha logarithmic band power of electrodes F3 and F4.

The values obtained for arousal and valence are calculated using sliding windows over the signal in order to obtain a more smooth data. It is worth noting that there are not absolute levels for the maximum and the minimum values for both arousal and valence, as these values may differ from subject to subject, and also vary over time for the same subject. To overcome this problem we computing the mean of the last five seconds of a 20 second window and normalize the values by the maximum and minimum of these 20 sec window. This way we obtain values that range between minus one and one. We consider a window size of 4 seconds with 1 second hop size.

3.3 Synthesis

For synthesis we have used a real-time based implementation of the KTH group, pDM (Pure Data implementation of Director Musices Program) (Friberg, 2006). Thus, the coordinate on the arousal-valence space is mapped as an input for the pDM activity-valence space expressive control. In our implementation, this control is adapted in the pDM program, so the coordinates are rotated to fit the ones of the arousal valence space. Then the transformation of each of the seven expressive rules takes place by interpolating 11 expressive parameters between four extreme emotional expression values (Bressin and Friberg, 2000).

3.4 Experiments

Two types of experiments were performed: a first one listening while sitting down and motionless and the other listening while playing (improvising) with a musical instrument. In both the aim was to evaluate whether the intended expression of the synthesized music corresponds to the emotional state of the user as characterized by his/her EEG signal. In both experiments subjects sat down in a comfortable chair facing two speakers. Subjects were asked to change their emotional state (from relaxed/sad to aroused/happy and vice versa). Each trial lasted 30 seconds with 10 seconds between trials. In experiment one the valence is set to a fixed value and the user tries to control the performance only by changing the arousal level. In experiment 2 the expression of the performance is dynamically changed between two extreme values (happy and sad), while the user is improvising playing a musical instrument. A 2-class classification task is performed for both experiments.

4. Results

The EEG signal and the corresponding calculated normalized arousal is shown in Figure 2. Vertical lines delimit de beginning and ending of each subtrial, and are labeled as "up" for high arousal and "down" for low arousal. The horizontal line represents the arousal average of each class segment. It can be seen how the calculated arousal corresponds to the intended emotion of the subject, and how the 2 classes can be separated by a horizontal threshold. However, further work should be done in order to obtain a smoother signal.

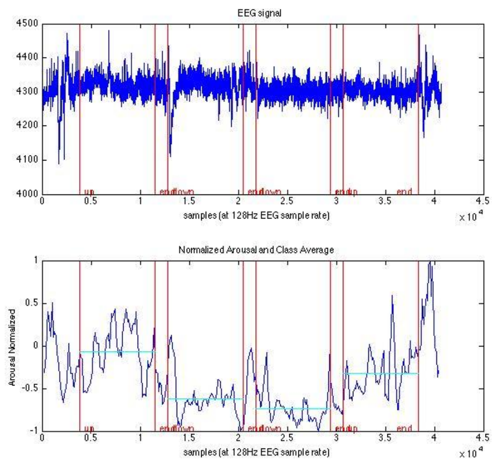

Figure 2. A subject's EEG signal (top) and calculated arousal (bottom). Vertical lines delimit each subtrial for high arousal (1^{st} and 4^{th} subtrials) and low arousal (2^{nd} and 3^{rd} subtrials). Horizontal line represents the average of each class segment.

Two classifiers, Linear Discriminant Analysis and Support Vector Machines, are evaluated to classify the intended emotions, using 10 cross fold validation. Initial results are obtained using the LDA and SVM implementations of the OpenVibe library (OpenVibe, 2010). Our aim was to quantify in which degree a classifier was able to separate the two intended emotions from the arousal/valence recorded data. For high-versus-low arousal classification we obtained a 77.23\% for active listening without playing, and 65.86\% for active listening when playing an instrument (improvising) along the synthesized expressive track, using SVM with radial basis kernel function. Results were obtained using 10-fold cross validation.

Initial results suggest that the EEG signals contain sufficient information to classify the expressive intention between happy and sad classes. However, the accuracy decreases, as expected, when playing an instrument. This may be due to the fact that the action of playing requires attention, thus, the alpha activity may remain low and beta may remain high

5. Conclusions

In this paper we have explored an approach to active music listening. We have implemented a system for controlling in real-time the expressive aspects of a musical piece, by means of the emotional state detected from the EEG signal of a user. We have perform experiments in two different settings: a first one where the user tries to control the performance only by changing the arousal level, and a second one where the performance is dynamically changed between two extreme values (happy and sad), while the user is improvising playing a musical instrument. We applied machine learning techniques (LDA and SVM) to perform a two class classification task between two emotional states (happy and sad). Initial results, in the first set where the subject was sitting still, suggest that EEG data contains sufficient information to distinguish between the two classes.

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MUSIC AND DISSOCIATION: EXPERIENCES WITHOUT VALENCE? 'OBSERVING' SELF AND 'ABSENT' SELF

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Abstract

Empirical studies of music listening in everyday life frequently frame individuals' experience of music primarily in terms of emotion and mood. Yet emotions - at least as represented by categorical and dimensional models of emotion - do not account for the totality of subjective experience. This is particularly apparent in the case of a range of so-called 'alternate' or 'altered' states of consciousness including 'flow', aesthetic and spiritual experiences. Some researchers have responded by highlighting the process of absorption (effortless attention) within significant experiences of music. To date however, the role of dissociation (detachment), the counterpart of absorption, has received little research attention outside ethnomusicological accounts of ritualistic trance. This paper explores the importance of dissociation to everyday musical experiences, drawing on findings from the author's past and ongoing empirical studies of psychological processes of everyday involvement with music in 'real-world' UK contexts. Free phenomenological reports from unstructured diaries compiled by participants aged 9-85 indicate dissociation from self, surroundings or activity in conjunction with music is a common occurrence in everyday life, particularly for teenagers. Significantly, a number of experiences appear to possess neither positive nor negative valence, instead functioning to offer a relief from aspects of self (emotion and thought). Dissociation and Absorption are accepted characteristics of trance in hypnotherapeutic literature. Results from the data discussed here suggest that moves away from a perceived baseline state of consciousness in conjunction with hearing music in daily life are a common phenomenon and that such experiences may facilitate freedom from emotion.

Keywords: dissociation, altered states, consciousness

1. Introduction

Despite widespread acceptance that emotion and mood constitute components within the broader field of affective science, and that musical effect can encompass spiritual and aesthetic experiences (Juslin & Sloboda, 2010: 8), 'real-life' studies of everyday musical engagement continue to frame the way individuals experience music primarily in terms of emotion and mood. This accords with an established tradition, traceable to the ancient Greek notion of catharsis, of conceptualizing musical experience in terms of emotion (Cook & Dibben, 2010: 47). In their consideration of the current state of music and emotion research, Lamont and Eerola (2011), echoing Juslin and Sloboda (2010) noted the continued inconsistency in the use of terms such as affect, mood, feelings, observing the need for studies to distinguish between felt (induced) and recognized (perceived) emotion, and the utility of music-specific models of emotion and ecologically valid musical stimuli. These points have been reiterated by Eerola and Vuoskoski in their review of the field (2013). The latter authors also highlight the theoretical dominance of categorical and dimensional emotion models, calling for greater theoretical reflection and use of a broader range of data collection methods, including experience sampling and diary studies (2011: 326).

There is a danger that researchers examining experience from the exclusive vantage point of particular theoretical frameworks (in this case emotion) can end up excluding particular elements of the totality of subjective experience. Despite increasing recognition of 'music experiences that do not clearly fall within the category of emotional responses' (Juslin & Sloboda, 2010: 940), study of the phenomenology of altered states of consciousness (ASC) with music, including aesthetic and spiritual experiences, remains at an early stage of development, perhaps partly because of its inherently cross-disciplinary focus (referencing the fields of consciousness studies, hypnotherapy, music therapy etc). Notable exceptions have been the study of strong experiences with music (Gabrielsson, 2011; Lamont, 2011), everyday trancing with music (Herbert, 2011), studies of trait absorption (effortless involvement) and music (Snodgrass & Lynn (1989); Nagy & Szabo, (2003); Garrido & Schubert (2011)) and theorizing regarding music and consciousness (Clarke & Clarke, 2011).

Dissociation, unlike absorption has rarely been a principal focus of musical research. Studies including dissociation as a central focus include the present author's work (Herbert, 2011; Herbert forthcoming), Garrido and Schubert's (2011) study of the contribution of trait dissociation to enjoyment of negative emotions in music and a brief overview of music and dissociation by Becker-Blease (2004). Other work has identified the dissociative potential afforded by sound technologies (e.g. Bull, 2003, 2007; Heye & Lamont, 2010) and touched on dissociative uses of music e.g. amongst teenagers as a diversion from stress (Saarikallio & Erkkilä, 2007:98) or means of 'suppression' or 'distraction' (Helsing et al (2012: 413-4) but these studies reference *aspects* of dissociation rather than the totality of the construct. In the field of ethnomusicology dissociation has long been accepted as an intrinsic component of possession trances featuring music.

The term dissociation refers to a disconnection between usually integrated mental processes, which serves to transform consciousness. Spiegel et al. (2011: 825) have observed that 'neither the DSM-IVTR of the American Psychiatric Association (APA) nor the ICD-10 of the World Health Organization (WHO) provides a comprehensive definition of dissociation'. Neither is there a consensus as to whether pathological and nonpathological (normative) dissociation are separate constructs or instead shade into one another along a continuum. Absorption is sometimes equated with normative dissociation (e.g. Butler, 2006; Garrido & Schubert, 2011), although others argue that absorption involves attentional focus on limited stimuli whereas the *exclusion* of stimuli from consciousness is key to dissociative experience. The Dissociative Experiences Scale (DES) suggests a three-factor structure, consisting of absorption, depersonalisation/derealisation and amnesia. However, because - to date - all psychometric measures of dissociation are designed for use in clinical as opposed to normal populations, they may not accurately tap nonpathological dissociation. In hypnotherapeutic literature absorption and dissociation are recognized as key components of trance, including both trances facilitated via an induction by a hypnotherapist in a clinical context and those occurring spontaneously outside such contexts (Spiegel, 2005).

In sum, the role of dissociation in musical experience merits phenomenological exploration and clarification. The current paper draws on results from two studies (past and ongoing) designed to explore the phenomenology of everyday experiences of music in naturalistic settings. The overarching aims of the first study (2005 - 2007) were: 1. to explore the psychological processes present in everyday music listening experiences and the range of consciousness they encompass; 2. to compare musical and non-musical everyday experiences. The overarching aims of the second study (2012 - 2015) are: 1. to explore the psychological characteristics of young people's (aged between 10 and 18) subjective experiences of music in daily life; 2.To assess the impact of age, musical training and personality upon musical involvement. This paper focuses on findings from both studies relating to dissociative experiences with music. (It relates only to the first stage (of three) of the second study as this project is in its early phase.)

2. Method

2.1. Participants

In Study 1, purposive sampling was used to recruit 20 unpaid volunteers (8 males, 12 females, ranging from 18 to 71 years (mean age 46). Level of musical involvement was assessed by interview questions drawing on Greasley & Lamont's (2006) research on musical engagement. In Study 2, purposive sampling was used to recruit 34 participants (18 males, 16 females) ranging from 9 to 18 years (mean age 14.2). Level of musical involvement was assessed using the Music USE (MUSE) questionnaire (Chin & Rickard, 2012).

2.2. Procedure and Materials

In Study 1 participants received an introductory letter and information sheet prior to completion of written consent. Individuals completed semi-structured interviews c. 1 hour in length. Approximately three months later participants recorded their music listening experiences over two weeks in an unstructured diary. Prior to the negotiated start date each participant received a diary information and instructions sheet. Study 2 replicated the procedure of the first study, but materials were adapted for the age range (e.g. two different age appropriate interview schedules were used, for children and older adolescents respectively. In both studies, interviews and diaries were subjected to Interpretative Phenomenological Analysis (IPA), a qualitative, idiographically focused methodology commonly used by UK researchers in the fields of social sciences and health.

3. Results

Analysis of data relating to dissociation from Studies 1 and 2 highlighted three superordinate thematic categories: 1. *Changed self*; 2. *Absent Self;* 3. *Observing self*. Dissociative processes of derealisation and depersonalisation were intrinsic to all three categories.

1) Changed Self

"In one piece – something by 'Basshunter' ... I just see myself in some random road ... floating in the air, moving stuff with my mind...Well, it wouldn't be a road it would sort of...I would be randomly in the middle of the playing fields just sort of controlling the weather 'Basshunter's very techno-modern and it is easier to access it in the techno-modern music because it is very ... sort of bass dominated ...
Q. This is regular this accessing?...
R. Yes. Daily. Sort of alternate world sort of thing... because I don't really like ***my*** *world a lot". [John, 17]*

"I've had places I go with my mind from when I first got my iPod, which was five years ago... Listening to contemporary classical music [Einaudi] kind of takes me off into a different place where I don't think about homework - a calming place ... I'm in front of my dolls house where I used to play with my Sylvanians - and I used to spend hours and hours creating stories ... and I kind of go there. I'm not watching myself play, it's actually me there with them and the music". [Mei, 14]

Free descriptions from the second study indicated that young people's experiences of listening to music frequently demonstrated a strongly dissociative element, allowing detachment from stressful thoughts, situations or simply (very common) boredom. Music also afforded a means of experimentation with alternative selves or identities (a particularly common practice in adolescence) facilitating a temporary relief from the 'burden of selfhood' (Baumeister, 1991). Experiences demonstrated a selective attentional focus with diminished awareness of surroundings and increase in internal imagery and possessed either a positive or negative valence. Individuals visualized themselves in fictional or fantastical contexts (as in the first extract above), or in happy, safe scenarios, often relating to childhood (as in the second extract). In both studies travel was the most common context for dissociative experiences of this type.

2) Absent Self

"On the bus listening [to metal] I start looking out and I do know I am looking out and then eventually there is just a fade where I am just unaware that I am unaware ... kind of inside the music, disappearing ... it's not positive or negative, just about an alternative space, somewhere else to go ... I am not aware of myself, I am just aware of the track, like the track is my thoughts" [Jake, 15]

"If I'm really tired I put on what I call my 'white noise' sort of music ...non diegetic sound like Lemon Jelly, Flying Lotuses ...I have it in my ears to create a more pleasant environment ...it's not real, it's definitely not the real world, just somewhere where I've got this absent minded sort of blank non-state" ... [James, 18]

"A mix between opportunities within the scope of the compilation – let's say an hour and a half to escape, but also moments where you're re-engaging if you like ... it has periods of ambience which are really quite dreamy, which are the escape bits. And then there are the more rhythmic, funky tracks as well. So, the moments where it's dreamy are where I would feel most comfortable with who I am, because it's a space you've created that you can disappear into ... And the rhythmic tracks are ... kind of bringing you back into consciousness" [Gary, 33]

"Filling in children's assessment files. Music track finishes; I stretch and yawn. Gaze at the shadows on the wall created by chair legs . . . one spot about three metres away where my eyes came to rest. Mind quite blank. Realise that I am still tapping the rhythm of the music on to my highlighter pen – unaware of this before" . . . [Gabrielle, 27]

A significant number of reports referred to experiences in which sense of self – both self in the moment and an 'autobiographical' self, where past experience colours or shapes perception (Damasio, 1999) – retreat from awareness. Rather than a sustained preoccupation (absorbed focus) on stimulus properties of music or sources specified by music (e.g. associations and memories), the prime intention appeared to be to dull consciousness, either by flooding or numbing it. Music provided an initial platform or informal induction for dissociative experience then receded from conscious awareness, (fulfilling a function equivalent to the spoken inductions given by hypnotherapists in clinical contexts). Experiences often occurred when individuals were tired or bored and were characterized by a gradually narrowing field of awareness (described as 'a fade' by Jake).The subsequent absence of perceived sense of self was accompanied by a dissociation of affect - a 'nothingness' or 'void', rather than feeling of relaxation or peacefulness - resulting in experiences that were neither positive nor negative in valence. Recurring terms used by participants to describe this were 'unaware', 'disappearing' (as in experience 1), 'absent minded', 'blank non-state' (experience 2) 'escape' (experience 3). Whilst there was no causal relationship between musical characteristics and transformations of consciousness, cross-comparison of written reports suggested that for these two participant samples, certain musical features appeared to support or afford dissociative consciousness shifts of this nature e.g. repetitive loops, uniform dynamic (unchanging extremely loud or quiet dynamic) or affect, slow rate of musical change, absence or 'flat' expression. A small number of descriptions described extreme instances of spontaneous dissociation in conjunction with music (as in experience 3), marked by retrospective awareness of previous blankness William James (1890: 404) termed such shifts of consciousness 'vacancy' or 'absence.'

3) Observing self

When walking home after school the music became a soundtrack to my life. I could imagine the opening scene of a film with me walking, seen from my right side. . . . I was focused on the music, the pavement in front of me and my steps . . . my body moving in time with the music . . . The street was completely empty... I think about things and my mind is empty.

[Jimi, 18]

Translate landscapes from train window into bird's eye perspective – hard to explain really, basically seeing things from above. It's a combination of things – claustrophobia of a train, staring out of window at blurred, changing views, repetitive movement and recent music memories running through my head, altering my perception of reality a bit. Takes me away from humdrum internalized thoughts and worries and gives me a different 'bigger picture' angle on things. Hard to rationalize exactly what's going on – some sort of (slight) out-of-body experience thing . . . I'm not 'me' looking out . . . [Max, 46]

Steve Reich is in the CD player . . . feels risky, like driving on a glass of wine . . . feel absorbed in emotionless patterns . . . traffic slows as we approach town outskirts and I feel curiously remote . . . Pedestrians at junction look paper thin, almost alien, I have no connection with them: or rather, I do have a connection but am observing it and them. [Will, 57]

By contrast with instances in which music was used to cut off from or block out internal or external phenomena, a number of reports from the two studies referred to situations in which music reconfigured experience of self and surroundings in unexpected or unfamiliar ways. In particular, a disjunction or conflict between musical characteristics (e.g. the mood represented by music, extra musical associations) and current listening scenario (understood as a composite of mental state, intention, immediate circumstance, patterns of response to music accumulated over time) promoted a sense of derealization. Experiences demonstrated an equanimous attentional focus, were multimodal, and heteronomous (hearing, looking, thinking) and music was perceived as indivisible from or blending with surroundings, which might take on a preternatural or dream-like quality (as in experience 3 above). Individuals described observing themselves at one remove, as if through the eyes of another (e.g. Jimi watches himself walking as if in a film, Will observes his connection with pedestrians) i.e. from a third person perspective. Free descriptions suggested that dissociative episodes of this type could be positively valenced (experience 2), negatively valenced (experience 1) or without valence (experience 3). Some episodes featured a focus on simple awareness, as opposed to thoughts and feelings (as in experience 2) suggesting a dissociation from self via deautomatization of thought, i.e. 'an undoing of the automatic processes that control perception and cognition' (Deikman, 1982: 137). Such episodes featured a sharpening of consciousness and an inclusive sense of experiencing 'things as they are', reminiscent of the Buddhist practice of insight meditation, i.e., 'attention to, yet detachment from, the object of meditation, which may be the meditator's own stream of consciousness' (Pekala, 1991: 40). At such times a perceived 'everyday' self appeared to have been replaced by an alternative 'observing self' (Deikman, 1982).

4. Conclusion.

Music is subjectively experienced in a diverse number of ways, not all of which fall into the category of emotional response. The phenomenon of dissociation is a case in point.

The emphasis in psychological and medical literature on pathological manifestations of dissociation has served to mask its adaptive potential as a normative defence or coping mechanism that enables individuals to temporarily insulate or release themselves from stressful situations, the constraints of subjective experience (including aspects of self, identity, highly aroused emotional responses, negative rumination) and consensual reality. Free phenomenological report from two studies of the subjective experience of music in daily life in the UK suggests that music is a popular and versatile facilitator of normative dissociation. Music's portability, its polysemic potential and invisibility (in recorded form) mean that it is a particularly effective mediator of experience, a medium individuals can turn to when too distracted or tired to engage with semi-prescriptive activities such as reading.

Because dissociative experiences with music are not primarily 'about' emotion, they have not attracted as much research attention as other instances of consciousness transformation (notably peak experiences with music).

The phenomenology of such experiences merits further study.

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AN EMOTION-BASED METHOD TO PERFORM ALGORITHMIC COMPOSITION

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Abstract

The generative music using algorithmic composition techniques has been developed in many years. However it usually lacks of emotion-based mechanism to generate music with specific affective features. In this article the automated music algorithm will be performed based on Prof. Phil Winosr's "MusicSculptor" software with proper emotion parameter mapping to drive the music content with specific context using various music parameters distribution with different probability control, in order to generate the necessary music emotion automatically. When the emotion scenario varies, the generative music will be logically made via the emotion and context control based on the emotion music classification method. This innovative technique not only generates the emotion music according to the scenario, but also plays the different content of the music every time to make listeners feel "fresh". The emotion music classification method and the automated music development can be analyzed as the reference for the input of the automated music program. The result shows the proposed method generating music emotions successfully such as happy, angry, sad, and joy, with the correspondent parameter mapping between music and emotion. Although this paper only demonstrates the possibility of emotion-based algorithmic composition, hopefully the proposed idea can be extended to apply into the fields including multimedia and game, to make the background music automatically generated any time according to the context changed by the interaction between human and machine.

Keywords: algorithmic composition, automated music algorithm, emotion music classification

1. Introduction

This paper is mainly based on the automated composition technique to generate emotion-based music via Prof. Phil Winsor's "MusicSculptor" software. Automated composition or so-called algorithmic composition can be implemented with probability control with musical style synthesis (Cope, 2004), to generate music with intelligence in experimental way (Cope, 1987 & 1992).

Emotion and music can be related and mapped with their various features. A 2D emotion model was established with arousal and valence to define the emotion (Thayer, 1989), and the related music features can be mapped with emotion features (Gabrielsson and Lindstrom, 2001). For instance, tempo, mode, loudness, melody, and rhythm can be related to emotion expression. In this paper, the proposed way is to use Prof. Phil Winsor's "MusicSculptor" program to compose a section of emotion-based music automatically in an experimental way (Duarte, etc, 2006) with proper music parameter settings.

2. Emotion-Music Feature Mappings

The proposed way to generate music with desired emotions such as happy, angry, sad, and joy, with the correspondent parameter mapping between music and emotion, is based on the 2D emotion plane (Wagner, Kim, & André, 2005), as shown in Fig. 1. The X-axis stands for positive/negative emotion, which is the valence of the emotion, where Y-axis represents the arousal of the emotion for exiting/calm.

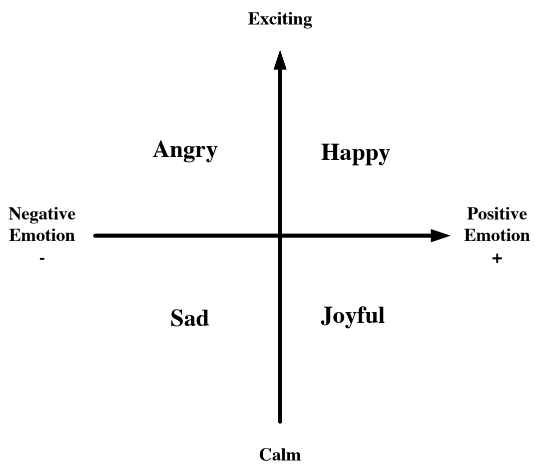

Figure 1. 2D Emotion Plane

After the desired emotion coordinate is determined by the 2D emotion plane, based on Haag's article (Haag, 2004), Table 1 is summarized and extracted with all of the music parameters into a mapping table with the composition method for the emotion-based generative music.

Table 1. The Composition Method for Emotion-based Music Parameter Mapping

Music Parameter	**Composition Method**
Mode	Major – Minor
Tempo	Fast – Slow
Harmony	Simple -- Complex Melodic
Loudness	Soft – Medium -Loud
Articulation	Staccato – Legato
Pitch	High – Low
Rhythm	Flowing – Smooth – Rough – Activity – Complex – Firm
Pitch Range	High – Low
Pitch Variation	Large – Small
Pitch Contour	Up – Down
Note Onset	Rapid - Slow - Sharp
Loudness Variation	Rapid - Few - Small
Timbre	Few - Many – Sharp
Vibrato	Fast - Deep – Intense
Meter	Triple – Duple
Tonality	Tonal - Atonal – Chromatic

3. Algorithmic Composition

Algorithmic composition is implemented with algorithms. The total randomized music can be automatically generated easily with random function, however it lacks of any musical rules and algorithms to control the music progression. In 1950's Lejaren Hiller and Leonard Isaacson used computer by Illinois University to compose music automatically, with the composition of ILLIAC Suite (Xenakis, 1959). Stochastic process and "Sieve" theory (Ariza, 2005) is used to generate music in a formulized way (Xenakis, 1971) automatically. Our proposed way to compose emotion-based music automatically is according to 2D emotion model, and control emotion-based music features such as pitch, rhythm, velocity (dynamic), articulation (duration), tempo, and timbre, which can be set up by MusicSculptor program (Winsor, 1992). Please refer to Fig. 2 for the proposed automated emotion-based music composition method. Every time the music composed with the same parameter settings, however the music result is different due to the random number function, even though the emotion expression is consistent.

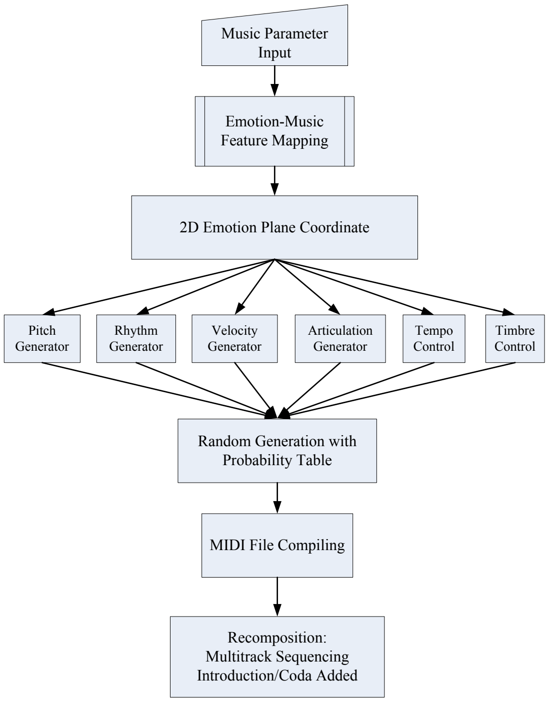

Figure 2. The Proposed Automated Emotion-based Music Composition Method.

Sieve Theory becomes one of the most important theories to generate pitches within a specific scale when the scale is defined by the user. The function is described as below, where RP means Random Pitch, where $0 \leq RP \leq 127$, and RC refers to Residue Class.

$$RC = RP \bmod 12$$

For example, if Chinese Pentatonic Scale is selected, the RC set (RC) is {0, 2, 4, 7, 9}; for Japanese Five Tone Scale, the RC set (RC) is {0, 2, 3, 7, 8}, and for Balinese Pelog Scale, the RC set (RCB) is {0, 1, 3, 7, 8}.

4. Using MusicSculptor for Emotion-Based Music Generation

The automatic composition function included with MusicSculptor is designed to produce an anonymous stream of "musical wallpaper" in the ubiquitous environment. Our proposed way is to compose unique pieces of emotion-based music within a specific emotion style using probability distribution table. The sieve function to generate music scale is also considered (Duarte, etc., 2006).

Fig. 3 shows the inter-onset time distribution table by MusicSculptor.

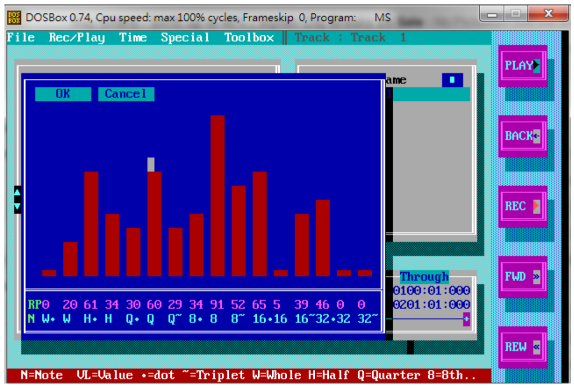

Figure 3. The Inter-onset Time Distribution Table.

Pitch class settings can be implemented with the distribution table too, and Fig. 4 shows the example of a pentatonic scale with a higher octave range to express "happy" emotion.

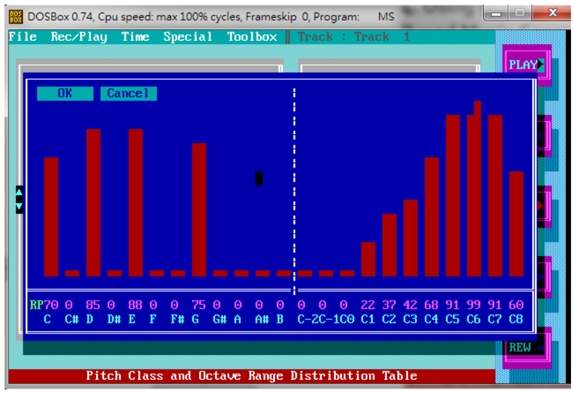

Figure 4. The Pitch Class and Octave Range Distribution Table.

Fig. 5 and Fig. 6 show the velocity distribution table and the duration range setting, which can be used to generate various emotion expressions too.

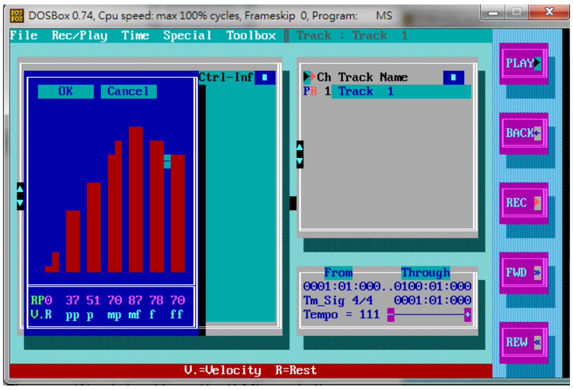

Figure 5. The Velocity Distribution Table.

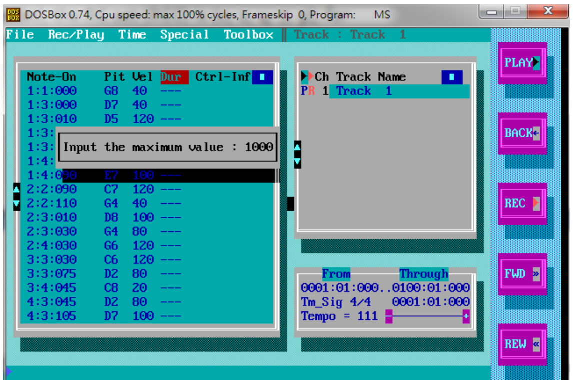

Figure 6. The Duration Range Setting.

5. Conclusion

This experimental result of the proposed music generation is to relate both music and emotion features, and the following a few points is summarized.

1. User can compose music easily by our proposed way using MusicSculptor.
2. The emotion that user would like to express is mapped to music features.
3. Style imitation is currently not considered yet, and users can compose their music in a specific emotion (Angry or Happy, for instance) simply.
4. Melody generation is based on thematic development with PC (pitch class) distribution table, according to the music-emotion feature mapping.
5. The system will synthesize MIDI file to produce the musical pieces with emotion characteristics.
6. In the future the emotion-based music can be generated in more efficient way with the implementation of Java or C languages and proper GUI design.

6. Acknowledgment

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THE AUTOMATED EMOTIONAL MUSIC GENERATOR WITH EMOTION AND SEASON FEATURES

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Abstract

Nowadays, there are various types of automated music generating systems to automatically compose music clips instantly; however, those randomly-generated music clips still sounded uncomfortable and discordant. This paper attempts to add with emotion and season features to assist automated music generating systems based on algorithm, and then tries to make all generative music clips sound with harmonious and emotional meaning to listeners. The automated music generator used in this topic is not only based on algorithm but also adopts Thayer's emotional model as well as four season factors, so all music clips will not only express unique music emotions but also indicate all seasons which may match to equivalent emotions. In the experiments for this automated music generator, the resultant music is generated from high-valence presets presented as positive emotions and warmer seasons, while the opposite side presented as negative seasons as well as colder seasons. Furthermore, this kind of automated music generator can be used at the occasion of children or elders' caretaking so that the children or elder people's mood would be cheered up while listening to those enlightened music clips generated by the proposed music generator.

Keywords: algorithm, automated music generator, emotion, season

Preface

Composing and playing music scores and songs automatically is always the direction everyone struggling for, and people who expert in music and computer work together to develop systems which could automatically and randomly generate music clips. They tried to utilize their in-depth studies in music composition, algorithm, programming and user interface design altogether, and then began to develop an automated music generator which includes generating random music clips that based on algorithm. Since automated music generator seems to be difficult for ordinary users, it is very important to reduce the difficulty of operating progress, complexity of user interface, and generate melodic music clips.

Another issue in this article is season factors. Different seasons may affect or reflect users' moods, and the automated music clips perform as well; one of the typical examples is *The Four Seasons* by Antonio Vivaldi, he depicted four unique features on each season, like the chilling *Winter* and the stormy *Summer* movements (Wikipedia, 2013a). These images of each season are transformed into melodic symphonies, and people may reflect their emotions by playing the music, just like Vivaldi did before.

1. Reference Reviews

1.1. Automated Music Generator

The automated music generator is the primary issue in this article, and people will use this kind of system to generate random emotional music clips in a few seconds. This way can help users to create their favorite music clips easily, and randomly-generated music clips will show different melody, and they would feel the new, different types of music clips every time.

These automated music generators use algorithm as the foundation stone of the whole process for generating music clips. A commonly used algorithm is based on valence-arousal plane (a.k.a. Thayer's plane), and both factors may affect the algorithm to generate music (Campana, Ingalls, & Wallis, 2008). On the other hands, both of valence and arousal factors would affect human emotions, and features of different emotions will play the role on all four quadrants on the valence-arousal plane; the emotional value on the X-axis (valence) indicates positive or negative moods of a person; while Y-axis (arousal) reflects the intensity of a person's mood. For the emotional mappings to the valence-arousal plane, the first quadrant (high-valence, high-arousal) indicates a people is in a highly delightful mood, while the mood on the second quadrant (low-valence, low-arousal) may display a person whose emotion is in a deep grief. Other opposite quadrants of emotional signs are totally different to the normal states.

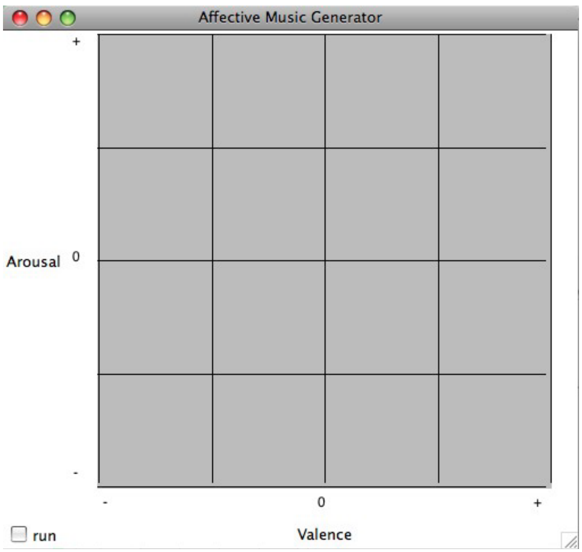

Figure 1. Valence-arousal plane
Note. From Campana, E., Ingalls, T., & Wallis, I. (2008). Computer-generating emotional music: the art of an affective music alghorithm. *11th Conference on Digital Audio Effects* (pp. 7-12). Espoo, Finland: Helsinki University of Technology.

In Berg and Wingstedt's (2005) study on music emotions, they analyzed several music parameters and mapped them into happy or sad emotions, and listed all musical features on each parameter.

Table 1. The mappings of happiness/sadness emotional expressions to musical parameters

Parameters	Happiness emotion	Sadness emotion
Articulation	Staccato	Legato
Harmony	Simple and consonant	Complex/dissonant
Loudness	Loud	Soft
Melodic range	Wide	Narrow
Melodic direction	Ascending	Descending
Mode	Major	Minor
Pitch level	High	Low
Rhythm	Regular/smooth	Firm
Tempo	Fast	Slow
Timbre	Few harmonics	Few harmonics/soft

Note. Revised from Berg, J., & Wingstedt, J. (2005). Relations between selected musical parameters and expressed emotions: extending the potential of computer entertainment. *2005 ACM SIGCHI International Conference on Advances in computer entertainment technology* (pp. 164-171). New York, NY: ACM.

1.2. Season Factors

All four unique seasons are factors to affect everyone's emotions, and the scenery of each season could be transformed into the music. *The Four Seasons* suite composed by Baroque–style musician Antonio Vivaldi is the classical music accomplishment to describe all four seasons vividly. (Wikipedia, 2013b) Also, each scene of all four seasons could be implemented onto the automated music generators, as the mapping onto four quadrants of the valence-arousal plane.

Spring feature may be mapped onto the first quadrant, and it could present the image filled with harmonious and delightful mood in positive valence and high arousal; summer feature performs ever-changing weathers like thunderstorm and tempest during the summer, and it would reflect angry and violent emotions; in the autumn feature, the tempo and temperature become lower, and the emotion would act as slow and wild; the chilling and snowy winter would make people's mood become very down and low.

2. Research Methodology

In this project, experiments on the automated music generator and survey on the users are necessary, and then collect questionnaire as users' response to the automated music generator. On one hand, the automated music generators may add on with season features; and on the other hand, conducting an online survey will quickly and efficiently retrieve users' opinions to the automated music generators with season features. The experiment will try to find the influence of season factors on automated music generators.

3. Experiments and Statistics

At first, the automated music generator with seasonal features has been introduced for the following test and survey:

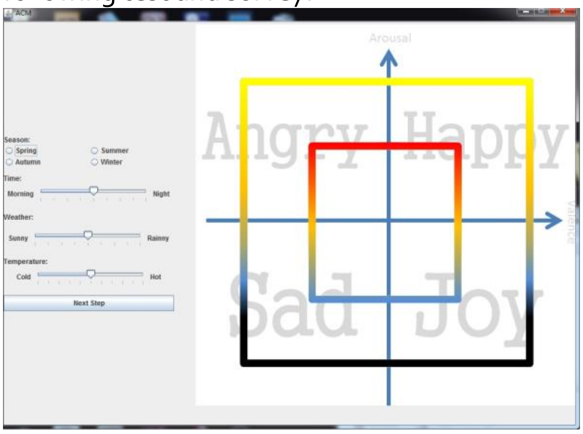

Figure 2. User interface of the automated music generator

The first step is clicking either season, and then dragging the scroll bar to adjust weather, time and temperature parameters, the light dots will appear on the valence-arousal plane to adjust designated emotion zone; the last step is clicking the "start" button. A randomly-generated music clip based on algorithm will be played soon afterwards.

This experiment had been undergone at the Gerontechnology Research Center of Yuan Ze University, and initially tested by the staff and assistants, and then the volunteer elders, their relatives and other people were invited to do this survey. Also, their response to this system had shown below:

Table 2. Experimental statistics

Coordinates	Season factors
1st quadrant (high-valence, high-arousal)	Spring (69), Summer (37), Autumn (28), Winter (16)
2nd quadrant (low-valence, high-arousal)	Spring (43) ,Summer (82), Autumn (17), Winter(8)
3rd quadrant (low-valence, low-arousal)	Spring (21), Summer (14), Autumn (48), Winter (63)
4th quadrant (high-valence, low-arousal)	Spring (25), Summer (22), Autumn (56), Winter (47)

In the above table, the highest vote of all four seasons within all four quadrants indicated which season could be the most dominating one in different valence or arousal values on the 2D emotional plane.

4. Results and Discussion

4.1. Reviews of the Result

According to Table 1, each quadrant clearly has shown one of the all four seasons: spring is mapped to the 1st quadrant (69/150 people), summer is mapped to the 2nd quadrant (82/150 people), autumn is mapped to the 4th quadrant (56/150 people), and winter is mapped to the 3rd quadrant (63/150) people. For the maximum value of each quadrant and its equivalent season, summer had 82 votes, and this sign indicated that summer displayed the strongest influence on automated music generator with season features; while autumn, which had 56 votes, displaying the least influence on this system.

4.2. Future Works

From the above experiment, season factors on the automated music generator is still have a room to improve the composing style representing all four seasons in all generated music clips properly, and there will be a long way to make all generated music clips sound vivid and harmonious like Vivaldi had done.

Nowadays, several types of automatic theme music composing software could generate music clips with season features, like "Band-in-a-Box" (Wikipedia, 2013c), users can select the assigned season category, and then generate a music clip with the season feature; but this software uses its internal pre-recorded MIDI clips to put together and then generate a music clip. The way to generate a beautiful music with season factors will be a future goal to be done.

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ABSOLUTE OR RELATIVE? A NEW APPROACH TO BUILDING FEATURE VECTORS FOR EMOTION TRACKING IN MUSIC

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Abstract

It is believed that violation of or conformity to expectancy when listening to music is one of the main sources of musical emotion. To address this, we test a new way of building feature vectors and representing features within the vector for the machine learning approach to continuous emotion tracking systems. Instead of looking at the absolute values for specific features, we concentrate on the average value of that feature across the whole song and the difference between that and the absolute value for a particular sample. To test this "relative" representation, we used a corpus of popular music with continuous labels on the arousal-valence space. The model consists of a Support Vector Regression classifier for each axis, with one feature vector for each second of a song. The relative representation, when compared to the standard way of building feature vectors, gives a 10% improvement on average (and up to 25% improvement for some models) on the explained variance for both the valence and arousal axes. We also show that this result is not due to having the average of a feature in the feature vector, but due to the actual relative representation.

Keywords: continuous emotion tracking, dimensional space, machine learning

1. Introduction

Over the last twenty years or so, the interest in music as a research focus has been growing, and it is attracting attention from a wide range of disciplines: philosophy, psychology, sociology, musicology, neurobiology, anthropology, and computer science. From the computer science perspective there has been an increasing amount of research concerned with automatic information extraction from music that would allow us to manage our growing digital music libraries more efficiently.

In addition to that, the birth of the Affective Computing field (Picard, 1997) together with a sparking interest in emotion research in general led people to look into the relationship between music and emotion (Juslin & Sloboda, 2001, 2010).

After the early debate about whether or not music could express or induce emotions at all, both are now generally accepted with multi-disciplinary backing. Not only that, but it has been shown that emotion in music is shared between different cultures (Peretz, 2010), and therefore is universal and related to the basic emotions in people. It also has as strong an effect on the brain, as everyday emotions, activating the same or similar areas in the brain (Koelsch, Siebel, & Fritz, 2010).

Since the first paper on automatic emotion detection in music (Li & Ogihara, 2003) was published nearly 10 years ago, the field has been growing quite rapidly, but there is still a lot to be explored and a lot of guidelines for future work to be set.

In this paper we aggregate and show several different sources of information (temporal, axis-dependency) that are present in music, but not in the basic approach to building feature vectors for machine learning approach to emotion tracking. We also test a novel feature representation technique that provides a substantial improvement to the results.

2. Background

There are several things that complicate music emotion research. One of the least recognized ones is that there are two types of musical emotions one can investigate – emotion "expressed" by the music, and emotion induced in the listener. The former is concerned with what the music sounds like and is mainly influenced by the musical features and cultural understanding of music. It is also more objective, since the listener's state and preferences have less of an effect on the perception of emotion in music. The later, on the other hand, describes the user's response to a piece of music. It clearly depends on the perceived (expressed by music) emotion, but is also heavily influenced by the individual's experiences, history, personality, preferences and social context. It is therefore much more subjective and varies more between different people.

Even though the vast majority of papers in Music Emotion Recognition (MER) do not make the distinction, there is clear evidence that the two are different. In their study, Zentner et al. (Zentner, Grandjean, & Scherer, 2008) have found a statistically significant difference between the (reported) felt and perceived emotions in people's reported emotional response to music. They have also found that certain emotions are more frequently perceived than felt in response to music (particularly the negative ones), and some are more frequently felt rather than perceived (e.g. amazement, activation, etc.).

Another issue that needs to be addressed is the granularity of the labels attached to a song. Even though there is no doubt that emotion in music can and does change over time (Schmidt & Kim, 2010a), the majority of research in MIR is aimed at classifying the whole musical piece, rather than tracking the emotion. In order to get around the dynamic nature of emotion and music, many researchers choose to look at a (usually) 30s segment of a piece, therefore making their systems less applicable in the real world. It has also been shown that emotion tracking can lead to an improvement in accuracy if classification of the whole musical piece is required (Carvalho & Chao, 2005).

The last key choice is the representation of emotion. A growing number of researchers choose to use dimensional emotion models. These models disregard the notion of basic (or complex) emotions. Instead, they describe emotions in terms of affective dimensions. The theory does not limit the number of dimensions that is used – it normally ranges between one (e.g. arousal) and three (valence, activation and power or dominance), but four and higher dimensional systems have also been proposed. The most commonly used model is Thayer's arousal-valence (AV) emotion space, where arousal describes how active/passive emotion is and valence - how positive/negative it is. In addition to being more flexible and less interpretation dependent than basic emotion (happy, sad, etc.) model, it has also been shown that classification which predicts AV values internally has higher accuracy than models that predict basic emotions directly.

The dimensional representation offers, in our opinion, the best solution – time varying MER, or continuous emotion tracking. Even though it is clearly not restricted to the dimensional approach (as has been shown by (Liu, 2006) and (Schubert, Ferguson, Farrar, Taylor, & Mcpherson, 2012)), it is inherently more difficult to use, especially in user studies.

Even within dimensional emotion tracking, there are different ways of approaching the problem. (Korhonen, Clausi, & Jernigan, 2006), (Panda & Paiva, 2011), (Schmidt & Kim, 2010a), (Schmidt, Turnbull, & Kim, 2010), and others have tried to infer the emotion label over a time window individually. Another solution is to incorporate temporal information in the feature vector either by using features extracted over varying window length for each second/sample (Schubert, 2004), or by using machine learning techniques that are adapted for sequential learning (e.g. sequential stacking algorithm (Carvalho & Chao, 2005), Kalman filtering (Schmidt & Kim, 2010b) or conditional random fields (Schmidt & Kim, 2011). Interestingly, it has also been reported (Panda & Paiva, 2011; Schmidt et al., 2010) that taking the average of the time-varying emotion produces results that are statistically significantly better than simply performing emotion recognition on the whole piece of music.

3. Methodology

Dataset: The dataset that we have been using for our experiments is, to our knowledge, the only publicly available emotion tracking dataset of music extracts labelled on an arousal-valence dimensional space. It also focuses on perceived emotion rather than the perceived one. The data has been collected by (Speck, Schmidt, Morton, & Kim, 2011) using Mechanical Turk (MTurk, http://mturk.com), asking paid participants to label 15-second long excerpts with continuous emotion ratings on the AV space, with another 15 seconds given as a practice for each song. The songs in the dataset cover a wide range of genres – pop, various types of rock, hip-hop/rap, etc., and are drawn from the "uspop2002" (http://labrosa.ee.columbia.edu/projects/musicsim/uspop2002.html) database containing Western popular songs. The dataset consists of 240 15-second clips (without the practice run) with 16.9 +/- 2.7 ratings for each clip. In addition, the dataset contains a standard set of features extracted from those musical clips: MFCCs, octave-based spectral contrast, statistical spectrum descriptors, chromagram and a set of EchoNest (http://developer.echonest.com/downloads) features.

The design of the experiments: Using the audio analysis features provided in the MTurk dataset and LIBSVM (Chang & Lin, 2001) implementation of support vector regression, we implemented a number of models for emotion tracking in music. The most basic model, based on the features provided and the LIBSVM library is also the common baseline model used in the field. We chose not to use the EchoNest features, since they have been extracted with proprietary software that does not provide clear documentation or explanation of how the features are extracted.

For the baseline method, the feature vector consists of the audio features averaged over a 1s window – the mean and standard deviation for each feature. There is only one feature vector for each second of the song (so 15 training/testing samples for each song), labelled with the average valence or arousal value computed from the labels in the dataset for that second. Two support vector regressors are trained – one for the arousal and one for the valence axes. Both regressors use RBF kernels and use 5-fold cross-validation within the training set to choose the best values for the parameters used.

Cross-validation: In all of our experiments we used 5-fold cross-validation to split the dataset into training and testing sets. This minimizes the risk of accidentally choosing a particularly bad or good set of songs and therefore making the results more reliable.

Table 1: Squared correlation of the baseline approach using different ways of splitting songs across folds.

	No constraints	Song-level split	Album-level split	Artist-level split
Arousal	0.69	0.64	0.65	0.64
Valence	0.34	0.25	0.26	0.23

We experimented with three different ways of distributing the songs between the folds (the effect on the squared correlation of the baseline method is depicted in **Table 1** and **Table 2**). The most obvious requirement is to keep all the feature vectors from a song in the same fold, to ensure that the model is not overfitting to individual songs. For the baseline method, this lowers the squared correlation coefficient (R^2) from 0.34 to 0.25 for valence and 0.69 to 0.64 for arousal, and increases the mean squared error (MSE) from 0.038 to 0.045 for valence and from 0.032 to 0.039 for arousal.

Table 2: Mean squared error of the baseline approach using different ways of splitting songs across folds.

	No constraints	Song-level split	Album-level split	Artist-level split
Arousal	0.033	0.039	0.038	0.038
Valence	0.038	0.045	0.045	0.046

Another factor worth considering is making sure that songs from the same album are all within a single fold. It has been reported and widely accepted that the so called "album effect" can artificially improve the performance as machine learning models overfit to a particular set of post-production techniques used on an album (Kim, Williamson, & Pilli, 2006). Removing the album effect made little difference to the results of the baseline method with the dataset we use. This is probably due to the fact that a large majority of songs come from unique albums – the 240 songs we am using come from 200 different albums.

The third approach we used was to make sure that all the songs from the same artist are within the same fold. Unsurprisingly, there is often statistically significant correlation between artists and mood in music (Hu & Downie, 2007), which, we expected, might lead to some overfitting. Again, it did not have a significant effect on the results, with the baseline method, which is most likely because the dataset is fairly well balanced even for the artists – the 240 songs used were recorded by 156 different artists. It could also be argued that this restriction is unnecessarily strict – in real life, a fully trained system is unlikely to receive unseen songs from an album that it was trained on, but is definitely expected to analyse unseen songs from an artist that it has seen before. For these reasons, we decided to use album-level cross-validation for all of the experiments.

Further experiments: The next step we took was to exploit some of the dependency between the valence and arousal axis (Eerola & Vuoskoski, 2010). It has been reported that including the valence label in the feature vector for arousal prediction and the arousal label for valence prediction can improve the accuracy of the model both in emotion recognition in music (Schmidt et al., 2010) and affect prediction from human behaviour (Nicolaou, Gunes, & Pantic, 2011a).

Another dependency that we decided to exploit was time. Since the emotional ratings for each second are clearly dependent on the previous ratings, in the next experiment we included audio features from a several one-second feature vectors. We experimented with varying sizes of windows – from 1s lag (just the audio features for the current second and all the audio features for the previous second) to 5s lag (current second and five previous seconds) for both the valence and the arousal axes.

Expectancy is also a very important factor to consider. There is a theory that violation of or conformity to expectancy when listening to music is a (main) source of musical emotion. It has been at least partially proven across different fields concerned with emotion in music (e.g. neuroimaging – (Koelsch et al., 2010), experimental aesthetics – (Hargreaves & North, 2010), etc.). To address that, we tried three different approaches: adding a "future" window in addition to the delay (similar to that used by (Nicolaou, Gunes, & Pantic, 2011b)), including the average over a song for each audio feature, and representing each feature as a difference between its (absolute) value at that second and the average over that song (which we will refer to as the relative representation).

4. Results

The results achieved by our basic implementation fall within the area of the results achieved within the field (R^2 of 0.65 for arousal and 0.26 for valence, and MSE of 0.038 for arousal and 0.045 for valence). Using the relative representation in the standard approach, on the other hand, showed a substantial improvement on the results (R^2 of 0.74 for arousal and 0.34 for valence, and MSE of 0.028 for arousal and 0.040 for valence).

Adding the label of the other emotion axis to the feature vector, as expected, had a positive effect on the valence prediction, but no effect on arousal prediction – results that agree with the findings in the literature (Schmidt et al., 2010). The same effect was seen both in the standard, basic representation and in the relative representation.

Adding temporal information in the form of concatenating several seconds' worth of previous vectors (delay window) improved the performance of the basic representation models for both the valence and the arousal axes. For valence, the R^2 peaks at 2-3s window size and then plateaus or drops slightly. For arousal the optimal window size appears to be 4s (**Table 3** and **4**). For the relative representation, on the other hand, the effect is smaller or non-existent.

Table 3: R^2 of the basic (basic) and relative representations (rel) using delay windows of different size for arousal (A) and valence (V) axes.

	1s	2s	3s	4s	5s
A-basic	0.68	0.69	0.69	0.70	0.71
A-rel	0.74	0.76	0.73	0.74	0.74
V-basic	0.26	0.29	0.31	0.29	0.29
V-rel	0.31	0.31	0.31	0.32	0.31

Table 4: MSE of the basic (basic) and relative representations (rel) using delay windows of different size for arousal (A) and valence (V) axes.

	1s	2s	3s	4s	5s
A-basic	0.035	0.033	0.033	0.032	0.031
A-rel	0.028	0.026	0.029	0.028	0.028
V-basic	0.042	0.045	0.042	0.042	0.043
V-rel	0.042	0.042	0.041	0.041	0.042

Concatenating the current frame with feature vectors of the "upcoming" frames (future window) was also tested. We kept the range of future window sizes the same as for the delay window and it led to an improvement (between 0.01 and 0.02 for the R^2 value) when used on a standard feature representation for arousal at each window size. For the relative representation, adding the future window to the arousal model had no effect at all, and for valence model the results were inconsistent both in the standard and the relative representations. The addition of average was only tested on the standard representation, as the relative representation already contains average values by definition. For the basic approach, it produced a similar effect to that of the addition of the future window – inconsistent results on the valence model and small improvement on the arousal model (though smaller than the addition of future window).

5. Discussion

The results we have achieved with our models are very encouraging. The performance of the baseline method falls within the expected range reported in the literature, which suggests that the same techniques we used could be employed on other datasets. We have also managed to achieve the expected improvements by incorporating valence-arousal and temporal dependence information, in a similar way that has been achieved in the field. This confirms that there is a dependency both between different frames (temporal information) and between the two axes, and that it is beneficial to extract that information.

In order to address the expectancy, we tried several different approaches. Using a future window and adding an average over the whole song showed little, if any, improvement on the results. The major improvement on the accuracy of our predictions was introduced by the use of relative representation in the feature vectors. Interestingly, it seems that this representation makes a lot of other additions redundant – the results are not improved by adding the future window or the label of the other axis. This might be because the size of the feature vector grows too large, or because the information is somehow covered by this new representation.

Another important observation can be made from the results of these experiments – different modifications can have different levels of improvement to the valence and arousal models. This seem to imply that in order to achieve the best results, different feature representations and/or feature fusion techniques might need to be used for the two models, in addition to potentially using or prioritizing different feature sets.

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THE PLEASANT EMOTION OF SAD MUSIC

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Abstract

In general, sad music is thought to cause us to experience sadness, which is considered an unpleasant emotion. As a result, the question arises as to why we listen to sad music if it evokes sadness. We hypothesized that felt and perceived emotion may not actually coincide in this respect: sad music would be perceived as sad, but the experience of listening to sad music would evoke positive emotions. A total of 44 participants listened to musical excerpts and provided data on perceived and felt emotions by rating 62 descriptive words or phrases related to emotions on a scale that ranged from 0 (not at all) to 4 (very much). The results revealed that the sad music was perceived to be more tragic, whereas the actual experiences of the participants listening to the sad music induced them to feel more romantic, more blithe, and less tragic emotions than they actually perceived with respect to the same music. Thus, the participants experienced ambivalent emotions when they listened to the sad music. After considering the possible reasons that listeners were induced to experience emotional ambivalence by the sad music, we concluded that the formulation of a new model would be essential for examining the emotions induced by music and that this new model must entertain the possibility that what we experience when listening to music is vicarious emotion.

Keywords: sad music, ambivalent emotion, vicarious emotion

1. Introduction

Why do we listen to sad music? Sad music induces sadness in listeners, and sadness is normally considered an unpleasant emotion that people wish to avoid. For instance, people hope to avoid misfortunes, such as the death of a loved one. However, people sometimes "lose themselves" in the beautiful sounds of sad music and even enjoy listening to it. Musicologists have been puzzled by this contradiction (Levinson, 1997), which has also been discussed in the field of philosophy. Although this contradiction has increasingly captured the attention of psychologists in recent years, few studies have investigated the issue empirically (Garrido & Schubert, 2011; Huron, 2011; Schubert, 1996; Vuoskoski, Thompson, Mcilwain, & Eerola, 2012).

In the field of emotional psychology, sadness is considered to be an affective state with negative valence. The dimensional model of emotion is one of the current models of emotion and is a circumplex model (Russell, 1980). This model suggests that emotion is a mixture of two dimensions, and various emotions can be located in a two-dimensional space with respect to coordinates of valence and arousal (Lang, 1995) or positive activation and negative activation (Watson & Tellegen, 1985). According to Russell and Feldman-Barrett (1999), emotions, including happiness, sadness, anger, fear, disgust, and surprise, can be mapped along several dimensions, such as pleasant–unpleasant and activation–deactivation. In such two-dimensional (two-axis) affective models, sadness is generally located in the third quadrant, in the same position as displeasure and deactivation emotions (Russell, 2003).

Although sadness is generally understood as negative and unpleasant in the psychology of emotion, sadness in the field of artistic appreciation may have different features or may be perceived differently. For example, in the field of drama, in which both comedy and tragedy are popular, sadness as a focus of a piece is not necessarily to be avoided. On the contrary, sadness as a central theme is fundamental to the aesthetic experience of drama. In the same manner, the type of sadness that is evoked by sad music appears to be pleasant in its own way. In fact, it is reported that some of the most beautiful and profound listening experiences are associated with sad music (Gabrielsson & Lindström, 1993). Given all of these factors, it is difficult to conclude that sadness is an unpleasant emotion when we experience it as a reaction to an artistic form such as music. Hence, the definition of sadness that is typically employed in the psychology of emotion is viewed as inappropriate for use in artistic contexts. In this study, we attempt to promote a better understanding of sadness in relation to listening to music by investigating both perceived emotion and felt emotion.

In summary, we hypothesized that felt emotion would not necessarily correspond to perceived emotion, especially in response to music in a minor key (hypothesis 1). Because listeners with substantial musical experience have been found to evaluate music in a minor key as more pleasant when rating felt emotion than when rating perceived emotion in our previous study (Kawakami et al., 2013), we hypothesized that when people listened to minor-key music, those with more musical experience would feel more pleasant emotion than would be indicated by their reported perceptions of the same sad music (hypothesis 2).

2. Method

2.1. Participants

Forty-four people (25 females and 19 males) participated in our experiment (mean age of 25.3 years; SD = 6.6). Seventeen of these individuals were professional musicians or college students who were majoring in music (the "musician group"; n = 17). The other 27 participants were working people or college students who were not majoring in music (the "non-musician group"; n = 27).

2.2. Materials

Three types of musical excerpts of approximately 30 seconds each were used. We used the following pieces as musical stimuli: 1) Glinka's La Separation (F minor), 2) Blumenfeld's Etude "Sur Mer" (G minor), and 3) Granados's Allegro de Concierto (C sharp major, but the excerpt was in G major). Because we aimed to investigate whether the perceived emotions evoked by minor-key (sad) music differed from the felt emotions evoked by the same music, we transposed Granados's Allegro de Concierto, which is normally in the key of G major, into G minor. Furthermore, because it appeared that using music in a major key would allow for a helpful comparison of the two keys for each work of music, we also transposed Glinka's La Separation into F major and Blumenfeld's Etude "Sur Mer" into G major, as the original music for those music was in F minor and G minor, respectively (see the appendix for information regarding the scores). The excerpts were played at the following tempos: quarter note = 80 in Glinka's La Separation, half note = 72 in Blumenfeld's Etude "Sur Mer," and quarter note = 70 in Granados's Allegro de Concierto.

2.3. Self-report measures

We used 62 emotion-related descriptive words and phrases to measure both perceived and felt emotions. These descriptive words and phrases were used to measure perceived emotion by Hevner (1936) and Taniguchi (1995) and to measure felt emotion by Zentner, Grandjean, and Scherer (2008). The participants rated the two types of musical emotions after listening to each musical excerpt by rating these descriptive words and phrases on a scale ranging from 0 (not at all) to 4 (very much).

2.4. Procedure

The experiment was conducted with each individual participant in a sound-insulated room. The listeners engaged in four tasks individually. In the first task, they listened to the music either in the major or minor key and rated either perceived or felt emotion using the 62 emotion-related descriptive words and phrases. In the second task, the listeners rated the same type of emotion as in the first task. If they rated perceived emotion in the first task, they also judged perceived emotion in the second task but listened to the music in a key that differed from the key in the first task. In the third task, the participants rated the remaining emotion (i.e., the emotion that they did not address in the first and second tasks) using the 62 emotion-related descriptive words and phrases after listening to the music either in a major or minor key. Finally, the listeners rated the same emotion that they answered in the third task after listening to the music in the key that differed from that of the third task. In a preliminary task occurring prior to this actual rating process, the participants had practiced rating descriptive words or phrases on a scale ranging from 0 (not at all) to 4 (very much) for both perceived and felt emotions; the participants employed the numerical keypad after listening to each of the four types of music subsequently used in the four actual rated tasks, although different music was used.

2.5. Statistical analysis

The data that we obtained in our experiment were analyzed in two stages. First, we sorted the 62 emotion-related descriptive words and phrases by performing a factor analysis. This procedure enabled us to determine the characteristics of some factors that were extracted from the analysis. Then, for each factor that was extracted through factor analysis, we conducted an ANOVA with the following design: musical emotion (perceived vs. felt) × key (major vs. minor) × musical experience (musicians vs. non-musicians) for each factor. The first two factors of the ANOVA were repeated measures, and the last factor was a between-subjects factor. The factor analysis and ANOVA were performed using SPSS for Windows (version 19.0), and p-values of less than 0.05 were considered significant.

3. Results

3.1. Factor analysis

The 62 emotion-related descriptive words and phrases were investigated via a factor analysis. Four factors were extracted, accounting for 62.83 % of the total variance. The number of factors extracted was determined based on interpretability. An oblique rotation was performed, and the 62 emotion-related descriptive words and phrases with factor loadings are reported in Table 1. Sixteen emotion-related descriptive words or phrases, such as gloomy, meditative, and miserable, were included in Factor 1, "tragic emotion" Twenty other words or phrases, such as overwhelmed, agitated, and stimulated, were included in Factor 2, "heightened emotion" In the third factor, "romantic emotion," there were 15 words or phrases, such as fascinated, dear, and in love. Because the 11 words or phrases in the fourth factor included merry, animated, and feel like dancing, we labelled it "blithe emotion."

Table 1. Factor Loading of 62 Emotion-Related Descriptive Words or Phrases

	Emotion-related words or phrases	Factor 1	Factor 2	Factor 3	Factor 4
32	Gloomy	**1.04**	-0.15	-0.05	0.20
24	Meditative	**1.04**	-0.14	-0.04	0.19
48	Miserable	**1.03**	-0.07	0.02	0.14
45	Disconsolate	**0.98**	-0.03	-0.07	0.09
26	Blue	**0.96**	-0.05	-0.10	0.17
17	Sorrowful	**0.90**	0.06	0.02	-0.04
8	Sad	**0.85**	0.06	0.05	-0.13
5	Sentimental	**0.85**	0.04	0.21	-0.07
55	Wistful	**0.85**	0.01	0.14	-0.11
62	Melancholic	**0.79**	0.06	0.15	-0.16
36	Tearful	**0.71**	0.16	0.25	-0.12
18	Irritated	**0.63**	0.05	-0.26	0.22
37	Nervous	**0.59**	0.25	-0.24	0.22
60	Grave	**0.51**	0.39	0.09	-0.24
49	In awe	**0.49**	0.36	0.24	-0.02
31	Sensual	**0.42**	0.27	0.41	-0.09
54	Overwhelmed	0.05	**0.82**	-0.11	-0.09
27	Agitated	-0.23	**0.81**	-0.08	0.05
25	Stimulated	-0.05	**0.81**	-0.27	0.03
20	Feeling of transcendence	-0.04	**0.79**	0.15	-0.11
56	Passionate	0.04	**0.76**	0.01	0.11
2	Chills	0.08	**0.74**	-0.03	-0.15
3	Energetic	-0.25	**0.73**	-0.20	0.34
21	Strong	0.12	**0.70**	-0.22	0.13
50	Lofty	-0.08	**0.69**	0.36	-0.16
40	Heroic	-0.24	**0.68**	-0.13	0.06
12	Fiery	0.18	**0.66**	-0.29	0.14
39	Inspired	0.03	**0.63**	0.07	0.13
10	Filled with wonder	0.13	**0.61**	-0.31	0.06
51	Determined	0.16	**0.60**	-0.23	-0.07
9	Impatient	0.04	**0.52**	-0.45	0.27
28	Moved	0.25	**0.50**	0.40	0.16
29	Feeling of spirituality	0.15	**0.50**	0.49	-0.07
44	Tensed	0.33	**0.48**	-0.23	-0.05
38	Dazzled	0.20	**0.47**	0.33	-0.05
57	Solemn	0.32	**0.36**	0.30	-0.32
11	Fascinated	-0.21	0.08	**0.76**	-0.01
4	Dear	0.26	-0.23	**0.72**	0.22
22	In love	0.36	-0.11	**0.71**	0.06
15	Serene	-0.04	-0.35	**0.69**	0.12
46	Admiring	-0.15	0.30	**0.69**	0.08
6	Soothed	-0.07	-0.22	**0.66**	-0.18
41	Graceful	-0.21	0.15	**0.65**	0.04
33	Delicate	0.53	-0.05	**0.64**	-0.001
13	Tender	-0.18	-0.20	**0.64**	0.15
34	Relaxed	-0.29	-0.12	**0.64**	-0.09
23	Dreamy	-0.04	0.02	**0.61**	0.29
14	Nostalgic	0.27	-0.32	**0.60**	0.18
19	Allured	-0.11	0.48	**0.50**	-0.22
43	Satisfied	-0.36	0.26	**0.48**	0.21
1	Happy	-0.37	0.05	**0.45**	0.34
52	Merry	0.03	-0.01	0.05	**0.81**
59	Animated	-0.28	0.16	-0.04	**0.70**
7	Feel like dancing	-0.11	0.08	0.12	**0.70**
61	Bouncy	-0.21	0.10	0.13	**0.69**
16	Amused	-0.21	-0.01	0.22	**0.68**
58	Easy passion	-0.05	-0.06	0.11	**0.62**
53	Joyful	-0.25	-0.01	0.25	**0.60**
35	Cheerful	-0.35	-0.01	0.25	**0.54**
42	Gay	-0.28	0.24	0.11	**0.52**
30	Triumphant	-0.34	0.34	0.05	**0.51**
47	Whimsical	0.20	0.01	-0.05	**0.47**

Correlations among factors	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	—	0.29	-0.30	-0.69
Factor 2		—	-0.02	0.08
Factor 3			—	0.31
Factor 4				—

3.2. ANOVA

- **Factor 1 (tragic emotion)**

The ANOVA revealed significant main effects for key [$F(1, 42) = 298.72$, $p < 0.001$], musical emotion [$F(1, 42) = 12.14$, $p = 0.001$], and musical experience [$F(1, 42) = 11.77$, $p = 0.001$]. More importantly, there was a significant two-way interaction between key and musical emotion [$F(1, 42) = 26.26$, $p < 0.001$].

The significant two-way interaction led to a post-hoc analysis that indicated that the ratings of perceived emotions and felt emotions in sad music (music in a minor key) were significantly different [$F(1, 43) = 22.16$, $p < 0.001$]. For tragic emotion, the perceived emotions were rated as stronger than the felt emotions (mean ratings: 2.50 and 2.08, respectively) when the participants listened to the sad music.

- **Factor 2 (heightened emotion)**

The ANOVA revealed a significant main effect for key [$F(1, 42) = 37.05$, $p < 0.001$]. Heightened emotion, including feeling overwhelmed, agitated, and stimulated, was rated higher in sad music than in happy music (music in a major key), with mean ratings of 1.69 and 1.22, respectively.

- **Factor 3 (romantic emotion)**

There was a significant main effect for key [$F(1, 42) = 104.18$, $p < 0.001$]. More importantly, there was a significant two-way interaction between key and musical emotion [$F(1, 42) = 5.37$, $p = 0.025$].

The significant two-way interaction led to a post-hoc analysis that indicated that the ratings of perceived emotions and felt emotions in sad music were significantly different [$F(1, 43) = 5.07$, $p = 0.03$]. For romantic emotion, the felt emotions were rated as stronger than the perceived emotion (mean ratings: 1.31 and 1.04, respectively) when the participants listened to the sad music.

- **Factor 4 (blithe emotion)**

There were significant main effects for key [$F(1, 42) = 193.96$, $p < 0.001$] and for musical experience [$F(1, 42) = 10.02$, $p = 0.003$]. More importantly, there was a significant two-way interaction between key and musical emotion [$F(1, 42) = 15.30$, $p < 0.001$].

The significant two-way interaction led to a post-hoc analysis that indicated that the ratings of perceived emotions and felt emotions in sad music were significantly different [$F(1, 43) = 5.07$, $p = 0.03$]. For blithe emotion, the felt emotions were rated as stronger than the perceived emotions for sad music (mean ratings: 0.40 and 0.24, respectively). In contrast, the analysis indicated that the ratings of the perceived emotions were higher than those of the felt emotions (mean ratings: 2.27 and 1.98, respectively) in happy music [$F(1, 43) = 8.25$, $p = 0.006$].

4. Discussion

4.1. Perceived vs. Felt Emotion

We used three-way ANOVA to test our hypothesis that felt emotion would not necessarily correspond to perceived emotion, especially in response to music in a minor key (hypothesis 1). Our results showed a significant two-way interaction between key and musical emotion in tragic, romantic, and blithe emotion. Post-hoc analyses revealed that although the sad music was perceived as more tragic, the listeners did not actually experience the tragic emotion (e.g., gloomy, meditative, and miserable) to an equivalent degree. Moreover, the participants felt more romantic emotion (e.g., fascinated, dear, and in love) and blithe emotion (e.g., merry, animated, and feel like dancing) than they perceived such emotions when listening to the sad music.

In short, when the participants listened to the sad music, they indeed felt tragic emotion, but the degree to which they actually felt this emotion was lower than that for which they perceived it. Additionally, the listeners experienced romantic and blithe emotions more than they perceived these particular emotions when they listened to the sad music. In view of our results, we consider hypothesis 1 to be confirmed.

4.2. The effects of musical experience

The difference between felt and perceived emotions was not affected by musical experience in this study. Our hypothesis was that when people listened to minor-key music, those with more musical experience would feel more pleasant emotions than they would perceive with respect to the sad music (hypothesis 2), but this hypothesis was not supported by our results.

Independent of their musical experience, the listeners felt less gloomy, meditative, and miserable as well as more fascinated, dear, in love, merry, animated, and inclined to dance when they listened to sad music compared with their actual perceptions of the same music. The reason that musical experience was not important in the difference between the perceived and felt emotions for the sad music could lie in the musical stimuli that we used. Because the musical stimuli used by Kawakami et al. (2013) consisted of only a few measures (from one to four measures), they lacked ecological validity. By contrast, the musical stimuli in this experiment were excerpts from existing musical pieces (from nine to 19 measures). Therefore, the listeners were able to capture more information about the musical structures for the music to which they were listening than they was allowed by the musical stimuli in the experiment by Kawakami et al. (2013). As a result, the participants may have been able to react to the aesthetic aspects of the sad music, regardless of their musical experience, leading to the disappearance of the difference between the musicians and non-musicians regarding perceived and felt emotion in relation to the sad music. Given the familiar phenomenon that people, regardless of their musical experience, can enjoy sad music in everyday life, it seems natural that we did not find a difference between the musicians and non-musicians regarding perceived and felt emotions.

4.3. Sad music induces ambivalent emotions

In the psychology of emotion, as a rule, sadness is classified as unpleasant in an evaluative dimension (unpleasant–pleasant). If an emotion with properties that are similar to those of a sad perceived emotion were evoked in listeners, then they would experience more unpleasant emotion when they listened to the sad music. If sad music actually evokes only unpleasant emotions in listeners, then why do people listen to sad music? Green, Baerentsen, Wallentin, Roepstorff, and Vuust (2008) found that although minor-key music was judged to be sadder than major-key music, the former was rated as more likeable than the latter. It is peculiar that people appear to love stimuli that induce only unpleasant emotions.

Although musicologists have experienced difficulties in attempting to explain why people listen to sad music (Levinson, 1997), the findings from this study may be able to provide possible answers to the question of why people listen to sad music. In accordance with an earlier study that revealed minor-key music to be perceived as sad (Hevner, 1935), the perceived emotions in this study were rated as more unpleasant (e.g., more gloomy, meditative, and miserable) than the felt emotions with respect to the sad music. Additionally, the participants actually experienced gloomy, meditative, and miserable emotions when they listened to the sad music, although the degree of felt emotions was lower than that of the perceived emotions. In addition, the participants felt fascinated, dear, in love, merry, animated, and inclined to dance when listening to the same music. Overall, consistent with the suggestion of Bigand, Vieillard, Madurell, Marozeau, and Dacquet (2005), sad music was not systematically associated with unpleasant emotions in this study. Rather, the participants experienced ambivalent emotions when they listened to sad music. Because sad music elicits both tragic and pleasant emotion in listeners, people may choose to spend a significant amount of time listening to sad music and even enjoying it (Schubert, 1996; Vuoskoski et al., 2012).

Against this backdrop, why do we experience ambivalent emotions when we listen to the sad music? We consider the following possibility.

4.4. Vicarious emotions in relation to art

Is the "unpleasant" emotion (e.g., sadness) experienced through art actually unpleasant at all? As Eerola and Vuoskoski (2011) noted, although sadness is generally considered to be an unpleasant emotion, sadness in the context of music might not be classified as unpleasant in an equivalent manner. In the context of art, emotion-evoking processes may differ from those of day-to-day emotions. Thus, the sadness that we experience while listening to sad music may differ from that which we experience in our daily lives, as Scherer (2004) proposed when discussing the distinction between goal-oriented utilitarian emotion and aesthetic emotion. In fact, some researchers have denied that music can induce common "everyday emotions" (e.g., sadness, happiness, and anger; Kivy, 1990; Konečni, 2003; Scherer, 2003).

Given this reasoning, what is the difference between day-to-day emotions and emotions that are evoked by music? In the emotions that we experience in daily life, an actor who experiences emotions has a direct relationship with the object or situation by which the emotion is aroused. In contrast, when we listen to music, a person is safe from any threat or danger that the music represents (Zentner et al., 2008). Thus, the emotions that we experience when we listen to music may be characterized as vicarious property. When we feel a certain type of emotion when listening to music, there is no objective or situation that acts as a cause to induce emotion as in everyday life. Rather, the composer, performer, or music itself that expresses emotion may be the entity that enjoys the direct relationship with the originating situation. The felt emotion of music can be regarded as a vicarious emotion if we conceptualize our experience of the emotion, which originated with the composer, performer, or music itself, as occurring through a mechanism such as sympathy. In contrast to the emotions of everyday life, such a vicarious emotion would not be accompanied by any essential pleasantness or unpleasantness that provides incentives to approach or avoid it.

4.5. A new model of musical emotion

It seems unsuitable to consider sad emotions through music in a traditional emotion model, such as the two-dimensional affective model with two axes (e.g., pleasant–unpleasant and aroused–sleepy) because such a model assumes everyday-life emotions—i.e., emotions elicited in non-musical contexts. Such traditional models cannot represent the vicarious nature of musical emotions. Therefore, the adoption of a new model appears essential for understanding musical emotion.

Figure 1 shows the two-dimensional affective space (pleasant–unpleasant, direct–vicarious). The horizontal axis shows the emotional evaluation of experienced emotion, and the vertical axis shows the relationship with the object causing the emotion. The relationship axis represents the manner in which an individual relates to the stimuli that elicit the emotion, which is exactly what differentiates the emotions of everyday life from those that occur when listening to music; this axis frames "direct" and "vicarious" as polar opposites. Thus, emotions that are experienced in everyday life would be located in the first and second quadrants in Figure 1. The emotions that are felt when listening to music are considered below.

As defined in an existing theory of emotion, emotions experienced in everyday life are distributed widely across the first and second quadrants—i.e., from pleasant to unpleasant. For example, sad emotions in daily life would be mapped in the second quadrant, as shown in Figure 1. In contrast, felt emotions in music, including both sad and happy music, would be located primarily in the fourth quadrant. Given that the emotions elicited by music are vicarious, they cannot include unpleasant experiences and would even be almost pleasant because of the cognitive processes associated with listening to music. Therefore, the sad emotions that listeners feel when listening to sad music could be mapped in the fourth quadrant, as shown in Figure 1.

In this study, we clarified that people listen to sad music because it evokes ambivalent emotions in listeners. Furthermore, we suggested new model of musical emotion.

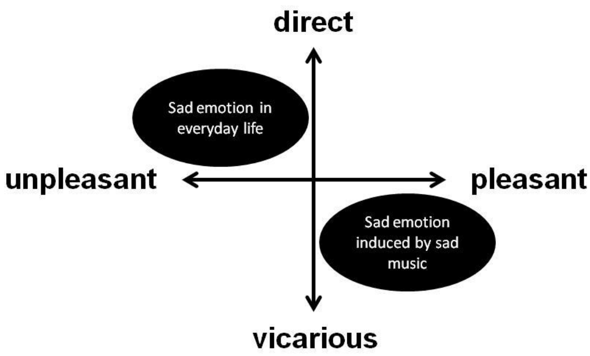

Figure 1. New model of musical emotion.

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MUSIC-RELATED NOSTALGIC EXPERIENCES OF YOUNG MIGRANTS

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Abstract

Music is a powerful means for constructing identity – both formulating and remembering who one is – and migration can be seen as a particular situation creating challenges for this sense of identity. This qualitative study focused on investigating music-related nostalgic experiences of young migrants. The aim of the study was to identify features characteristic to music-related nostalgia particularly in relation to the experience of migration. Ten university students (Iranians currently living in migration) participated in the study. Data was collected through spoken interviews with an additional short questionnaire and a task to listen to self-selected nostalgic music. The interviews focused on the participants' current situation in the foreign country, their nostalgic experiences and the role of music in their nostalgic experiences. The data was analyzed qualitatively through the grounded theory approach. The results showed that the participants' nostalgic memories focused on their home country. The inclusion of music to nostalgic episodes appeared to intensify and stimulate the experience. The participants employed different strategic methods in utilization of music-related nostalgia: for counteracting loneliness, for bringing new perspectives into one's sense of self, finding meaning in life, and sympathy for one's feelings. Accordingly music seemed to play a triple role in nostalgic reverie; as a trigger, as a mean to recall and simulate the memory-related emotional state, and finally as a mood regulator tool. Furthermore, individual participants showed differences in their encounter style (avoidance or acceptance) towards nostalgic experiences. Preference for these encounter styles was influenced by the personal experiences and mood (including depression) of the participants.

Keywords: music-related nostalgia, immigration, mood regulation

1. Introduction

1.1. Music

Nowadays music is present everywhere in individuals' everyday life. People are exposed to the music they do not choose to listen to in many places; in restaurants, cafes, shops, waiting rooms, and elevators. Besides, they also engage with music in more active ways; they listen to their self-selected music while driving, going to work, or doing daily routines at home. Some people may be more selective and choose different music for different occasions; a specific music when they are on their own and alone, and another piece of music when they have friends around.

In addition, music has become more and more easily accessible these days due to the inventions of music player devices and also musical social networks such as Spotify and Last.Fm. Those recent inventions provide the great opportunity of listening to music wherever and whenever one desires to. Individuals choose different music in order to achieve different psychological states and moods, or they might wish to control their level of psychological arousal (e.g. different levels of arousal for exercising rather than mental concentration) (DeNora, 1999; North, 2004). Thus music as an accompaniment for life fits in different occasions for individuals with different personality traits and life conditions. In addition, the atmosphere and the place in which music is being played or listened to might also influence the quality and modality of musical experience. Listening to music in a familiar location and friendly atmosphere might be a different experience rather than listening in a new and unfamiliar place. In addition to the role of place and atmosphere, music might also have its influence on the atmosphere of the place. This might be the reason for playing specific types of music in restaurants, cafes, and other public spaces such as private clinics and beauty salons.

Regarding the presence of music everywhere and in individuals' everyday life, music plays an undeniable role in the construction of individuals' autobiographical memory. It also might affect the perception of self and others and thus being present in the identity formation (Jäncke, 2008). Present in memory construction, music becomes a useful medium for recalling one's autobiographical memories. Thus it is likely that by listening to autobiographical music one can recall her autobiographical memories and life events. The individual might experience various emotions as a result of recalling. Nostalgia is one of the most reported emotions that are evoked in response to listening to autobiographical music and recalling autobiographical memories (Jäncke, 2008).

1.2. Nostalgia

In an affective sciences framework, nostalgia is a positive self-relevant and social emotion. It is linked to one's past and autobiographical memories such as life momentous events, close people, childhood and important first-time life experiences. It is considered as a psychological response to the sense of loss, and is defined as a linking phenomenon that connects the mourner (nostalgic person) to the past through her symbols and objects of loss. However, nostalgia is considered as a predominantly positive emotion with an ambivalent nature, in which simultaneous expression of happiness and sadness is present (Sedikides, Wildschut, Arndt, & Routledge, 2008a). It is also defined as a secondary emotion that has a dual nature with the experience of both pleasure and regret (Dickinson & Erben, 2006). This dual characteristic demonstrates the vague and allusive quality of nostalgic episodes. Additionally nostalgia is regarded as a cultural feeling that is acquired during lifetime and is linked to basic emotions such as grief and depression (Dickinson & Erben, 2006). Nostalgic feelings arise in response to feelings of loneliness and sadness. When an individual perceives a lack of social support (loneliness) it might result in experiencing nostalgia. Nostalgia is an indirect psychological response that compensates for the perceived lack of social support through recalling autobiographical memories (Zhou, Sedikides, Wildschut & Ding-Guo, 2008).

1.2.1. Nostalgia and Immigration

Nostalgia can also be evoked in response to loss and life crisis. It is mostly considered as a positive response to loss, that brings the meaning back to one's life (Routledge, Arndt, Hart, & Juhl 2011). It is a psychological resource and coping strategy that counteracts loneliness when lack of social support is perceived (Zhou, Sedikides, Wildschut, & Gao 2008) such as in the time of life transitions and crisis. In addition nostalgia is defined as a culturally acquired feeling that could be a consequence of specific social and historical circumstances such as industrialization of societies (Dickinson & Erben, 2006).

Immigration is one of the life conditions that may result in experiencing nostalgia. Immigration or geographical move is considered as important life transition. It might take place for different purposes such as changing living conditions, building a new life in a new country, finding better job opportunities, studying abroad, and also escaping one's home country for political and social reasons and seeking asylum in another country. Immigration is accompanied with sense of loss and thus psychological imbalance and challenges (Akhtar 1999). The migrant leaves the cultural familiarity behind and enters an unfamiliar culture and atmosphere.

The cultural unfamiliarity can cause a profound sense of loss in an individual's mind (Akhtar, 1999) and consequently the concept of the ideal home becomes constructed and fantasized (Tummala-narra, 2009). In addition, the social, cultural and economic conditions of the host country can become or seem harsh and relentless and the migrant might encounter, or perceive prejudice and discrimination. Sometimes this new and unfamiliar condition (living condition in the new country) may result in anxiety, feeling excluded, discontinuity in one's self and, psychological imbalance.

The migrant may experience various psychological and physiological states of mind due to her background, personal attributes and other conditions. In addition to nostalgia, homesickness and depression can be among these experienced states. In the homesickness case, psychosomatic symptoms (such as stomachache, loss of appetite, sleep disturbance, and headaches, disrupted concentration and absentmindedness) can be diagnosed (Watt & Badger, 2009). At times, the symptoms may include mental depression as well. In contrast, nostalgia seems to be the most positive response to feelings of loneliness, exclusion and self-discontinuity in times of social hardships. In addition, nostalgia is a phenomenon that is linked to one's past and autobiographical memories such as life momentous events, close people, childhood and life experiences.

1.2.2. Nostalgia and Music

Additionally, musical sounds are time-dependent perceptions. These time dependent stimuli are processed and integrated in the working memory (Jäncke 2008). Musical sounds can be involved in various memory processes (semantic, episodic and associative) relevant to the situation; a piece of music can be associated with a person's life events, (Baumgartner, 1992) and thus will be processed as an episodic memory and be recalled as autobiographical memory, or it can be perceived as a stimulus that conveys meaning and contains semantic information, (Koelsch et. Al., 2004) and is encoded semantically. Music in the context of nostalgic experiences is more likely to associate with autobiographical memory and the episodic and associative memory processes. Besides, nostalgia is considered as a linking phenomenon to the one's past and autobiographical memory. Thus memory both in the time of its construction and recall is fundamental in a nostalgic experience. Music-related nostalgic experiences are those pieces of music that relate the individual to her past and autobiography. Considering the role of music in memory construction (both semantic and episodic), autobiographical music pieces can be expected to be highly remarkable to the person's mind. As previously explained, nostalgia is one of the most reported emotions in music (Zentner, Grandjean, Scherer, 2008; Jäncke, 2008). Thus, it can be expected that nostalgic music plays an important role in individuals with higher nostalgic proneness personalities.

2. Research Design

The current project consisted of ten semi-structured interviews in which the focus was on personal music-related nostalgic experiences of young Iranian students living in migration (Two students living in Finland, and eight of them living in Germany). The nostalgic experiences were investigated in different layers: First, the quality and modality of nostalgic experiences in general, second, the characteristics of music-related nostalgic experiences, and finally, the connections between nostalgic experiences, migration and the role of nostalgic music in individuals' emotional regulation and well-being. However, the main focus of the project was specifically on 'music'-related nostalgic experiences and the role and function of music in triggering, recalling, and regulating nostalgic states of individuals. The interviewees were asked (prior to the interviews) to choose and bring five pieces of their self-selected nostalgic music to the interview session, They were given a more than one-month time period to contemplate and choose from their nostalgic music. During the interview, both the interviewee and the interviewer listened to those selected pieces together and talked about every piece of music and its relevant autobiographical story.

2.1. Interviewees

All the interviewees were in same age range (25-31 years old) except for one (38 years old), and all of them were recent migrants (between 6 months to 2.5 years) except for one (8 years). The questions were about the interviewees' length of stay and overall satisfaction, their history in nostalgia proneness, their nostalgic elements and triggers, their music-related nostalgic experiences and relevant autobiographical memories, and the consequences of becoming nostalgic, and their encounter with music in everyday life. During the session the interviewees were given enough time to contemplate and explain about their autobiography, life conditions and experiences and feelings as much as they desired to, except when they deviated too much from the main discussion theme. The length of interviews varied between twenty minutes to one hour and they were held in some of the interviewees' homes.

2.2. Analysis

As previously mentioned the project had a grounded theory approach. The goal was to explore the individuals' 'lived experience' in migration, not to provide any statistical data. Migration was one of the authors' lived-experience (living and studying in Finland and experiencing nostalgia) as well. The main disagreement in the previous literature was over defining nostalgia: first in terms of where it sits in various emotional models (e.g. Is nostalgia considered an emotion, is it a primary or secondary emotion, etc.), and secondly in terms of its recognition with other psychological states such as viewing it as similar to grief and depression (Dickinson & Erben 2006), or distinguishing it from homesickness (Sedikides, Wildschut, Routledge, Arndt, & Zhou 2008c). In the latter cases of nostalgia, recognition of the similarities or distinctions remains paradoxical. The reason for this paradox is that nostalgia has an ambivalent nature, and more importantly the characteristics of nostalgic experiences overlap with other psychological states such as depression and homesickness. The difference is that nostalgia is a self-regulatory mechanism that mostly functions for the achievement of psychological stability and equilibrium.

The qualitative framework was selected to probe into the depth of this experience. The authors decided to conduct interviews to simulate and discuss this 'lived experience' with those who had experienced it. Choosing and listening to (their autobiographical) music was a strategy for the actual simulation of nostalgic experiences for the interviewees. By listening to the music during the interview the autobiographical memory could be recalled and flowed to the forefront of one's mind. The individual could be exposed to the original experience, its images, events, and the feelings in her mind. This non-retrospective method allowed for better assumptions about the quality of (nostalgic) experiences.

The interviews were transcribed, and in the next step the transcriptions were codified with regard to four important keywords: Nostalgia: 1) Definition, 2) Content, 3) Elements, 4) Functions. This was the first stage of probing into the content of transcription. After several trials of the codifying process new themes and categories emerged from the transcriptions. The themes were being modified regularly and after the final decisions on main themes and categories, the transcription was codified, and the data was collected again for final data analysis, based on emerged themes.

3. Results

3.1. Nostalgia; How does it feel?

> "It is beautiful in a way, it is not painful, it is sweet but not very sweet, a faint pleasure…" (Pendar)
>
> "How I feel depends on the memories which arise … sometimes it is positive, sometimes it is negative" (Ramak)
>
> "Complicated, something between bittersweet and complicated, it has variations" (Golnaz)
>
> "It is bittersweet. In my opinion, the nature of life is kind of bitter but there are lots of little stories and tales in your life which make it sweet, so it is a combination of sweetness and bitterness." (Farhad)

The interviewees considered nostalgia as a complicated feeling with positive and negative characteristics, and its negativity or positivity depends on the specific experience itself. Interestingly some of interviewees reconsidered their definition of nostalgia almost at the end of the interview (after the music listening and discussions) with describing it as 'an enjoyable suffering', and 'pain in the teeth'. It seemed the music listening task influenced and changed the interviewees' opinion about the nature and quality of nostalgic experiences. After the listening task some of the interviewees claimed that the nostalgic experience is not as negative as they defined it in the beginning of the interviews. This can imply the important role of music in changing the nostalgic experience to a relatively positive experience.

3.2. What triggers nostalgia?

> "Smells, smell of orange blossoms, and the sounds in general, sound of my friends, and music too. Smell is more intensive" (Pendar)

> "Photos from my friends and places from Iran, photos from Tehran" (Ramak)

> "It can be music, and smells" (Golnaz)

> "Music, one food can have the same effect, one taste, but mostly music" (Kousha)

> "I feel nostalgic mainly by music ... I would say mostly by music or maybe by some movies" (Farhad)

Smells, photos (recalling family and friends by watching photos of them), a taste and music can trigger nostalgia.

> "Past loves, more with friends and beloved ones, past experiences, sounds of my friends" (Arash)
>
> "I remember I was in a car with my mom, with my family" (Ramak)
>
> "Something that reminds me of childhood" (Pendar)
>
> "People that I don't have around me, like my uncle, my mom, my friends in my homeland, mostly people" (Farnaz)
>
> "The past times with my friends and family, we had some good times, even bad times"
>
> "I miss people, like my grandmother, I missed a period of my time that I was very happy, like my childhood" (Siavash)

Important life periods such as childhood and loss of important life figures (grandparents) are the elements that trigger nostalgia in an indirect way. A feeling (such as loneliness) or a smell or a piece of music triggers and recalls the associated memory. Nostalgic feeling arises as a consequence of recalling process. Nostalgia evokes in response to yearning for the past or the lost, and fosters the individual's life with meaning and memories of the sweet past.

3.3. Personal nostalgic music

Music-related nostalgic experience is a special experience from various aspects. As participants discussed their music-related experiences, it could be noticed that their description is very accurate and in-detail. In addition listening to nostalgic music can evoke relevant emotions and it can help the individuals in expressing themselves. Regarding the overlaps of musical and memory processes in the brain (Jäncke 2008), the autobiographical music helps the listener in recalling the relevant event and feeling and it's every specific detail. The participants described almost every event carefully by constructing the whole scene and atmosphere.

> "My grandpa used to listen to this music, small LDs and he used to listen to it everyday. I was four or five. I remember very clear how the situation was with my grandparents, the yard, the basement, this music brings it out." (Pendar)
>
> "Actually I was listening to this music and my mother called and told me that your grandpa passed away. As I was moving to my grandpa's house, when I arrived there I saw him passed away. I remember his face ..." (Kousha)

Music is direct and inevitable, thus it is capable of evoking emotions while listening. A listener cannot completely control her emotional experience when listening to autobiographical music. Another issue in listening to nostalgic music is the matter of typicality; either individual listen to their nostalgic music intentionally or unintentionally.

> "I never collect nostalgic music in my computer, most of the time I don't listen intentionally." (Siavash)
>
> "It doesn't work if I want to produce it. I play it first and the nostalgia comes to me, it depends on how my memory works" (Golnaz)
>
> "I do it intentionally sometimes, to put the memories behind and move on. It is stimulating" (Ramak)
>
> "When I wake up in the morning, I play these kinds of music that I love for myself, and I feel myself as at home and life goes on" (Farhad)

Other important issues for listeners are musical characteristics and the meaning lies in that specific piece of music. A nostalgic individual listens to her nostalgic music with accuracy and attention. The lyrics and the vocal expression are important factors in musical meaning and value.

> "The story of Inferno, by Dante (music by Tchaikovsky); I was 9 or 10, it was so painful, hard music. It made me very sad at that time; I started to read Dante … It was mayhem; it was so painful for a kid. Brings me back to that age, exactly the feeling I had, living and hell and the situation when you are dead, and combining the music and its story"(Pendar)
>
> "This song is an Iranian traditional, basically the music is sad but the lyrics are so hopeful, it talks about that 'we are all hopeful, we hope for better days, there are some kind of problems, we will overcome those problems, we will wake up to see brighter days" (Golnaz)
>
> "It is sad music, in the northern dialect of Iran. It is talking about the moon and asks the moon to please come out" (Farnaz)
>
> "It is a song from Elend, my favorite band. I like this song, really a sad and melancholic one … the song is about the coldness of society and how lonely we are in this planet …" (Babak)

For those with a musical background (instrument players or professional listeners) musical value, quality and interpretation of a piece can affect its nostalgic attribute.

> "Listening to it without knowing Beethoven, very fast and very hard, too sad I realized that he was deaf, the feeling is not that sadness, its very static, nostalgic for me only because of Toscanini, his interpretation of this music"(Pendar)

To summarize, music is a strong and successful tool in recalling autobiographical memories comparing to other triggers (such as smells, photos, taste, etc.). It is also utilized for mood regulation. Thus music can be considered as a convenient means in the nostalgic experiences.

Additionally in migration, other factors impact the quality, frequency, and functionality of nostalgic experiences. Of those factors the length of stay and the new environment's atmosphere can be mentioned.

> "There is a difference between listening to this music here and back there, that I know now that I will never experience this again, I experienced it once and it's gone" (Pendar)
>
> "But here that I am too far from my country, all of these songs are stronger for me, because I think I am really far. Maybe I will never live like before anymore, because I have left something behind, and therefore, those songs are stronger for me." (Farnaz)
>
> "When I am here, and here the whole society is different compared to my country … those music pieces that I was always listening to back in Iran, when I listen to them here I kind of feel myself at home" (Farhad)

3.4. How do individuals benefit from nostalgic experiences?

An important topic in a nostalgic reverie is nostalgic proneness as an individual factor (Barrett, Grimm, Robins, Wildschut, Sedikides, & Janata, 2010). Individuals differ in encountering a condition that might result in becoming nostalgic. Various individuals with different personality traits (e.g. low avoidance vs. high avoidance) and backgrounds (e.g. stable vs. clinically depressed) benefit differently from becoming nostalgic, and nostalgic experiences have various rewards (or in some specific cases harms) for them.

The individual differences in confronting and utilizing nostalgia (Zhou, Sedikides, Wildschut, & Ding-Guo, 2008) are based on individuals' attachment style, resistance and avoidance. The noticeable psychological attribute -emerged from interviews- was the encounter style that refers to individuals' avoidance or acceptance of nostalgic moods. The encounter style seems to be a very important factor that determines the functions of nostalgia.

Acceptance in encounter:

> "I am entering that time, as a kid, for a short interval I stay there and I come back to the present and that's me feeling nostalgia … It feels good, it should come for itself, helps me to understand many thing" (Pendar)
>
> "No I don't avoid the memories, I don't like to escape from reality." (Kousha)

Avoidance in encounter:

> "Mostly I don't like this feeling and I feel negative about it. I am a kind of person who doesn't like to go to this [nostalgic] mood" (Farnaz)
>
> "Nostalgia always has this definition for me; to be influenced by past times … to be a slave of the environment … the moment is like a threshold for me, I lose the power to control myself" (Babak)

Avoiding a potential nostalgic condition is evident when an individual has a clinical depression background. The clinically depressed individuals seem to avoid nostalgia assertively, and they resist against becoming nostalgic. Because it obviously has more harms than benefits for them. Volkan (1999) has termed this state as poisoned nostalgia.

> "It is not good for me. It doesn't help me. I had a long depression for 7 years; I miss the time before that depression … I don't feel good now, when I am listening to this music, I cannot stop thinking about that period before depression … Always try to listen to happy songs; because I don't want to return to my previous state … I avoid my memories, and I am a very nostalgic person, being nostalgic is harmful for me … I don't want to make myself sick again, so I don't listen to some old music" (Siavash)

> "This nostalgic feeling, I try to avoid it when I am here, maybe because I went through a very hard depression when I came here…" (Shabnam)

The subjective experience of nostalgia is another interesting aspect for some individuals.

> "It makes me feel this kind of love, I don't know why, maybe because of the voice of the female singer. Maybe the events of love or passion or something like that. I was in this kind of love, but not exactly related to a specific event in past … It makes me nostalgic because it hasn't happened" (Farhad)

Within this specific imagined experience the individual constructs every detail in her desired situation: 'what kind of event is the situation', 'what music is being played, 'what is her role in the scene', etc. It might be perceptions of philosophical meanings.

Another feature is the relevancy of the experience to a social context that is called 'shared nostalgia'.

> "I liked this music, and I tried to find the singer and the composer and I was unsuccessful. Now, recently I found this track and I suggested it to my friends and they liked this track, and at that time I had a little jazz band and we tried to play this track together…" (Farhad)
>
> "I used to play this song maybe a thousand times after that political event, in my car, at home, like a loop…" (Golnaz)
>
> "There is nobody here that has this feeling [nostalgia]. If somebody has such a feeling that can be shared … I have friends, and we have some common nostalgic experiences together when we talk about it" (Pendar)

Nostalgic experiences have different functions for individuals regarding their personal and socio-cultural differences. For example nostalgia is a relevant topic in the discussion of 'self and identity'. Nostalgic experiences are the result of the recall of one's autobiographical memories and life experiences. By remembering and reviewing the history, one can obtain and rebuild her individual self. In a social context, sharing memories with others, feelings of inclusion in a society, feelings of belonging, and possessing a collective identity are the factors that counteract loneliness, nurture one's identity, and foster meaning in one's life. Nostalgia as a linking phenomenon is the experience that connects the individual to her background and history, brings continuity, value and meaningfulness for the self, and nurtures the identity.

> "Something belonging to my past, doesn't help me, not at all, it is restricted to me too. Nostalgia is the only thing that connects me to some parts of my life, the past…" (Pendar)
>
> "When I feel nostalgic and I remember something good from the past, I feel good that I had such good times there … somehow I feel happy that I experienced that condition as well" (Golnaz)

Nostalgia also plays an important role in the mood regulation process. Considering the bittersweet nature of nostalgia, it might convey the bitterness of the lost and gone past, and thus some individuals may resist or avoid experiencing it, but at the same time it consists of the sweetness of remembering and recalling one's life experiences. As participants phrase it, nostalgia is a 'kind of joyful suffering', 'a masochistic feeling', 'a sad feeling that one should push it to come out in order to put memories behind and move on'. The latter expression is the exact function of nostalgia as a tool in regulating negative moods in order to obtaining a more stable emotional state. The process can be repetitive for some individuals as to achieve the desired stability.

> "I try to regenerate the feeling of the past and feel the same" (Arash)

Additionally meaningfulness is fundamental in the time of individuals' life crisis (Routledge, Arndt, Hart, & Juhl, 2011). In a nostalgic experience the meaning is obtained by recalling memories and important life experiences of 'being together', 'understand something about life', and 'feelings of love'. By recognizing 'valuable moments of life', and 'review of what one has done in life' the meaning is imbued in one's life.

> "I like to feel nostalgic, it makes me very deep, there is a meaning for me in that time, valuable moments in life ... somehow made me experience love. I felt the whole concept of love without it being real" (Arash)

Another utilization of nostalgia can be sympathizing-empathizing.

> "The feeling is like my father is sad, because the song is sad, so it reminds me of the sadness of my father ... I suppose that it was a nostalgic song for him." (Farnaz)

> "Listening to it without knowing Beethoven, too sad I realized that he was deaf, the feeling is not that sadness, it's very static ... nostalgic for me only because of Toscanini's interpretation of this music" (Pendar)

> "I am listening to this music, I feel myself- same as in movies- as the performer of the music, for example the pianist" (Farhad)

In those cases the individuals may benefit from reverse sympathizing in the sense that they sympathize with a closed one (my father) or an important life figure (Beethoven), and/or empathize with those people's conditions (putting themselves in others' shoes). Individuals compensate for their need of being sympathized and empathized with by sympathizing or empathizing with others.

4. Final Thoughts

4.1. Music's role in a nostalgic process

A general important observation is the outstanding role of music in nostalgic experience. Music can be involved in the construction of a specific memory, it can trigger nostalgia by recalling autobiographical memory, and it accompanies the individual through the process of 'mourning the loss' and finally regulates the feelings and brings emotional stability for the individual. Thus, music can be considered a very important means in nostalgic experiences, from its initial stages of memory construction until the final stages of regulation and relief.

In this project migrants described that they utilize their autobiographical music to recall their memories of homeland and past life, and to review their life passages and reconstruct their identity and collective self based on their past and present conditions. Additionally, music itself has an important position in identity and cultural construction. Parts of the self-selected music pieces were homeland-related. Famous old songs, old national anthems, liberty and folklore songs were included in participants' self-selected music. Overall, the results show that the role of music in nostalgic experiences takes place in a regulation cycle, which is depicted in the next page.

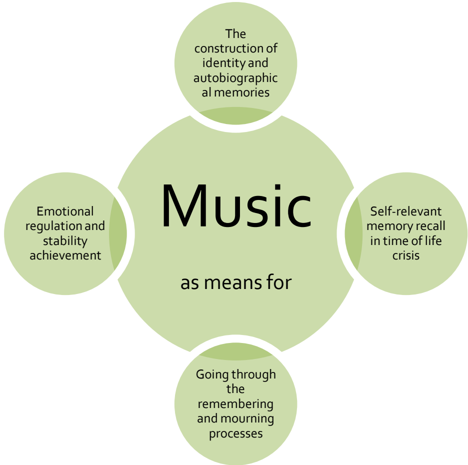

Figure 1. The role of music in nostalgic experiences in a regulation cycle.

4.2. Cultural and socio-economic considerations

The concept of homeland and its importance are among cultural and historical attributes of many cultures, and nostalgia, depression, grief and homesickness are consequences of becoming detached from the nature and roots. This paradigm of exile for Iranians resides in poetry and literature (Naficy, H., 1991). It has to be emphasized that poetry is an influential actor in Iranian culture that shapes and suffuses its attributes and is present in Iranians' worldviews and thoughts. The most popular and famous example for the concept of exile and nostalgia is a poem by Molana (Rumi), the 'Song of Reed'. In this piece the reed tells its life story, in which it got detached from its origins, and now the reed has become the symbol for expressing exile and detachment:

Song of Reed*

1. Now listen to this reed-flute's deep lament
About the heartache being apart has meant
2. Since from the reed-bed they uprooted me
My song's expressed each human's agony,
3. A breast which separation's split in two
Is what I seek, to share this pain with you:
4. When kept from their true origin, all yearn
for union on the day they can return.
5. Among the crowd, alone I mourn my fate,
with good and bad I've learned to integrate,
6. That we were friends each one was satisfied
but none sought out my secrets from inside…

*Translated by Jawid Mojaddedi. From "Rumi: The Masnavi, Book One," New York: Oxford University Press, 2004

In addition, the sample population of this project was limited to students from the same ethnicity; the interviewees were all Iranians in their late twenties (except one). They all have lived in Tehran, Iran's capital. This age group (again except one interviewee) is born after the 1979 revolution, and has experienced the socio-economic consequences of an eight-year war (Iran-Iraq) during their childhood (The war took place mostly in the south-western Iranian border, although Tehran was bombarded many times as well.).

Specific socio-economic circumstances, and possible psychological consequences might influence the intensity and quality of nostalgic experiences for a specific generation.

Another effective factor might be the social, political, economic and cultural attributes of the host country. Moreover, the weather climate can be highly effective as well. Living in a new cultural framework, coping with different social and political issues, a different climate and different social regulations for migrants are all among the issues that an international student is confronted with. The range of similarities or dissimilarities of the mentioned cases (in comparison with their home country) can impact the psychological conditions of international students. Considering all such influential factors in emotional states of immigrants, our research results can be applied for other nationalities and generations as well.

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A SIMPLE, HIGH-YIELD METHOD FOR ASSESSING STRUCTURAL NOVELTY

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Abstract

The structural dimension of music plays an important role in its affective appreciation. One particular aspect is related to the temporal succession of moments, each characterized by particular musical properties. One classical approach in computational modelling of this aspect is based on similarity matrix representations, where successive states are visualized by successive squares along the main diagonal, bearing some resemblance to checkerboards. One referential method estimates a so-called novelty curve, representing the probability along time of the presence of transitions between successive states, as well as their relative importance. Novelty is traditionally computed by comparing – through cross-correlation – local configurations along the diagonal with an ideal checkerboard kernel. The method is limited by a strong dependency on kernel size, which imposes a single level of granularity in the analysis and fails to grasp common musical structures made of a succession of states of various sizes. We introduce a simpler but more powerful and general method that automatically detects homogeneous segments of any size. Only half of the similarity matrix is retained, in order to compare each new instant solely with the past and exclude the future. For each instant in the piece, novelty is assessed by first determining the temporal scale of the preceding homogeneous part as well as the degree of contrast between that previous part and what just comes next. Detailed results show how and why this method offers a richer and more intuitive structural representation encompassing all granularity levels.

Keywords: structure, similarity matrix, novelty

1. Introduction

The structural dimension of music plays an important role in its affective appreciation. One particular aspect is related to the temporal succession of moments, each characterized by particular musical properties. The idea is to automatically segment audio files into a series of homogeneous sections, through the estimation of temporal discontinuities along diverse alternative features such as timbre in particular (Foote & Cooper, 2003).

One classical approach in computational modelling of this aspect is based on similarity matrix representations, where successive states are visualized by successive squares along the main diagonal, bearing some resemblance to checkerboards. The referential method estimates a so-called novelty curve, representing the probability along time of the presence of transitions between successive states, as well as their relative importance (Foote & Cooper, 2003).

We show the limitation of the state of the art and introduce a new method that offers a richer and more intuitive structural representation encompassing all granularity levels.

The model has been implemented in *MIRtoolbox* (Lartillot & Toiviainen, 2007) and is available in the new version 1.5 of the toolbox.

2. Similarity matrix

One common MIR method to describe the structural content of music is based on *dissimilarity* and *similarity matrices*, constructed from a selected audio or musical feature. A *dissimilarity* (resp., *similarity*) *matrix* shows the dissimilarity (resp., similarity) between all possible pairs of frames from the input data. The matrix is constructed as follows: At each successive instant of time (each column *x* in the matrix), numerical distance (in the case of dissimilarity matrix) or numerical similarity (in the case of similarity matrix) is computed between that current instant (point (x,x) on the diagonal of the matrix) and previous instants (points (x,y<x) that are below point (x,x)), as well as succeeding instants (points (x,y>x) that are above point (x,x)).

A graphical representation of the dissimilarity (resp., similarity) matrix, as in Fig. 1, shows these numerical distances (resp., similarities) using a color convention. In *MIRtoolbox*, high values are indicated by warm colors (red, yellow) whereas low values are indicated with cold colors (dark blue, light blue). In a dissimilarity matrix, the main diagonal, representing the absence of dissimilarity between one time frame and itself, is by property dark blue (Fig. 1). Similarly, the main diagonal of a similarity matrix is by property red (Fig. 2).

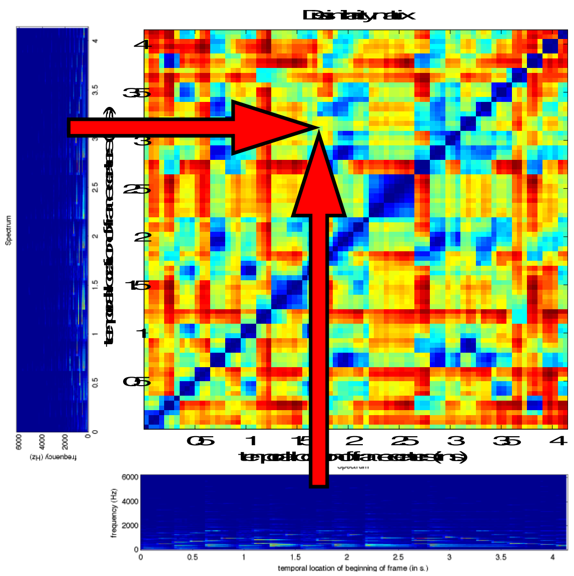

Figure 1. Dissimilarity matrix (top right) showing dissimilarities between frames of a spectrogram (represented both left and bottom).

In the dissimilarity matrix, the distance at each point can be computed using various distance measures. Cosine distance seems to be a good choice for most features, because it enables to compare profile of feature vectors without focusing on the absolute amplitude of the elements of those vectors. For instance, when comparing key strengths (Krumhansl, 1990; Gómez, 2006) between two frames, what is of relevance is the relative importance of tonal centers, not the actual energy in each of those. This distance is chosen my default in *MIRtoolbox*:

ks = mirkeystrength(filename, 'Frame')
dm = mirsimatrix(ks, 'Dissimilarity');

On the contrary, for other features such as Mel-Frequency Cepstral Coefficients (MFCCs), the absolute values are of importance for the comparison. In such case, Euclidean distance, for instance, is more suitable:

cc = mirmfcc(filename, 'Frame')
dm = mirsimatrix(cc, 'Dissimilarity', 'Distance', 'Euclidean');

In similarity matrices, similarity at each point is computed by turning the dissimilarity measure into a similarity measure based on a transformation. One simple choice is a linear transformation of the type $y = 1-x$; a common alternative is an exponential transformation of the type *exp(-x)*, which emphasizes a small dissimilarity through a more important drop of similarity than in the linear transformation. In the following, we will use this exponential similarity measure, which is chosen by default in *MIRtoolbox* when computing the similarity matrix:

sm = mirsimatrix(dm, 'Similarity')

Dissimilarity and similarity matrices reveal homogeneous parts: successive homogeneous states are visualized by successive squares along the main diagonal, bearing some resemblance to checkerboards.

3. Previous "kernel approach" for novelty curve estimation

The main idea behind the notion of *novelty* is that the structure that can be seen from the similarity matrix, with the succession of homogeneous states, could be explicitly represented in a temporal curves where peaks indicate the position of those transitions, and the height of the peaks would correspond to some kind of structural importance.

In a seminal approach (Foote & Cooper, 2003), the estimation of novelty curve is based on the observation that important structural transitions can be seen in the matrix as a succession of squares along the diagonal. For that reason, the novelty curve at each time frame *t* is estimated by comparing the subpart of the matrix around the corresponding point on the diagonal, i.e., (t,t), with an ideal representation of a structural transition, modelled as a 2*2 checkerboard made of two red squares on the diagonal (representing high similarity between a same segment) and two blue squares outside the diagonal (representing low similarity between successive segments). More precisely, the novelty curve results from the cross-correlation of a Gaussian smoothed checkerboard kernel along the diagonal of the similarity matrix.

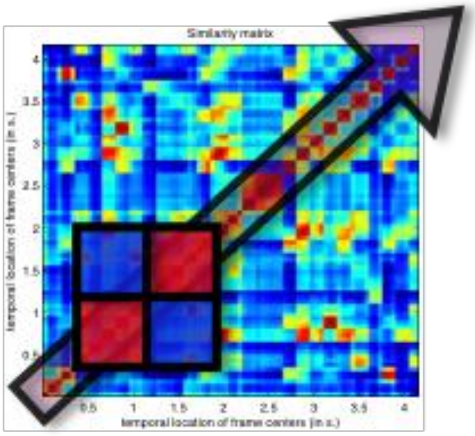

Figure 2. In the kernel approach, segmentations are detected by comparing each successive subpart of the similarity matrix along the diagonal with a checkerboard kernel, idealizing a perfect succession of two segments of same size.

The method is strongly dependent on the specification of the size of the checkerboard kernel. Fig. 4c, 5c, 6c, 7c, 8c and 9c show examples of novelty curves extracted using a kernel of size 64 samples, based on the following *MIRtoolbox* command:

mirnovelty(sm,'KernelSize',64)

Fig. 4d, 5d, 6d, 7d, 8d and 9d show examples of novelty curves extracted using a kernel of size 16 samples:

mirnovelty(sm,'KernelSize',16)

As we will see more in detail in Section 5, this kernel-based method imposes a single level of granularity in the analysis, thus failing to grasp common musical structures made of a succession of states of various sizes.

4. New approach

We introduce a simpler but in the same more powerful and more general method. The idea is to automatically detect homogeneous segments of any size (or *temporal scale*). Future events are excluded in order to focus on the temporal causality of music perception. This means that only half of the similarity matrix, below the main diagonal, is retained.

For each successive column in the similarity matrix, corresponding to a time frame *t*, the novelty value at that time is estimated by detecting whether a homogeneous segment ends just before *t* (cf. Fig. 3). More precisely, the idea is to estimate the *temporal scale* of the previous ending segment as well as the *contrastive change* before and after the ending of the segment. The novelty value is then represented as a combination of the temporal scale and the amount of contrast.

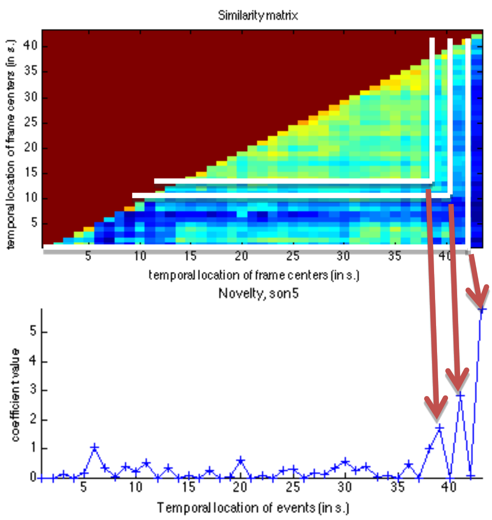

Figure 3. Dissimilarity matrix (top) and its corresponding novelty curve (bottom), computed using the new approach. For the three peaks at time t = 39, 41 and 43 s, the corresponding triangular homogeneous segments are shown in the matrix.

For the particular column at time *t*, in order to assess the temporal scale of the segment ending just before *t*, we consider the triangular part of the similarity matrix that is below the main diagonal and left to the column *t* (cf. examples of triangular part highlighted in Fig.3). The idea is to detect how much of this triangle, starting from its apex at point *(t,t)*, can be considered as a whole homogeneous segment that is globally of higher value than the new column on its right, at time *t*. The triangle is progressively constructed from its apex *(t,t)* downward, line by line, by checking whether each new line to be added to the triangle is globally of higher similarity values than the next point at time *t*. More precisely, for a given line, we check that both following conditions are fulfilled:

- the new similarity value at time *t* is lower than the similarity value at time *t* – 1 (i.e., the rightmost point of the triangle at that line).
- the new similarity value at time *t* is lower than two standard deviations below the mean of the similarity values along the current line of the triangle.

Once this does not hold true anymore, the construction is interrupted, and we keep the triangle above this unsuccessful line. We obtain a triangle that corresponds to the "ending segment", and the height of the triangle corresponds to the *temporal scale* of this ending segment.

The amount of contrast between this triangular segment and the new column at time *t* is simply computed as the city-block distance between the last column of the triangle and the new column at time *t* for that particular temporal scale.

As we will see in the examples in the next section, this method offers a structural representation that encompasses all granularity levels. This approach is integrated into MIRtoolbox 1.5 and is used by default when calling *mirnovelty*.

5. Detailed analysis of one piece of music

This section presents various structural analyses – spectral (Fig. 4 and 5), timbral (Fig. 6), tonal (Fig. 7 and 8) and metrical (Fig. 9) – of the first 160 seconds of a performance of the *Scherzo* of L. van Beethoven's *Symphony No.9 in D minor, op.125*. Each figure shows first the similarity matrix (Fig. 4a, 5a, etc.) – or more precisely the half, below the main diagonal, corresponding to the memory of the music already heard, with respect to each current time – followed by the novelty curve estimated using the new method introduced in the previous section (Fig. 4b, 5b, etc.), as well as two versions of the kernel-based method using two different granularity levels (Fig. 4c and 4d, 5c and 5d, etc.)

Whereas in the kernel-based method, close points are highly correlated (Fig. 4c and 4d for instance), the curve produced by the new method (Fig. 4b for instance) precisely indicates the temporal location of various segmentations with relatively isolated pulses.

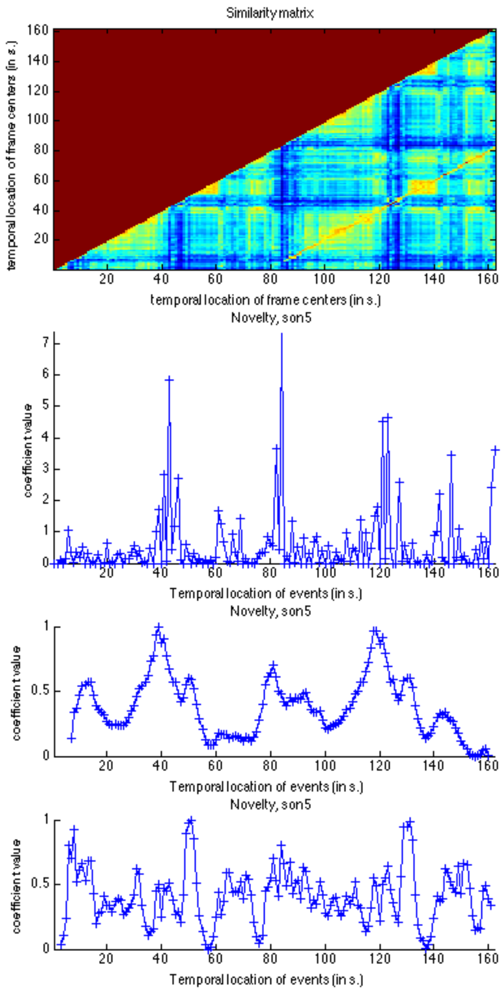

Figure 4. Similarity matrix (4a) and novelty curves based on the new approach (4b) as well as the kernel-based approach with kernel size 64 samples (4c) and 16 samples (4d), all based on a spectrogram with frame size 2 seconds, and a hop of 1 second.

In the kernel-based method, the choice of kernel size has a strong impact on the result. For large kernels, highest peaks in the curve might indicate important segmentation points in the piece, but lower peaks and the curves in-between might be more difficult to interpret. When using a shorter kernel, the actual size of the larger homogeneous parts is not taken into account. In fact, peaks may indicate a transition between segments, an ending segment or a starting segment (such as around t = 55 s in Fig. 5d), which makes the result more difficult to interpret.

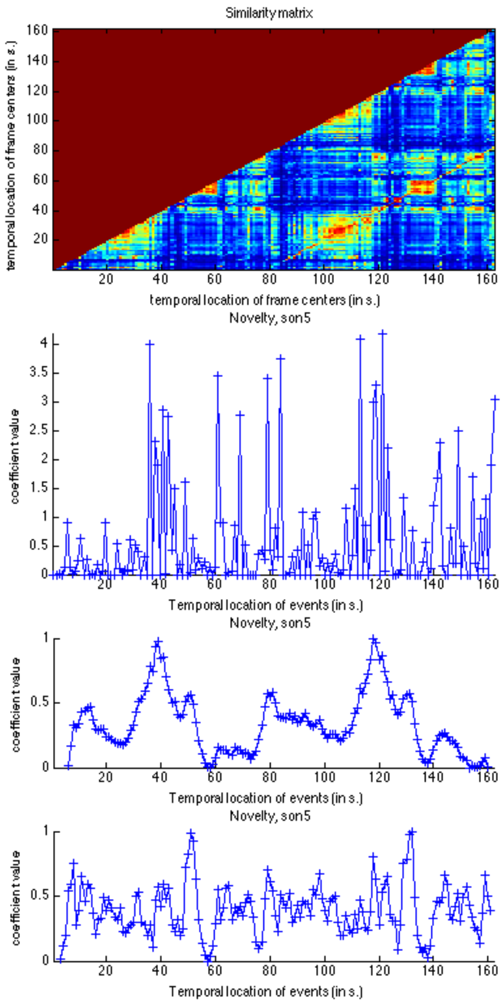

Figure 5. Same as in Fig. 4 but with an autocorrelation function as input, with frame size 2 seconds, and a hop of 1 second.

Fig. 6c and 6d eloquently show a main limitation of the kernel approach: since the idea was to detect structure resembling checkerboard patterns, the transition between two squares of same size, in particular around t = 30 s and t = 110 s, are considered as the most important segmentation points in the piece. The new approach, on the contrary, shows that this transition is not of high importance. It rather highlights the presence of more salient structural endings, related to homogeneous parts of larger temporal scale (such as the 30 s long part ending a little after t = 40 s, t = 70 s, etc.; or the 70 s long part ending at the half and at the end of the piece).

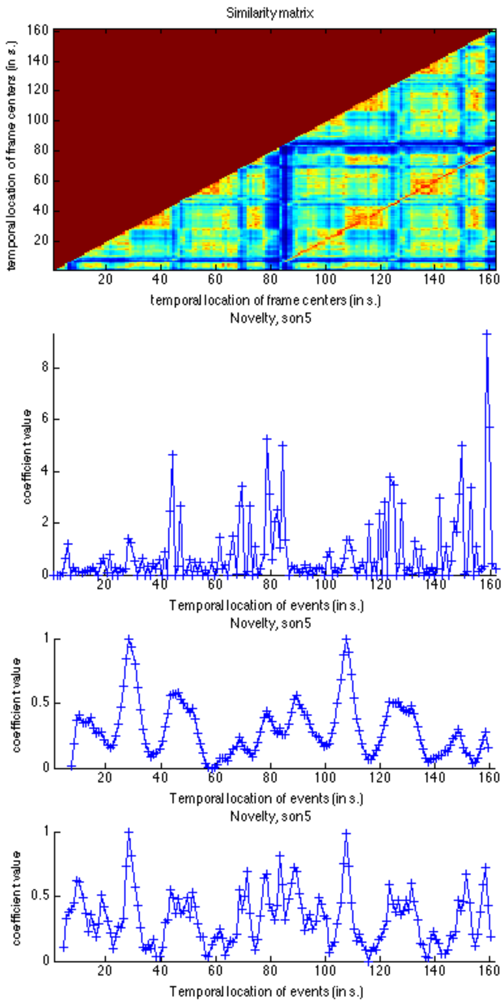

Figure 6. Same as in Fig. 4 and 5 but with MFCCs as input, with frame size 3 seconds, and a hop of 1 second. The dissimilarity is based on Euclidean distance.

On the other hand, Fig. 7b shows a limitation of the current version of new approach, due to a hypersensitiveness to isolated columns that are highly dissimilar to neighbor columns, such as around t = 90 s. This problem can be avoided by filtering out somewhat the isolated column through blurring: by considering a frame size of 5 s instead of 2 s (Fig 8a and 8b), the isolated columns are less important, and not detected anymore by the new approach. We notice also that these outlying columns do not affect the kernel-based approach (cf. Fig. 7c and 7d, compared to Fig. 8c and 8d).

This shows that the current version of the new approach cannot properly handle similarity matrix with highly salient isolated columns.

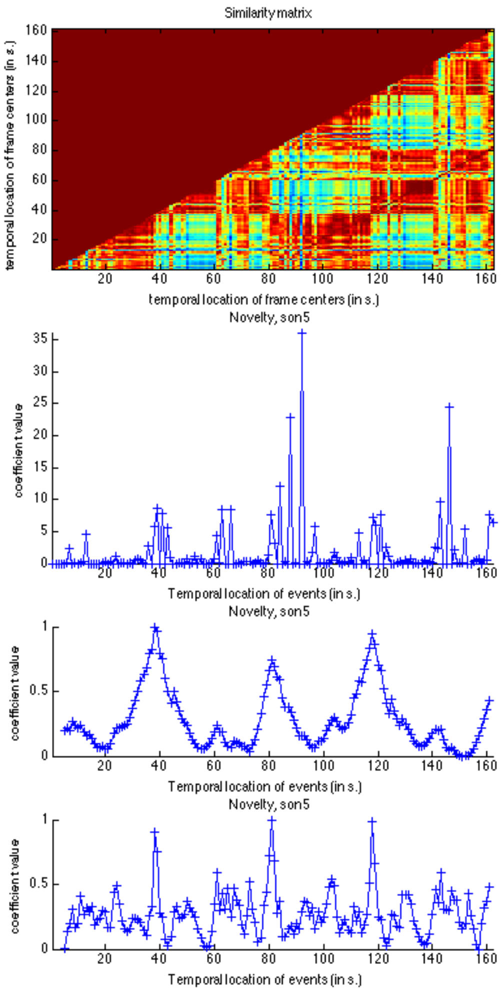

Figure 7. Same as in Fig. 4 to 6 but with key strength vectors as input, computing on a 2-second long moving window with 1-second hop.

The approach might be made more robust by finding more suitable conditions governing the construction of the triangle presented in section 4, in order to better treat such outlying columns and lines in the similarity matrices.

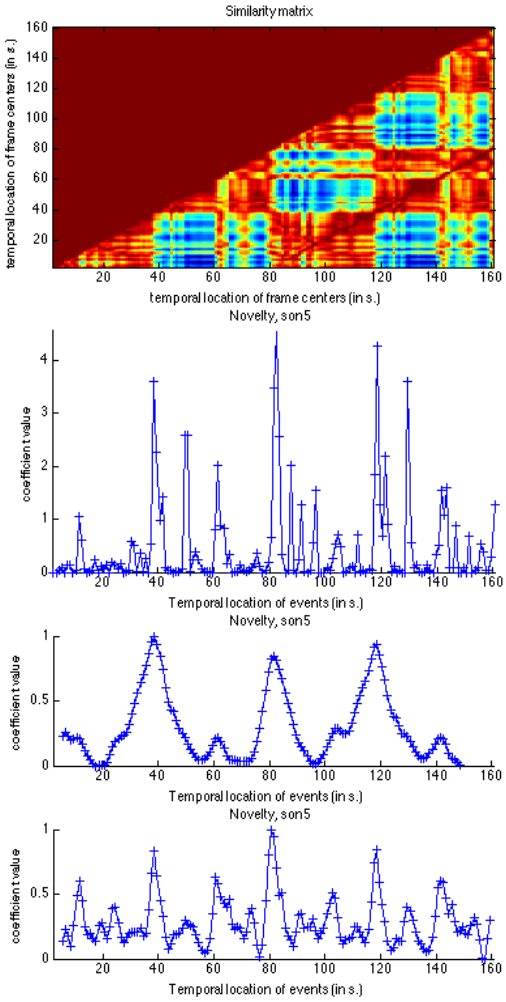

Figure 8. Same as previous figure but with a window length of 5 seconds.

Figure 9 shows another interesting property of the new approach for estimating novelty curve. The transition from one homogeneous state to the next one can sometimes be progressive, and each state can progressively decay over several frames, as can be seen in Fig. 9a with the progressive gradient of colors from dark red to dark blue at the right end of the triangular parts. This happens in particular when the frame decomposition is based on a smaller hop, such as .25 s in Fig. 9. In such case, the new approach for novelty curve shows not a single pulse, but a lobe, still very sharp, but with a width of several frames. Hence in the new approach, the importance of peaks in the novelty curve is indicated not only by height, but more generally by the area of such sharp lobes.

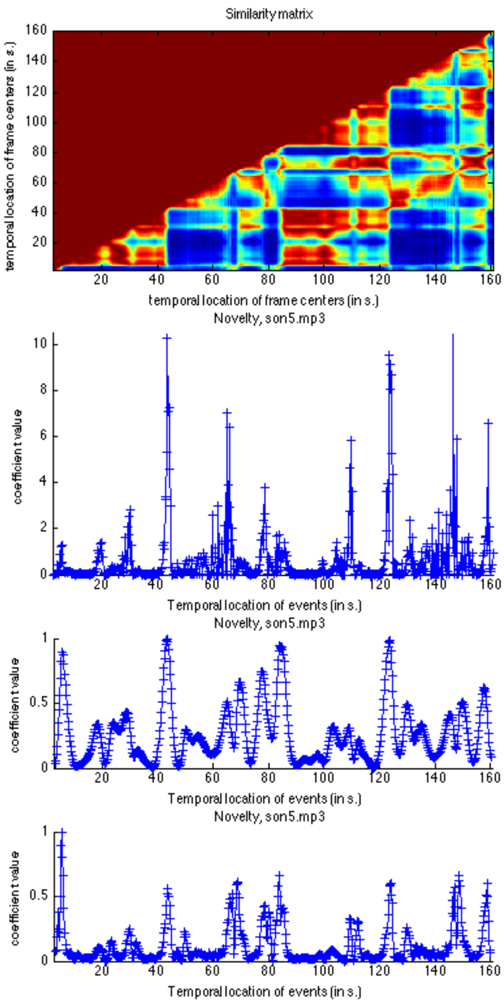

Figure 9. Same as in Fig. 4 to 8 but based on a metrical autocorrelogram with a hop equal to .25 s. (The first half of this metrical autocorrelogram is shown in Fig. 6a in (Lartillot et al., 2013).)

As for a more qualitative and musical conclusion concerning the structural analysis of this performance of Beethoven's *Symphony No.9 Scherzo*, we can notice the very interesting differences and imbrications between the similarity matrices computed from the different audio and musical features.

6. Synchronicity between novelty curves

In this paragraph, we evaluate the synchronicity of the novelty curves computed from main audio and musical features, using the current version of the algorithms while writing the paper, i.e., *MIRtoolbox* 1.4.1.5. The structural analysis is based on the following features:

- spectrogram with frame size 2 seconds, and a hop of 1 second:

a = mirspectrum(filename, 'Frame', 2, 's', 1, 's')

- cepstrogram with frame size 2 seconds, and a hop of 1 second:
  b = mircepstrum(a)

- autocorrelation function of the audio waveform with frame size 2 seconds, and a hop of 1 second:

c = mirautocor(filename, 'Frame', 2, 's', 1, 's')

- MFCC with frame size 3 seconds, and a hop of 1 second:

d = mirmfcc(filename, 'Frame', 3, 's', 1, 's')

- chromagram with frame size 2 seconds, and a hop of 1 second:
  e = mirchromagram(filename, 'Frame', 2, 's', 1, 's')

- key strength with frame size 2 seconds, and a hop of 1 second:
  f = mirkeystrength(e)

- chromagram with frame size 5 seconds, and a hop of 1 second:
  g = mirchromagram(filename, 'Frame', 5, 's', 1, 's')

- and key strength with frame size 5 seconds, and a hop of 1 second:
  h = mirkeystrength(e)

All features were extracted from thirty-six musical excerpts covering a large range of musical styles from baroque to contemporary classical music (Eliard et al., 2013; Eliard & Grandjean, in preparation) with a mean duration of 155.83 ± 10.66 seconds. As indicated in section 2, similarity is based on cosine distance for all features:

n1 = mirnovelty(a), *n2 = mirnovelty(b)*, etc.

except for MFCCs where Euclidean distance is used instead:

n4 = mirnovelty(d, 'Distance', 'Euclidean')

In order to evaluate the similarities between the different novelty curves, we compute a normalized cross-correlation – without centering – between each pair of novelty

Table 1. Normalized cross-correlation – without centering – between each pair of novelty curves computed from the following features: spectrogram (spec), cepstrogram (ceps), autocorrelation function (ac), MFCCs (mfcc), chromagram with 2 second frame (chro2) and key strength (keys2), and same for 5 second frame (chro5 and keys5).

	spec	ceps	acor	mfcc	chro2	keys2	chro5	keys5
spec	1	.42	**.78**	.41	**.7**	.45	.25	.19
ceps		1	.35	.35	.35	.26	.25	.18
acor			1	.36	**.65**	.45	.22	.16
mfcc				1	.3	.23	.26	.21
chro2					1	**.63**	.21	.15
keys2						1	.17	.12
chro5							1	**.66**
keys5								1

curves. Due to the particular aspect of the novelty curves given by the new approach, where the presence of isolated peaks makes the distribution non-Gaussian, it would not make sense to assess the linearity between curves based on Pearson correlation. We note however that due to the fact that the novelty values are always positive, and that most values are low and very few are high, a direct cross-correlation between novelty curves will show whether their peaks are well synchronized or not. The cross-correlation can be normalized in the same way as a traditional cross-correlation, except that in our case there is no centering, since the absolute magnitude (whether a point belongs to a peak, or is close to zero) plays an important role.

The results of the correlations are shown in Table 1. We can see that spectrum-based and autocorrelation-based novelty curves are highly similar, and similar to chromagram with same 2 s long frames. This may be intuitive since spectrum and autocorrelation function are two different but closely related low-level description of audio, and that chromagram is directly based on spectrum. Chromagram and key strength with same frame size are highly related, because keystrength is highly based on chromagram. On the other hand chromagrams (or keystrengths) with different frame sizes are not cross-correlated at all. This may be due to the problem related to excessive peaks using the 2 second long frame, as discussed in section 5.

7. Discussion

As explained in section 4, in the new approach, the novelty values correspond to a combination between two factors: the *temporal scale* of the previous ending segment and the amount of *contrastive change* before and after the ending of the segment. We might consider in future works a study of each factor separately, and a study of the optimal combination between these two factors.

We also observed in section 5 that in high-resolution similarity matrices, the new approach for novelty curve might include not solely single pulses, but also sharp lobes with a certain width. We noted that the importance of peaks in the novelty curve is indicated not only by height, but also more generally by the area of such sharp lobes. An alternative representation would be to integrate the novelty curve, so that the obtained novelty values would indicate the total contrastive change before and after a progressive transition between segments.

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ESTIMATING TEMPO AND METRICAL FEATURES BY TRACKING THE WHOLE METRICAL HIERARCHY

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Abstract

Meter is known to play a paramount role in the aesthetic appreciation of music, yet computational modelling remains deficient compared to other dimensions of music analysis. Classical audio-based methods detect the temporal repartition of notes, leading to an onset detection curve that is further analysed, in a second step, for periodicity estimation. Current state of the art in onset detection, based on energy and spectral flux, cannot handle complex but common musical configurations such as dense orchestral textures. Our proposed improvement of the flux method can detect new notes while ignoring spectral fluctuation produced by vibrato. Concerning periodicity estimation, we demonstrate the limitation of immediately restricting the range of tempi and of filtering out harmonics of periodicities. We show on the contrary how a complete tracking of a broad set of metrical levels offers a detailed description of the hierarchical metrical structure. One metrical level is selected as referential level defining the tempo and its evolution throughout the piece, by comparing the temporal integration of the autocorrelation score for each level. Tempo change is expressed independently from the choice of a metrical level by computing the difference between successive frames of tempo expressed in logarithmic scale. A new notion of dynamic metrical centroid is introduced in order to show how particular metrical levels dominate at particular moments of the music. Similarly, dynamic metrical strength is defined as a summation of beat strength estimated on dominant metrical levels. The model is illustrated and discussed through the analysis of classical music excerpts.

Keywords: periodicity estimation, onset detection, metrical analysis

1. Introduction

The metrical dimension of music is known to play a paramount role in the aesthetic appreciation of music, including emotion, yet computational modelling remains particularly deficient, compared to other dimensions of music.

Classical audio-based methods detect in a first step the temporal repartition of notes, leading to an onset detection curve that is further analysed, in a second step, for periodicity estimation. This paper follows the same two-step approach, and introduces new methods for each step.

The model has been implemented in *MIRtoolbox* (Lartillot & Toiviainen, 2007) and is available in the new version 1.5 of the toolbox.

2. Onset detection curve

The first step consists in producing an "onset detection curve", which is a temporal curve: musical events are indicated by peaks; the height of each peak is related to the importance of the related event, in terms of energy and/or spectral contrast. There are two main approaches to obtain such onset curve:

One approach consists in extracting an amplitude *envelope* curve, showing the general evolution of energy along time, corresponding to the following command in *MIRtoolbox*:

o = mironsets(a, 'Envelope')

where *a* can be for instance the name of an audio file.

Another approach consists in computing spectral *flux*, i.e. in evaluating the distance with respect to the global spectral distribution between successive instants:

o = mironsets(a, 'Flux')

Both methods give relevant results for music where notes are sufficiently isolated or accentuated with respect to the background environment, such as in Fig. 1a and 1b. But when dealing with a complex orchestral sound where notes cannot be detected based on global energy changes, such as in Fig 2a and 2b, things get more complex. The *'Envelope'* method does not work since the general envelope indicates the global dynamic change without revealing the note onset position hidden in the polyphonic texture. The *'Flux'* method, on the other hand, can detect notes in the polyphony but may fail in the presence of vibrato.

For that reason, we have developed an improved version of the flux method, called 'Emerge', that is able to detect more notes and in the same time ignore the spectral variation produced by vibrato. More precisely, when comparing two successive frames, for each periodicity, the energy from the new frame that exceeds the energy level *for a range of similar periodicities* from the previous frame is summed. By looking not only at the exact same periodicity in the previous frame, but also similar periodicities, this allows to ignore slight changes of periodicities. For the moment, the frequency tolerance has been simply fixed to an arbitrary value that corresponds to a maximal frequency difference between successive frames of 17 Hz.

The new onset curve is available in MIRtoolbox 1.5 by using the following command:

o = mironsets(a, 'Emerge')

The onset curves related to this new *'Emerge'* method are shown in Fig. 1c and 2c. We can also observe how the choice of onset curve has an impact in the estimation of periodicity, further discussed in the next section, since the *autocorrelogram* (the matrix showing the autocorrelation function frame by frame, as in Figure 3) computed with the new *'Emerge'* method shows more clearly the metrical structure than those computed with the other methods: In Fig. 3a, using the *'Flux'* method, the three metrical levels 1, 2 and 3 are not clearly shown in the autocorrelogram, but still detected by the metrical tracker, whereas they are clearly shown in Fig. 3b, using the *'Emerge'* method. Besides, the *'Emerge'* method clearly shows the subdivision of level 1 into six sub-beats. Notice also how accentuations on the fifth sub-beat (level 5/6) in the second half of the excerpt, shown in Fig. 3b, in a very constant tempo is roughly understood in Fig. 3a as a global tempo increase at level 1.

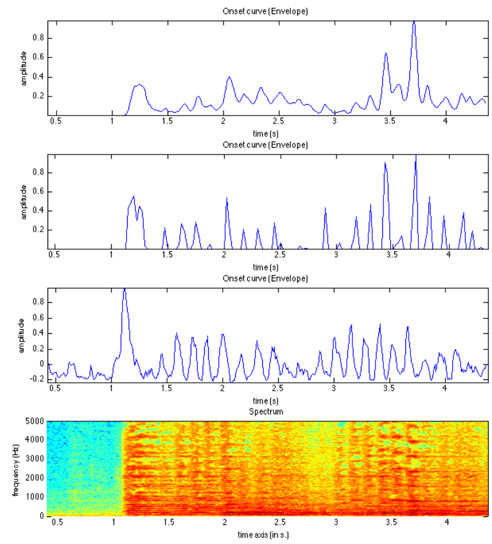

Figure 1. Three different onset curves extracted from the first seconds of a performance of the 3rd movement of C.P.E. Bach's *Concerto for cello in A major*, WQ 172, using the *'Envelope'* (1a), *'Flux'* (1b) and *'Emerge'* (1c) methods, with the detailed spectrogram (1d) used for the *'Emerge'* method.

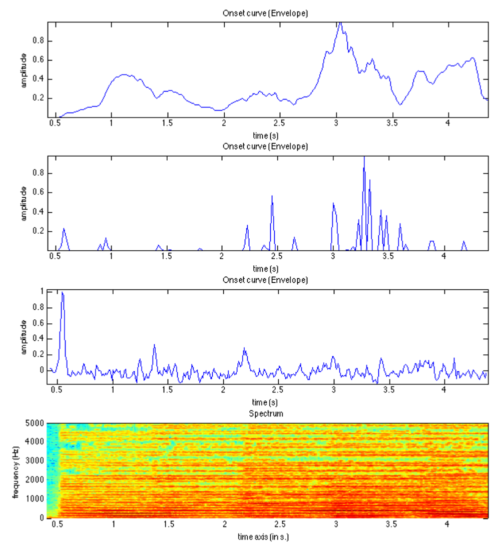

Figure 2. Three different onset curves and spectrogram extracted from the first seconds of a performance of the *Aria* of J.S. Bach's *Orchestral suite No.3 in D minor*, BWV 1068, using the same approaches as in Fig. 1.

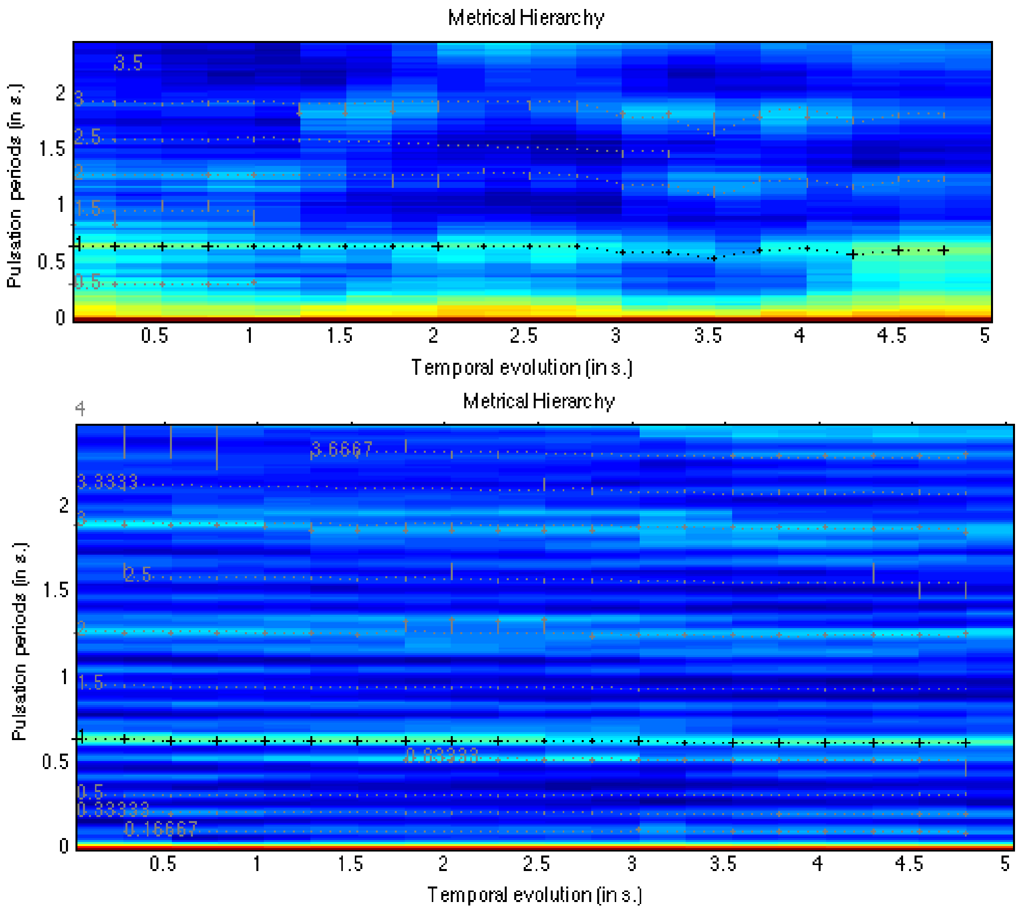

Figure 3. Metrical analysis of the first five seconds of a performance of the *Finale* (*Allegro energico*) of M. Bruch's *Violin Concerto No.1 in G minor*, op.26. Both figures show an *autocorrelogram*: each successive column corresponds to a time frame of 5 s, starting from 0 s and moving every .25 s. For each frame in each column the autocorrelation function is represented, showing periodicities with warm colours (green-yellow) at the given period in s. (on Y-axis). The autocorrelogram (3a) is computed using the *'Flux'* onset curve method, while for the second one (3b) the new *'Emerge'* method is used. On top of the autocorrelogram the metrical structure as tracked by the algorithm is annotated (cf. text for an explanation).

3. Periodicity estimation

Pulsation corresponds to a periodicity in the succession of peaks in the onset curve. This periodicity can be detected through the computation of autocorrelation function on successive large frames (of a few seconds) of the onset curve, such as:

ac = mirautocor(o, 'Frame')

mirpeaks(ac, 'Total', 1)

In the presence of a given pulsation in the musical excerpt that is being analyzed – let's say with a BPM of 120, i.e., with two pulses per second – the autocorrelation function will indicate a high autocorrelation score related to the period .5 s. But generally if there is a pulsation at a given tempo, subdivisions of the pulsation can also be found that are twice slower (1 s), three times slower, etc. For that reason, the autocorrelation function usually shows a series of peaks equally distant for all multiples of a given period. This has close connections with the notion of metrical structure in music, with the hierarchy ordering the levels of rhythmical values such as whole notes, half notes, quarter notes, etc.

One common approach to extract the tempo from the autocorrelation function is to select the highest peak, within a range of beat periodicities considered as most adequate, typically between 40 and 200 BPM, with the possible use of a resonance curve (Toiviainen & Snyder 2003).

This can be performed in *MIRtoolbox* by calling the *mirtempo* operator and toggling off the *'Metre'* option (further presented in the next sections):

mirtempo(a, 'Metre', 'No')

One main limitation of this approach is that if different metrical levels are emphasized throughout the temporal development (Fig. 4a), the tempo tracking will constantly switch from one BPM value to another one twice slower, twice faster, etc (Fig. 4b). This would happen very often, since in most music, successions of same durations can often be followed by succession of durations twice slower or faster for instance.

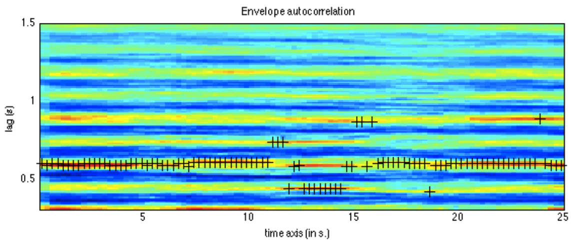

Figure 4a. Metrical analysis of the first seconds of the first movement of a performance of J.S. Bach's *Brandenburg concert No.2 in F Major*, BWV 1047. Traditional tempo extraction approach based on detecting the most dominant pulse frame by frame from the processed autocorrelogram.

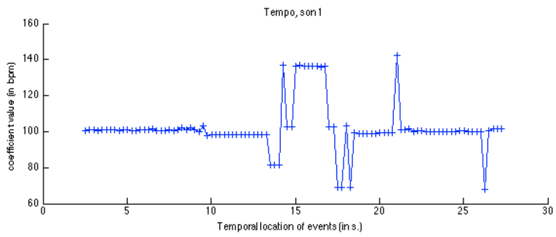

Figure 4b. Tempo curve resulting from the approach presented in Fig. 4a.

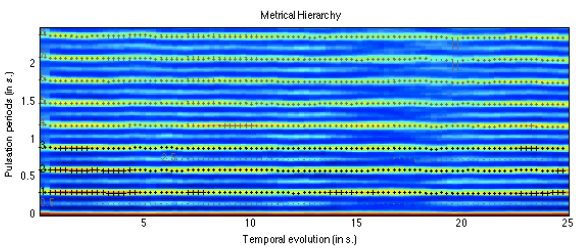

Figure 4c. New method constructing a metrical structure from the unprocessed autocorrelogram.

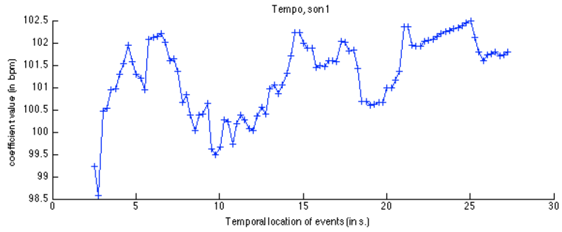

Figure 4d. Tempo curve resulting from the approach presented in Fig. 4b.

4. Metrical structure tracking

As a solution to this problem, we propose to track a large part of the metrical structure, by following in parallel each metrical level separately and combining all the levels in one single hierarchical structure.

The metrical structure of any audio file can be computed and displayed in *MIRtoolbox* 1.5 using the following command:

mirmetre(a)

Examples of metrical structures are shown in Fig. 3. Metrical levels are indicated with lines of crosses that are linked together between successive frames with dotted lines. The level index is indicated on the left of each line. The dominant metrical level, indicated as level 1, is drawn in black, while other levels are shown in light brown. The cross size indicates the related pulse strength, corresponding to the autocorrelation score for that periodicity. If the actual periodicity is deviated from the theoretical harmonic series of periodicities expected from a metrical structure, a vertical line is drawn between the actual and the theoretical periods.

In Fig. 3a, level 1 is subdivided into one sublevel .5, corresponding to a binary rhythm, with multiples 1.5, 2.5, etc. In Fig. 3b, on the contrary, level 1 is subdivided into six subbeats, with its elementary level 1/6, as well as its half slower level 2/6 corresponding to a ternary division of level 1, and finally its three times slower level 3/6 corresponding to a binary division of level 1.

Other examples of metrical structures are given in Fig. 4c, 5a and 6a. We can notice for instance in Fig. 6a that at the middle of the excerpt, the ternary rhythm turns into a binary rhythm for a dozen of seconds.

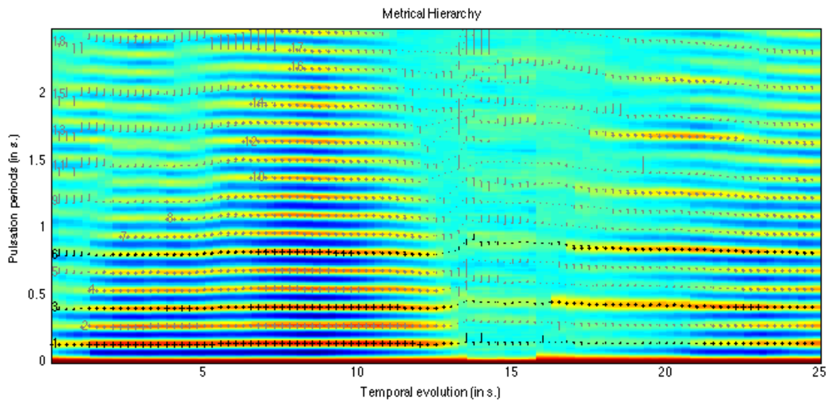

Figure 5a. Autocorrelogram with tracking of the metrical structure for the first seconds of a performance of the 3rd movement of C.P.E. Bach's *Concerto for cello in A major*, WQ 172.

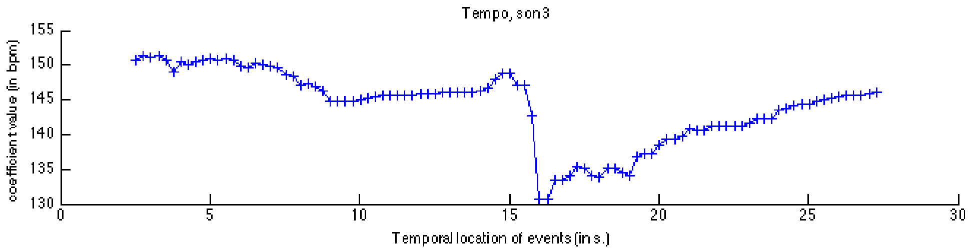

Figure 5b. Corresponding tempo curve.

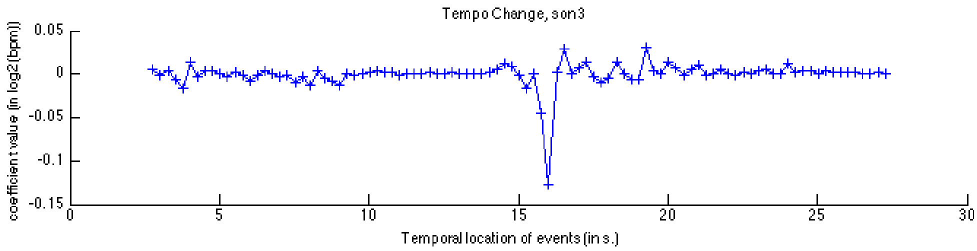

Figure 5c. Corresponding tempo change curve.

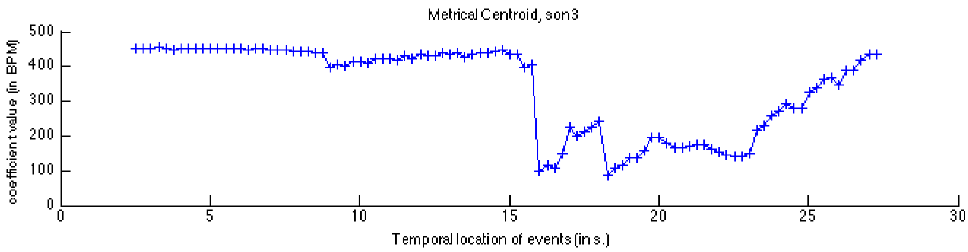

Figure 5d. Corresponding metrical centroid curve.

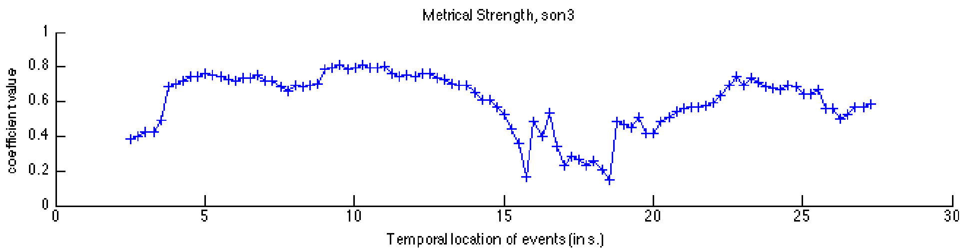

Figure 5e. Corresponding metrical strength curve.

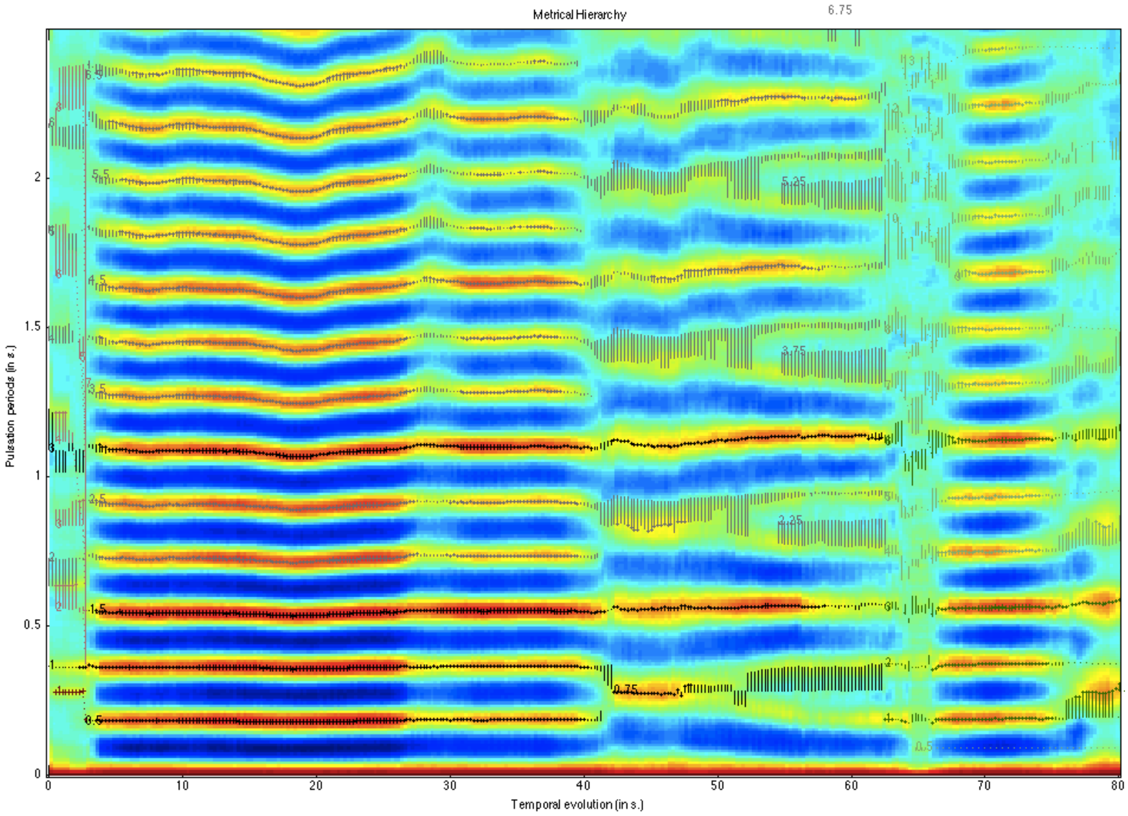

Figure 6a. Autocorrelogram with tracking of the metrical structure for the first 80 seconds of a performance of the *Scherzo* of L. van Beethoven's *Symphony No.9 in D minor, op.125*.

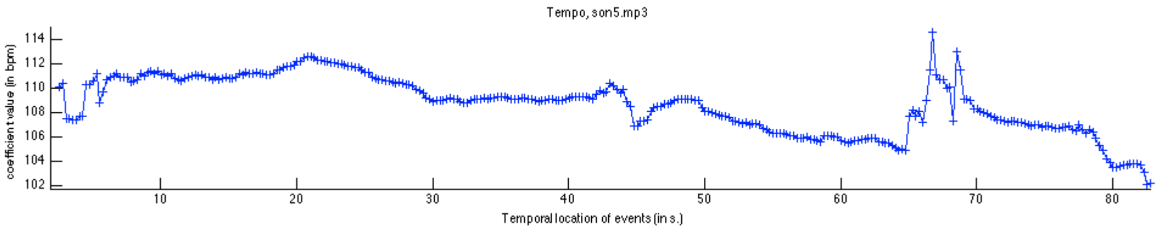

Figure 6b. Corresponding tempo curve.

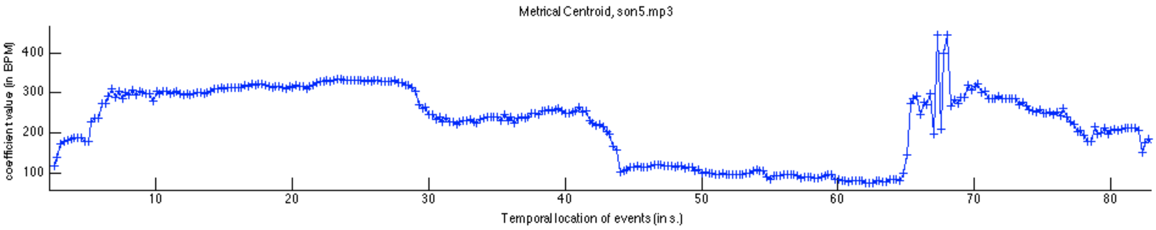

Figure 6c. Corresponding metrical centroid curve.

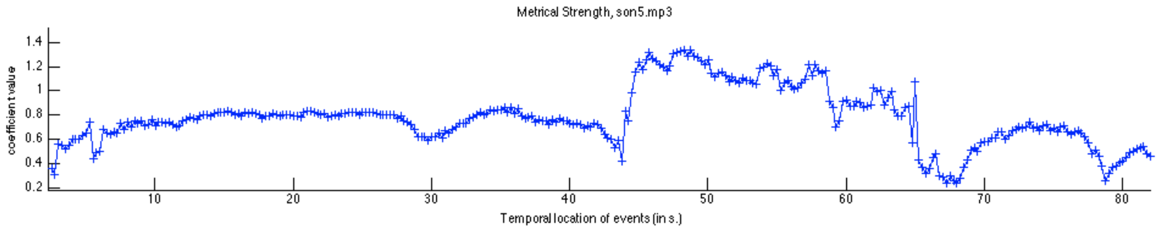

Figure 6d. Corresponding metrical strength curve.

5. Tempo and tempo change

Once the metrical structure has been constructed, one metrical level is chosen as the referential level that defines the tempo and its evolution throughout the piece (Fig. 4d). This metrical level is chosen due to its high degree of saliency and also because it is related to a tempo rate that fits best to the range of best perceived tempos. To each metrical level is associated a global sum by summing up the autocorrelation scores over time for each metrical level separately, and by weighting this total score with a resonance curve (Toiviainen & Snyder 2003) in order to emphasize most easily perceived pulsations. The metrical level with the highest global sum is selected as the main metrical level that defines the tempo.

This approach for tempo estimation based on metrical structure is used by default by the *mirtempo* operator in the new version 1.5 of *MIRtoolbox.* So it can be called simply like this:

mirtempo(a)

Fig. 4 compares the tempo tracking methods. The classical paradigm is based on selecting a preferred range of BPMs in the autocorrelogram, and choosing the maximum autocorrelation score at each frame (Fig. 4a). This leads to a tempo curve with a lot of shifts from one metrical level to nother (Fig. 4b). The new method builds a metrical structure (Fig. 4c), which enables to find coherent metrical levels leading to a continuous tempo curve (Fig. 4d). Other examples of tempo curve are given in Fig. 5b and 6b.

The selection of a main metrical level as referential level for the computation of tempo values remains somewhat subjective. Often neighboring levels (twice faster, twice slower, etc.) could have been selected as well. On the other hand, the dynamic evolution of tempo seems to play a more important role for the listener as it describes how music speeds up or slows down, in parallel along all the metrical levels. Tempo change is expressed independently from the choice of a metrical level by computing the difference between successive frames of tempo expressed in logarithmic scale.

The tempo change curve is computed in *MIRtoolbox* 1.5 using the following command:

mirtempo(a, 'Change')

An example of tempo change is given in Fig. 5c.

6. Dynamic metrical centroid

On the other hand, the fact that particular metrical levels may be more dominant than others at particular moments of the music is an important aspect of the appreciation of rhythm. The common method of selecting the most dominant metrical level at each successive frame is not satisfying, as it would lead to shifts between metrical levels that are somewhat artificial and chaotic. Instead of selecting one single metrical level at each frame, we introduce a new assessment of metrical activity that is based on the computation of the centroid of a range of selected metrical levels. Not all levels found in the autocorrelogram are taken in the computation of the centroid, because there can exist dozens of them, without theoretical limitations.

Only levels corresponding to actual theoretical metrical levels, such as whole notes, half notes, quarter notes, etc., are selected. This selection is performed automatically, so that it can detect whether the metrical structure is binary, ternary, etc. More precisely, for each frame considered in isolation, metrical levels whose strengths (defined by the autocorrelation value at those points) are higher than the strengths of all their underlying metrical sub-levels are selected. This corresponds to metrical levels that are N times faster for all $N > 1$. Indeed, if a given metrical level (let's say level 3) is weaker than one if its underlying metrical sub-level (for instance level 1), this means that the grouping of three pulses at level 1 does not emerge from the succession of such pulses. On the other hand, if that metrical level (3) is stronger than the immediately lower sub-level (2), this means that the grouping of 3 notes has still more importance than the grouping of 2 notes. For that reason we propose to select such metrical levels as well.

For each frame, the dominant metrical levels are selected and the centroid of their periodicity (in seconds) is computed, using as weights their related autocorrelation scores. A refined version of the algorithm defines the weights as the amount of autocorrelation score at that specific level that exceeds the autocorrelation score of the underlying metrical sub-levels. In this way, any sudden change in the number of selected metrical levels from one time frame to the successive one does not lead to abrupt changes in the metrical centroid curve.

The resulting metrical centroid curve indicates the temporal evolution of the metrical activity. The metrical centroid values are expressed in BPM, so that they can be compared with the tempo values also in BPM. High BPM values for the metrical centroid indicate that more elementary metrical levels (i.e., very fast levels corresponding to very fast rhythmical values) predominate. Low BPM values indicate on the contrary that higher metrical levels (i.e., slow pulsations corresponding to whole notes, bars, etc.) predominate. If one particular level is particularly dominant, the value of the metrical centroid naturally approaches the corresponding tempo value on that particular level.

The metrical centroid is computed in MIRtoolbox 1.5 using the following command:

mirmetroid(a)

Examples of metrical centroid curves are given in Fig. 5d and 6c. We can notice for instance in the metrical structure in Fig. 5a that the emphasis is put first on the fastest level (level 1), followed by a progressive activation of levels 3 and 6 from t = 6 s. Then, after a break around t = 15 s, level 3 becomes dominant. This can be seen in the metrical centroid curve, first focusing on the fastest pulsation (around 450 BPM) on the first half of the excerpt, followed by a focus on the lower pulsations (around 100 and 200 BPM) on the second half.

7. Dynamic metrical strength

Another major description of the metrical activity is assessing its strength, i.e., whether there is a clear and strong pulsation, or even a strong metrical hierarchy, or whether on in the other hand the pulsation is somewhat hidden, unclear, or there is a complex mixture of pulsations. Studies have been carried out in the old paradigm – i.e., one single metrical level detected at a time, as discussed in Section 3. In such case, since there is just one beat or pulsation, the strength is therefore related to that single metrical level (Lartillot et al., 2008). Following one simple traditional approach, beat strength is simply identified with the autocorrelation score of that main metrical level.

We propose a simple generalization of this metrical strength approach by simply summing the autocorrelation scores of the selected dominant levels (using the same selection method as in last section). The metrical strength is increased by any increase of autocorrelation score at any dominant level, or if new dominant levels are added to the selection. Whereas the autocorrelation score is a value lower than 1, the metrical strength can exceed 1.

The metrical strength is implicitly computed when assessing the metrical centroid, and can for that reason be obtained in *MIRtoolbox* as a second output (below: *ms*) of the *mirmetroid* command:

[mc ms] = mirmetroid(a)

Examples of metrical strength curves are given in Fig. 5e and 6d.

8. Collinearity between metrical features

In this section, we evaluate the collinearity of the most important metrical features introduced in this paper (tempo change, metrical centroid, metrical strength) – computed using the current version of the algorithms while writing the paper, i.e., *MIRtoolbox* 1.4.1.4 – to which we add two additional features. The first additional feature is *pulse clarity*, i.e. the strength of the main pulse detected at each frame (Lartillot et al., 2008), obtained in MIRtoolbox using:

mirpulseclarity(a, 'Frame')

The other additional feature is *metrical novelty*, i.e. the novelty curve, computed using the new method (Lartillot et al., 2013), in its beta-version in MIRtoolbox 1.4.1.4, based on the autocorrelogram function *ac* used for the assessment of the metrical structure (cf. §3):

mirnovelty(ac, 'Flux')

All these features were extracted from thirty-six musical excerpts covering a large range

Table 1. Pairwise Pearson product-moment correlation coefficients between the following features: pulse clarity (pc), metrical centroid (mc), metrical strength (ms), novelty of the autocorrelation computed from the onset curve (nv), tempo change (tc). Features are replaced with their square roots.

	pc	mc	ms	nv	tc
pc	r = 1 N=21721 p= ---	r = 0.203 N=21681 p<0.01	r = 0.053 N=21721 p<0.01	r = -0.167 N=21685 p<0.01	r = 0.006 N=21637 p=0.38
mc		r = 1 N=21682 p= ---	r = -0.314 N=21682 p<0.01	r = 0.057 N=21648 p<0.01	r = 0.006 N=21634 p=0.40
ms			r = 1 N=21722 p= ---	r = -0.036 N=21686 p<0.01	r = 0.011 N=21638 p=0.11
nv				r = 1 N=21686 p= ---	r = -0.002 N=21638 p=0.77
tc					r = 1 N=21638 p= ---

of musical styles from baroque to contemporary classical music (Eliard et al., 2013; Eliard & Grandjean, in preparation) with a mean duration of 155.83 ± 10.66 seconds. Frame size of the moving window was fixed to 1 second and the hop factor was fixed to 0.25 seconds. Since these features were Gamma distributed, Pearson product-moment correlation coefficients were computed on their square roots. Correlations were also calculated using pairwise deletion. The results of the correlations are shown in Table 1.

According to Cohen's convention (1988) effects sizes are small, except for the correlation between metrical centroid and metrical strength ($r = -0.314$, $p < 0.01$). Results also suggest that these features are relatively independents.

9. Discussion

This new computational model, freely available in the new version 1.5 of *MIRtoolbox*, enables a relatively robust assessment of tempo and its dynamic evolution in any piece of music. Even more, it offers a very detailed description of the metrical structure, revealing import aspect of the metrical structure that are independent from the tempo dimension: the new concept of metrical centroid (or *metroid*) that we are introducing, and metrical strength.

We may expect high impact of these metrical dimensions to the emotional experience of music, in particular with respect to activity (Russell, 1980) and more particularly to energetic arousal, and maybe tense arousal as well (Thayer, 1989).

Small deviations from the metrical structure in musical performances are a typical means of musical expressivity, and are therefore crucial for the affective impact of music. The methods presented here provide a procedure to quantify these metrical features, which will be very useful in studies that try to better understand the link of musical structure and performance features with emotions in response to music.

The actual tempo level is not so much of importance in this respect, because a same musical excerpt can often be associated with several parallel tempi in harmonic relation (let's say 60 and 120 BPM). Indeed, tempo is rather a musical convention that does not necessarily reflect the listener's subjective experience. We may expect however a positive correlation between a change in tempo and a change in arousal. An interesting complementary descriptor here is metroid, which could be also correlated with arousal, not only in terms of metroid change, but also in terms of actual metroid value. Metroid is somewhat independent from tempo: a change of metroid can be independent from a change of tempo, as can be seen for instance in Fig. 6b and 6c. Finally metrical strength can have also an important impact in arousal. The relative contribution from these different tempo and metrical descriptors to the two aspects of arousal, energetic and tense, remains an open question.

Tempo and metrical descriptions might also aspect the other main dimension of the emotional appreciation of music, i.e., valence. But a complete study of this aspect might require additional rhythmical and metrical descriptions, related to accentuation in particular, which would depend also on aspects related to dynamics in general, register and timbre.

Tempi and metrical changes as well as the clarity of them are probably crucial to explain the subjective entrainment during music listening and it has been proposed that this phenomenon is important in emotion emergence in music (Juslin et al., 2010). Entrainment, both visceral and motor components, seems to play an important role in the emergence of feelings during musical listening (Labbé & Grandjean, submitted). Moreover, these tempi and metric features might be combined with dynamic subjective musical feelings and/or dynamic perceived emotions in music. Such combination will allow the assessment of causality in the emergence of complex emotions using for example Granger causality measures to investigate how different characteristics of tempi and metrics might be crucial in the emergence of subtle musical feelings such as them described in Geneva Emotion Musical Scales (Zentner, Grandjean, & Scherer, 2008).

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TEMPORAL STABILITY OF MUSIC PREFERENCES AS AN INDICATOR OF THEIR UNDERLYING CONDITIONINGS

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Abstract

To emphasize the substantial impact of both cognitive and emotional processes on the development of music preferences, such definitions are formed which define preferences as a set of emotional-rational attitudes, which in turn affect the perception of a piece of music. It can be assumed that music preferences are dependent on the current situational and emotional aspects. Accepting this assumption, the absolute stability of the preferences of particular musical genres will be relatively low. As an alternative to the above reasoning, it can be assumed that the high temporal stability of the musical genres preferences may indicate deeper than, for instance, related to the current mood determinants of music preferences. The current study analyzed the temporal stability of musical preferences as measured with the Short Test of Music Preferences (Rentfrow, Gosling, 2003), which was tested within five months in a group of 88 people aged 20 to 58 years. Studies have shown that the Short Test of Music Preferences (STOMP) allows for a relatively stable measurement of music preferences in a period of 5 months. The analyzes revealed that the stability of the results of music preferences is high and constant. With the awareness of the limitations of the method to research the stability of results over time, you can assume with some caution that the high temporal stability of the music factors preferences may indicate deeper conditionings of music preferences than, for example, those connected to the current mood or situation.

Keywords: music preferences, temporal stability

1. Introduction

There are some compositions you like, some that you treat with indifference, finally some which irritate you. You would call them good, average, and uninteresting music respectively, while being aware of the subjectivity of your assessments, given that although you really like one genre, it may well irritate other person. With some other genre, the situation may be quite different. Your preferences determine your attitude to a particular musical theme. Music preferences include the condition that a person's choices concern pieces of music. Simultaneously, selected songs are indices of preferences.

To define the concept of “music preferences”, it is necessary to characterize the plane from which this idea originates. It is, undoubtedly, the notion “general preferences”. General preferences are described in literature as the standards governing the course of cognitive functions in situations that are characterized by complexity, ambiguity and uncertainty, in other words, when a person is free to choose the type of reaction (response) (Nosal, 1992). An alternative to this type of situations are those in which response depends on certain external patterns, i.e. when the role of preferences is small. Therefore, the disclosure of preferences applies to such situations in which there is a freedom of choice. Preferences influence the course of human behaviour by determining which possible mode of functioning a person is willing to choose. To facilitate the realisation of preferences, there should be no specific external requirements as to the manner of their realization. Certain situational factors often prevent or impede the realisation of preferences, whereas others may be helpful. Taking into account the difficulties that arise in the process of preferences realisation, you adjust to them as often as you oppose them. A situational feature conducive to the activation of preferences is their vagueness, namely, that there is either no information, or not enough information about the required modes of functioning. Such situations are far more frequent than situations that are based on an algorithm. As preferences disclose most freely in cognitively vague situations, their measurement is most valid in those circumstances.

Music preferences may have multifactorial conditionings. These conditionings are complex, and closely linked through their mutual interaction. Biological (Blood & Zatorre, 2001; Panksepp & Bernatzky, 2002), educational (Brittin, 1991), and cultural (North & Hargreaves, 1997; O'Hagin & Harnish, 2006) conditionings have been discussed among factors that shape individual music preferences. Preferred music is associated with the problem of the development and verification of one's social and personal identity (Tarrant, North & Hargreaves, 2004), differences in the styles of music perception (Hargreaves & Colman, 1981, Smith, 1987), social influence factors (Inglefield, 1972; Hargreaves 1986). In addition, much attention has been paid to the relationship between music preferences and perceived adequacy of music listened to, depending on situational context (Konečni, 1982), but also on emotional needs (Roe, 1985; Little & Zuckerman, 1986; Behne, 1997). The term "music preferences" denotes such reactions to music which show the degree of liking or not liking certain songs or types of music, and these reactions are not necessarily based on the cognitive analysis of music being the object of a personal disposition (Finnäs, 1989).

The concept of preferences appears in the theories of personality whilst the differences in the orientation of the mind and personality structure are explained (e. g. in Jung's theory of types, where "a preference" means a dominant possibility to direct both the behaviour and a potential cognitive standard) (Nosal, 1992). Thus preferences can be treated as inclinations, distributions of possibilities, multi-dimensional dispositions, which constitute a component of personality structure. The works of Cattell (1954), who assumed that music preferences are a window to human personality, were clearly inspired by psychoanalytic concepts. Thus personality can manifest itself in one's music choices. Previous studies have shown that people are aware of this relationship (Rentfrow & Gosling, 2003), and can quite accurately infer personality traits, such as openness and emotional stability, on the basis of one's music preferences (Rentfrow & Gosling, 2006). Consequently, a certain stability of music preferences can be assumed, resulting, for example, from the repeatability of personality parameters of an individual's functioning, or from the relative constancy of internal factors determining repetitive external reactions. Stability or relative stability of personality stems from the fact that personality comprises traits (Cattel, 1950; 1957). Thus the stability of personality based on constant traits becomes the basis to predict long-term patterns of behaviour.

2. Music preferences model according Rentfrow and Gosling (2003)

A huge variety of music categories is used to describe music preferences. Music continues to grow and change, and the boundaries between genres are flexible. Can music choices, then, be described and classified on specific dimensions?

In addition to genre classification, music can be characterized in terms of the elements of music (melody, rhythm, pace, dynamics, formal structure). Terms referring to the impressions and reactions to music are also used. Semantic differential and factor analysis, two methods established in experimental aesthetics, are used to fulfil this aim.

Rentfrow and Gosling (2003) attempt to answer many questions key to the issue of music preferences. They turn out to be the heirs of Cattell's thought, both when it comes to building a bridge between music preferences and personality, and to the statistical analysis of data. The researchers developed the STOMP (Short Test of Music Preferences), consisting of 14 music categories to measure music preferences corresponding to the following music genres: blues, classical, jazz, folk, heavy metal, rock, alternative, country, pop, religious, soundtracks, rap/hip hop, soul/funk, dance/electronica. These genres were selected from a pool of 80 music genres and subgenres (14 genres and 66 subgenres). During the procedure of developing the tool, only 7% of respondents knew all music subgenres (e. g., industrial, swing), whilst 97% of respondents knew all listed genres. Thus genre was established as a central category on which the procedure to analyze music preferences should be build (Rentfrow, Gosling, 2003).

Using a variety of statistical verification methods (including factor analysis), the cited authors found that the best construct to describe music preferences is a four-factor model. Expanding the scope of research on music preferences, they showed that listeners' individual music choices can be described in four dimensions. Factor analysis identified a positive grouping of the following genres: blues, classical, jazz, folk (Reflective and Complex). According to the authors, these are structurally complex genres, and they seem to facilitate introspection. The second factor was defined by such genres as heavy metal, rock, alternative music (Intense and Rebellious). These are genres that are full of energy, and emphasize themes of rebellion. The third factor includes the following genres: country, pop, religious, soundtracks (Upbeat and Conventional), which, due to the nature of the music material, were defined as structurally simple, with lyrics emphasizing positive emotions. Finally, the fourth factor comprised such genres as rap/hip-hop, soul/funk, electronica/dance music (Energetic and Rhythmic).They represent lively music, which often emphasizes the rhythm.

3. Method

A study using the Short Test of Music Preferences was carried out in two institutions of higher education in Poland within the period of five months. The STOMP includes 14 categories corresponding to the music genres described in theoretical foundations.

Respondents rate each of these categories on a 7-point Likert-type scale with endpoints at 1 - Not at all and 7 - A great deal (I like a particular music genre). The results of relevant music genres evaluations are averaged according to the key, indicating four music dimensions. The average of all responses in the scale indicates the strength of preference for a particular music dimension.

Temporal stability was tested on a group of 88 students (including 31 females, 35.2% of the total sample) aged 20 to 58 years (M = 24.7, SD = 13.1). The research was a group study, carried out during labs and lectures in the participants' home institutions. The experimenter was present during the test to ensure comforting conditions, but did not attempt to influence the answers. The participation was voluntary and anonymous. The respondents were encouraged to work at a steady pace.

4. Results

Although the structure of the dimensions in the presented model of music preferences is clear and understandable, the stability of these dimensions over time is an important aspect to discuss. As noted earlier, music preferences may be affected by the current situational and emotional factors. Therefore, absolute stability of the preferences for particular music dimensions is relatively low. Alternatively, however, it can be assumed that high temporal stability of the preferences for particular music dimensions may indicate determinants of music preferences which are deeper than those based on the current mood or situation.

The temporal stability of individual music factors is high (Table 1). The only exception seems to be soul/funk music, for which correlation coefficient does not exceed .60.

Table 1: Temporal stability of the Short Test of Music Preferences.

Classical	.75
Blues	.72
Country	.65
Dance/Electronica	.65
Folk	.61
Rap/Hip-Hop	.71
Soul/Funk	.53
Religious	.67
Alternative	.71
Jazz	.62
Rock	.73
Pop	.61
Heavy Metal	.65
Soundtracks	.75

Similarly, the temporal stability of music dimensions is high (Table 2), as all correlations exceed .60. This result suggests that music preferences are constant for a short period of time (as predicted by this study).

Table 2: Temporal stability of the results in the STOMP, total scores for dimensions.

Reflective & Complex	Intense & Rebellious	Upbeat & Conventional	Energetic & Rhythmic
.77	.66	.70	.61

The final stability test for the theoretical model of the STOMP preferences structure is a test of the stability of the factorial structure of the measurement, calculated by means of confirmatory factor analysis.

The model assumes that in each measurement the four dimensions describing music preferences are exogenous manifest variable. A mutual correlation of all the variables in each measurement is also assumed. However, only correlations between corresponding indices were allowed between measurements. To test accurately the hypothesis of the stability of the structure of the four music-preference dimensions measurement, two models were tested (Fig. 1). Model 1 does not make any additional assumptions about intercorrelations between factors. Model 2, however, assumes that there are equal correlations between analogous music preferences dimensions in pre-test (e.g. correlation between RC and IR marked as D) and retest (D1).

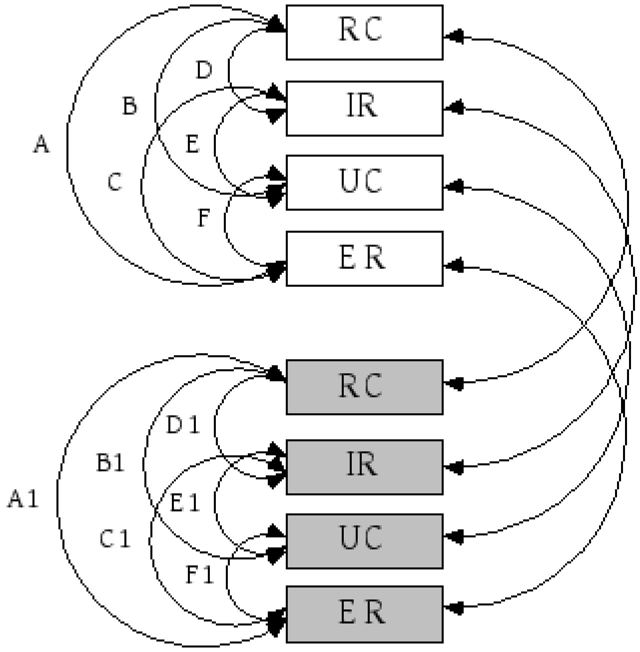

Figure 1: The scheme of the stability of the structure of declarative preferences measurement.

The analysis of the first model, assuming a free stability of the structure of music preferences measurement (Fig. 2), revealed fit indices slightly lower than expected boundary values. The results suggest that the Short Test of Music Preferences allows for a stable testing of preferences within the presented four-dimension structure. The strongest indices (λ = .70) can be predicted for the measurement stability of the preference for music dimension RC, although other indices are only slightly lower. Moreover, correlation coefficients between various factors in each measurement appear different, and the strongest differences manifest themselves in terms of correlation between the UC scale and the other scales - UC and IR (λ = .08 in pre-test and λ = .20 in retest), UC and ER (λ = .21 in pre-test and λ = .08 in retest), and UC and RC (λ = .16 in pre-test and λ = .09 in retest).This result may indicate a qualitatively different musical connotation of this music dimension in the first and second measurement.

Chi^2(16)=28.945; p=.024; NFI=.870; RFI=.708; CFI=.931; RMSEA=.059

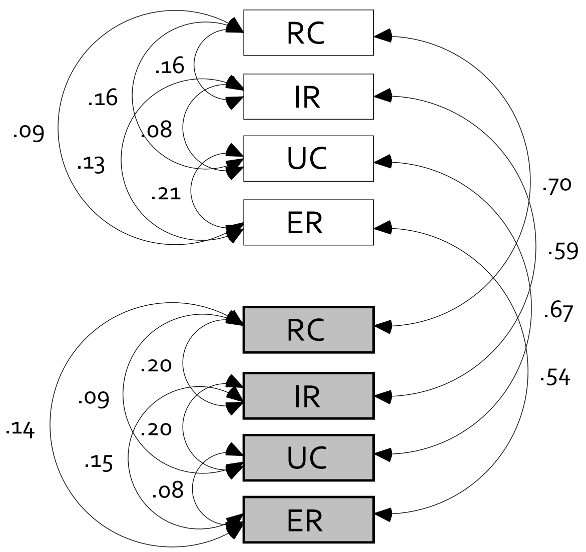

Figure 2: The path model of the stability of the measurement structure as tested with the STOMP.

Chi^2(22)=32.114; p=.079; NFI=.856; RFI=.764; CFI=.946; RMSEA=.049

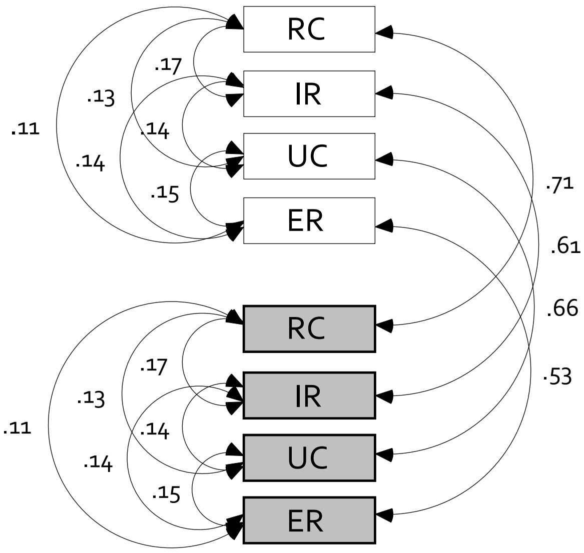

Figure 3: The path model of the stability of the measurement structure as tested with the STOMP - assuming the correlations equality between dimensions in two measurements.

However, Model 2 (Fig. 3), which additionally assumes the equality of correlations between dimensions in the individual measurements, provided a more satisfactory fit than Model 1, though not significantly better (p = .079). Moreover, it shows very similar correlations between the individual measurements for each of the dimensions. The differences are very small, less than .05.

To conclude, the results suggest that the Short Test of Music Preferences allows for a relatively stable measurement of music preferences within five months for those aged over 20 years. The stability of the result of the separate dimensions, and the stability of the structure appear to be satisfactory.

5. Discussion

It seems self-evident that the development of music preferences is influenced by widely understood situational and emotional factors. Apparently, musical tastes are determined also by the temporary level of emotion and motivation to listen to certain music. A preference for anything is associated with personal genesis, such as: personal utility, the uniqueness of stimuli evoking subjective experiences, emotions, and sensory experiences. Studies have shown that 85% of women and 74% of men respond positively to the question: "*Have you ever used music to change your mood*?"(Wells, 1990).

The tested model of music preferences, which is the Short Test of Music Preferences, turned out to be resistant to situational or emotional factors. This was concluded from the analysis of the temporal stability of the results, which showed that declared music preferences in the context of selected factors remained unchanged over the period of five months. Unquestionably, there are certain limitations of the method of testing the temporal stability of results. Nevertheless, high temporal stability of music-preference dimensions may indicate deeper conditionings of music preferences than those connected, for example, to the current mood or situation. Such an understanding of the result corresponds with Holbrook and Schindler's claims (1989). This observation can lead to a conclusion that situational factors exert temporary impact on the current functioning, and, consequently, also on music preferences. The preference for disco music over classical compositions does not have to mean only a familially conditioned tendency to listen to this type of music, but also it can indicate, for example, a temperamental need for this type of musical stimuli. The presented method of inference about a person's musical choices has been discussed in literature (Konečni, 1982; Kopacz, 2005). It seems, therefore, that developed music preferences make it impossible for a person to opt for something else. One can certainly choose other music elements following others' suggestions, but in case of free situations which do not restrict the choice, one is going to choose the musical elements that are consistent with one's individual preferences. Therefore, the condition of individual preference is the consistent manifestation of this preference during the performance of various tasks by a participant. Tasks characterized by freedom of choice allow acting in accordance with preferences. Conversely, the result can be interpreted differently. If certain "music situations" occur in individual experience often enough, they can consolidate as preferences. This is more likely in cases of higher compliance between the external and internal - developmental and temperamental-personal - requirements (Matczak, 1982). The assumed stability of music preferences is due to the repeatability of objective parameters of situations in which an individual functions, and the relative constancy of the internal factors determining their subjective parameters.

6. Summary

Music is a combination of emotions and mathematics. The emotional side is embodied within the intimate character that is attributed to music. On the other hand, music is a term that can be transformed into the language of mathematics. The current study has shown that the mathematical reasoning about the stability of music preferences seems to be an efficient, yet complex process. The result, which indicates the stability of declarative music preferences, seems to be a very important issue. Stability is a prerequisite to talk about preferences that seem to be truly individual properties. But although music choices may be the expression of a relatively stable mental apparatus, they are never exclusively that expression. However we specify what musical preferences are and within what context they should be analyzed, we can recognize and understand them only approximately, and any knowledge gained should not be treated as absolute. The study presented in this paper indicates the need for further, large-scale longitudinal studies.

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HOW MUCH DOES EARPHONE QUALITY MATTER WHILE LISTENING TO MUSIC ON BUSES AND TRAINS?

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Abstract

We report results from an investigation into the relationships between acoustic performance, price, and perceived quality of earphones. In Singapore today, the most common situation where people listen to music is while commuting, however such environments have generally high ambient noise levels. A survey (N=94) of listener habits on buses and trains was conducted. Results showed that people use a wide range of earphones, both in terms of price and measurable acoustic performance. Five typical earphone models were identified and employed in a perceptual experiment (N=15). Volunteers rated various aspects of earphone quality while listening to music under two conditions: studio silence and a reproduced commuter environment. Results showed that participants displayed a strong preference towards in-ear earphones and this can be attributed to these having better *acoustic isolation* than on-ear earphones. People tend to describe the music listening experiences in terms of sonic clarity and noise isolation. We believe that these results can inform development of an ecologically valid model of how noisy environments affect people's perception of audio quality, and through that, of music experience. Such a model could inform consumers as well as manufacturers.

Keywords: earphones, sound quality, perception

1. Introduction

There is an extensive variety of earphones available now in the market, partly due to the fact that we are living in a time where entertainment can be portable. A surround sound system to engulf us into a music or sound euphoria can now be placed into our pockets using digital signal processing (McCormick, 2005). In most developed societies like Singapore, more and more commuters are using earphones (Flamm, 2005). Commuters listen to music while on the train or bus for various reasons, such as to relax or as a form of entertainment. One other possible reason why listening to music is the most popular activity is because it allows the user to free up his or her hands to do something else or help maintain balance. Also, in a crowded train or bus, it can be very difficult to do anything that requires both hands, for example play a game.

A commuter's choice of earphone is influenced by price, information about acoustic performance, visual aesthetic, and other factors, varying greatly. For example, there is no standard of how to report acoustic performance for consumers on packaging. There are tests (Audio Check, 2013) and information to help consumers make better-informed purchases, however these materials do not necessarily have sufficient scientific backing to support the claims. Inevitably, their perception of sound and listening experience are affected. Plus, to a certain extent, damage their hearing.

Our research aims to analyze typical technical specifications of earphones and understand earphone consumer behavior through a multi-methodology. The present study is a pilot investigation involving a questionnaire survey, a series of technical measurements and a perceptual experiment.

2. Survey

There was no available data for earphone usage of commuters in Singapore. Therefore we performed a questionnaire study. Responses were collected on buses and trains at different locations and hours. Commuters who were actively using their earphones were approached. 100 people completed the questionnaire, out of which 94 could be used in the analysis. Respondents filled up a questionnaire sheet that included questions about:

- what they were listening to;
- what they were listening to;
- the level of *satisfaction* and *physical comfort* they felt with their set of earphones;
- the *brand*, model and price of their current set of earphones;
- which aspect of earphones they considered most important.

87% of respondents indicated that they were listening to music when they were approached to complete the survey. 50% of respondents were using earphones that were free of charge or costing less than $4USD. 75% of the respondents stated that sound quality was the most important aspect of earphones. A correlation analysis of the main survey results is shown in Table 1.

Table 1. Main correlations from survey (Pearson's *r*).

	Age	*Priciness*	*Satisfaction*
Priciness	-0.091		
Satisfaction	-0.019	0.18 .	
Comfort	0.119	0.224 *	0.42 ***

Priciness is an estimate of earphone cost. From the results, there is no significant relationship between *Satisfaction* and *Priciness* (t(88) = 1.71, r = 0.18, p-value = 0.09), and that none of the factors are dependent on *Age*. However, there was significant correlation between *Comfort* and *Priciness* (t(88) = 2.16, r=0.22, p-value = 0.03). Another correlation result to take note of would be *Satisfaction* and *Comfort* (t(92) = 4.4417, r=0.42, p-value = 2.481e-05). The strong correlation between them allows us to know that how satisfied the respondents feel about their set of earphones is related to how physically comfortable they feel with them. Listening to music through earphones was found to be the most popular activity during commuting compared to watching film or being engaged in other activities. This helped us determine the type of music played for the perceptual experiment.

From the survey, fourteen commonly used earphones were chosen for technical measurements.

3. Technical measurements

Measurements were made using a manikin head (Neumannn KC100) in an acoustically isolated recording room. A frequency sweep file, 12 Hz to 30 kHz over 30 seconds was played through the earphones and recorded with the built-in microphones. Technical aspects tested were frequency response, impedance, total harmonic *distortion* (THD) and isolation. *Acoustic isolation* are given in Table 2, and other results are reported in (Lim, 2013).

From Table 2, we can see that in-ear earbuds are able to provide more noise isolation (>2.0 dB) than non in-ear types. Flanged earbuds are able to provide the most amount of *noise isolation* (-14. 9 dB).

A Principal Component Analysis of frequency responses guided the selection of 5 physical earphones (referred to as C, G, H, I, and J4) to be used in the perceptual experiment, for being substantially different in terms of acoustic performance. Details are reported in (Lindborg & Lim, 2013)

4. Perceptual experiment

Although technology can analyze sound, it is ultimately up to the human ear to tell the designer that the right sound is heard (Brüel & Kjær, 2013). Thus, our aim was to compare different aspects of earphones, in terms of visual appearance, physical comfort and perceived audio quality.

15 people volunteered to take part in this experiment (10 females, median age 23 years). They were all survey respondents who had expressed interest in participation. The experiment session lasted for about an hour and each participant was given a movie voucher as a token of appreciation.

The procedure was as follows. Firstly, all earphones were ranked by visual aesthetic appeal, presented in individually sealed, transparent plastic bags.

Secondly, 3 different types of earbuds (flanged, foam, and silicon) were rated for physical comfort, using an Index by Casali et al. (1987) with minor adaptations. The index varies between 14 (most comfortable) and 70 (least comfortable) (Byrne, Davis, Shaw, Specht, & Holland, 2011).

Thirdly, sound quality was rated under two conditions: studio silence and reproduced commuter ambient noise. Music from a shuffled playlist of 14 songs was played through the earphones. Aspects of sound quality were rated on 6 separate scales, each represented by a 100mm horizontal line on a questionnaire sheet, anchored by adjectives at each end.

- *Clarity* (0= 'muddled', 100='clear')
- *Distortion* (0='annoying', 100='relaxing')
- *Sharpness* (0='boomy', 100='sharp')
- *Envelopment* (0='constricted', 100= 'expansive')
- *Tonality* (0='monotonous', 100='rich')

5. Results

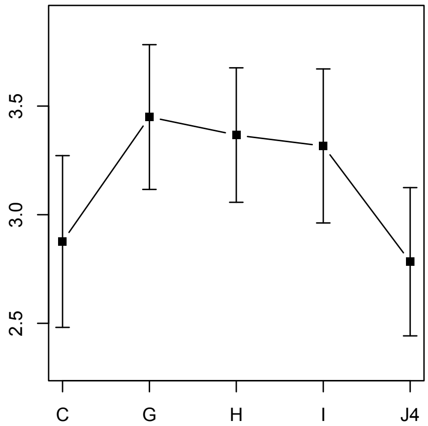

Figure 1. Rated Overall audio experience (95% conf. int.)

Overall, earphones C and J both have consistently low scores across the 4 qualities, while earphones G and H generally have higher scores. This means that G and H are perceived to deliver better sound quality.

The main results of independent (*price, acoustic isolation*) and dependent measures (perceptual ratings) are shown in Table 2.

Under the category of Price, rank 1 means the cheapest to rank 5 which is the most expensive. From the visual aesthetics ranking, 1 would be the set of earphones which most participants felt was the most visually pleasing to them while 5 meant the least visually pleasing. G was rated as the most visually attractive. It is a completely black, in-ear earphone with silicon earbuds. It has a small, simple earpiece and flat cables. J4 was rated least visually attractive and it is a white in-ear earphone with flanged earbuds. It has an angularly-shaped earpiece and has grey round cables. Tabulated scores based on the Comfort Index showed that foam was perceived to be most comfortable followed by flanged and silicon. However, their average scores were only marginally different: foam (35.9), flanged (36.9), silicon (37.7). Values reflected in perceptual ratings are the means calculated for each set of earphones across condition.

Table 2. Main results from perceptual ratings and objective measures of five earphones

					Perceptual Rating							
Ear-phone	*Brand*	*Price* (rank)	*Visual* (rank)	*Com-fort*	*Over-all*	*Clarity*	*Dis-tortion*	*Sharp ness*	*Envel-opment*	*To-nality*	*Noise isola-tion*	*Isola-tion* (dB)
C	Apple	1	3	-	2.9	55	50	52	47	48	2.1	-0.5
G	A-Jays	2	1	37.7	3.4	70	58	59	54	62	2.8	-2.5
H	Senn-heiser	4	2	37.7	3.7	61	49	65	51	63	2.9	-2.5
I	TDK	3	5	35.9	3.3	66	54	66	56	58	2.5	-6.3
J4	Shure	5	4	36.9	2.8	56	50	61	50	52	2.2	-14.9

Table 3. Correlations between independent and rated measures (Spearman's rho)

	Overall Experience	*Isolation Perceived*	*Clarity*	*Distortion*	*Sharpness*	*Envelopment*	*Tonality*
Price (SGD)	-0.06	-0.04	-0.05	-0.06	0.14	0.01	0.03
Visual Rank	-0.16	-0.26	-0.09	-0.02	0.02	-0.02	-0.18
Physical Comfort	-0.21	-0.09	-0.25	-0.26	-0.19	-0.17	-0.24
Acoustic Isolation	0.06	0.10	-0.01	0.01	-0.13	-0.06	0.01

A repeated-measures MANOVA was performed with the perceptual ratings as dependent variables, and *Acoustic Isolation*, *Price (SGD)*, *Visual Rank*, and *Physical Comfort* as independent variables, plus their interaction with *Condition* (silence, noise), as shown in Table 3.

Within-participants, significant main effects were found for *Acoustic Isolation* with *Overall Experience* (F=4.03, p=0.047) and with *Perceived Isolation* (F=4.87, p=0.029). There were also significant correlations for *Perceived Isolation* with *Price* (F=7.12, p=0.008) and with *Visual Rank* (F=5.13, p=0.02). This is similar to the correlation between *Tonality* with *Price* (F=4.33, p=0.04) and with *Visual Rank* (F=8.41, p=0.004).

As for interaction effects with Condition, there was a significant correlation for Price with *Distortion* (F=8.70, p=0.004) and with *Clarity* (F=4.39, p= 0.04). There were also significant correlations for *Envelopment* with *Acoustic Isolation* (F=5.26, p=0.023).

There was no significant relationship between the *physical comfort* of the 3 earbuds nor does it affect the overall perceived sound quality (F(2, 28) = 0.35, p = 0.7). Flanged earbuds fared very differently in the acoustic measurement and perceptual experiment. Technical measurements showed that flange is the most efficient in isolating noise (-14.9 dB) but silicon earbuds were perceived to be the most isolating.

The correlation between *tonality* and *visual rank* suggests that the price of earphones and the way it looks does affect a person's perception of how rich music sounds. The correlation between *isolation perceived* and *visual rank* shows that people do base their perception of noise isolation on how the set of earphones look and if they are perceived to be more noise isolating, they somehow can cause the user to feel that the earphones are more expensive. Correlation of *overall experience* with *acoustic isolation* reinforced the earlier finding that noise isolation affects a person's perception of music and sound.

Qualities that were affected by noise conditions were price with *Distortion* and with *Clarity*, and *Envelopment* with *Acoustic Isolation*. This tells us that the level of noise in the environment can affect our perception of how distorted and clear music is. The playlist did not have songs that were clipped, hence noise in the environment could have confused the participant, leading them to perceive distorted and muddled sounds. The correlation of noise on *Envelopment* with *Acoustic Isolation* shows that in a noisy environment, the level of isolation measured can determine how enveloped one feels by his music.

6. Conclusion

The human perception of music when using earphones are not only affected by sound quality, but also the physical aspects of earphones. Initially driving this research, we hypothesized a correlation between perceived quality and price of earphones. The survey showed no such relationship suggesting an alternative hypothesis that the price tag of earphones is not a good indicator of sound quality, neither perceived nor when measured acoustically. However, comfort ratings were correlated with the amount of *satisfaction* a person expresses with regards to his or her usage of earphones.

Physical comfort was then analyzed to find out which aspects of it was responsible for delivering comfort to the commuter. This led us to test 3 commonly found types of earbuds and we found that the level of comfort which a commuter would feel only affected how satisfied they are with their earphones but not their perception of music or sound quality. Earbuds could affect a person's perception of music through the level of noise isolation it can deliver. People seem to value noise isolation because from the analysis done, a more noise isolating set of earphones seem to allow the user to feel that they are having a better audio experience. Also, the more noise isolating the earphones are perceived to be, the more expensive it appears to the user.

From this study, we have observed how people tend to tie noise isolation with sound quality, suggesting to us the importance of it. This could be because when people use earphones, they expect it to shut off the noise from the outside, giving them the sense of tranquility.

This study faced the limitation of not being able to answer why people turn up their volumes and the emotions related to sound quality. The sample size of participants in the perceptual experiment could also be larger, including a wider range of ages. Another limitation would be the inability to run audiometric tests on experiment participants. Without knowing the full extent of each participant's sense of hearing, we had to assume that their perceived level of noise isolation was an accurate measure of their ability to discern music from background noise.

Further research involving *physical comfort* of would require a more discerning Comfort Index and its relevance to the earbuds on earphones. Further work based on this paper could be a research on the relationship of listening pleasure and volume levels, as well as the feelings associated with overall audio experience.

7. Acknowledgement

The 1st author is currently completing an undergraduate Final Year Project with the 2nd author as supervisor. The work focused upon in the present text represents a part of the FYP.

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PHYSIOLOGICAL MEASURES REGRESS ONTO ACOUSTIC AND PERCEPTUAL FEATURES OF SOUNDSCAPES

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Abstract

There is no exact model for the relationship between the autonomic nervous system (ANS) and evoked or perceived emotion. Music has long been a privileged field for exploration, while the contribution of soundscape research is more recent. It is known that health is influenced by the sonic environment, and the study here presented aimed to investigate the nature and strength of relationships between soundscape features and physiological responses linked to relaxation or stress. In a controlled experiment, seventeen healthy volunteers moved freely inside a physical installation listening to soundscape recordings of nature, urban parks, eateries, and shops, reproduced using 3D ambisonic techniques. Physiological responses were continuously captured, then detrended, downsampled, and analysed with multivariate linear regression onto orthogonal acoustic and perceptual stimuli features that had been previously determined. Measures of *Peripheral Temperature* regressed onto *SoundMass*, an acoustic feature, and onto *Calm-to-Chaotic*, a perceptual feature, in each case with a moderately sized effect. A smaller effect was found for *Heart Rate* onto *VariabilityFocus*, an acoustic feature, and for *Skin Conductance* onto the interaction between the acoustic features. These relationships could be coherently accounted for by neurophysiological theory of how ANS activation leads to emotional relaxation or stress. We discuss limitations of the present study and considerations for future soundscape emotion research, as well as more immediate practical implications.

Keywords: physiology, acoustic features, soundscapes

1. Introduction

Generally below the level of consciousness, the autonomic nervous system (ANS) is part of an organism's system to control organs and body functions through neuronal (rapid, precise, differentiated) and hormonal (slower and more diffuse modification of metabolic functions) activity levels, effectuating adaptive responses to various environmental demands (e.g. Kreibig 2010). Depending on the organism's needs and desires, ANS elicits quick response mobilisation, "fight-or-flight", via the sympathetic nervous system (SNS), or a "rest and digest" response via the parasympathetic nervous system (PNS). These two subsystems are continuously modulating bodily vital functions, usually in antagonistic fashion, to achieve homeostasis, i.e. trying to maintain a relatively constant inner environment for the organs to function properly, and assure the survival of the organism.

When SNS is activated, stimulating signals are sent to arouse heart and respiratory activity; constrict peripheral blood vessels (i.e. diverting blood away from the skin as well as from the gastro-intestinal tract); dilate blood vessels in muscles and prepare stockpiled energy for utilisation; and induce auditory and visual exclusion (i.e. reducing the range of sensation, such as in "tunnel vision" or temporary hearing loss). Such responses were first described by Cannon (1929). When PNS is activated, dampening signals are sent to calm the activity of heart and lungs; relax the muscles to release blood; and broaden the range of audiovisual sensation. If relaxation follows arousal, ANS stimulates glands to increase sweat production in order to reduce internal body temperature. Even though it is to a larger extent than the other physiological responses here considered open to conscious control, respiration activity is mostly involuntary. Breathing onset rate and air flow rate increase under SNS activation; however, the amplitude range of a breath sequence decreases. The inverse happens when respiration is influenced by PNS dampening. It is important to recall that the brain has evolved to produce integrated responses rather than modify functions one by one. As pointed out by Coutinho and Cangelosi (2011), neurobiological models of emotion focus not only on how ANS controls body activity but also on how afferent signals, going from organs back to the brain, bias feeling as well as cognition, in a process of peripheral feedback (Dibben 2004). Comprehensive arrays of physiological measures would be needed to map such regulation patterns.

People are typically not aware of ANS-influenced physiological changes as such, but have a rich vocabulary to describe their inner state in terms of evoked emotion, or 'feeling', which is to some degree captured with self-reports, e.g. using semantic or other scales. In addition, a person's inner state might be indirectly detected via self-reports of perceived qualities pertaining to stimuli. Correlating objective physiological measures with self-reported psychological measures is therefore a highly important method for cross-validation of emotion constructs. Yet another way to detect ANS responses is by observation of a subject's behaviour. Certainly self-report is useless to capture delicate involuntary mental states, such as distraction, bliss, or fascination. A limitation of the objectivity of physiological measurement is that directed attention can influence the readings, as evidenced by e.g. biofeedback training or mediation.

There is no consensus on the exact relation between ANS activity and evoked or perceived emotion (Kreibig 2010). Music has for a long time been a privileged resource for studying such relationships (see e.g. Friberg, Schoonderwaldt & Hedblad 2011, Juslin & Sloboda 2010). In the context of listening, Iwanaga & Moroki (1999) showed that heart and respiration activity were affected by music stimuli classified as either 'exciting' or 'sedative' . Khalfa and co-workers (2008) also used repertoire pieces classified as either 'sad' or 'happy' (in original as well as structurally modified versions) and found that skin conductance and blood pressure increased more during happy music than during sad. They pointed out that while happy music is arousing and perceived as pleasant, sad music is much less arousing but still perceived as rather pleasant, which is paradoxical. There is evidence that artificially induced physiological arousal or relaxation moderates the intensity of the emotion evoked by a musical stimulus (Dibben 2004). This could indicate that ANS influences perceptual processes at a pre-cognitive emotional processing stage (e.g. Juslin & Västfjäll 2008).

Many studies have mapped relationships in the communication between a transmitter's intended emotion and a listener's perceived or evoked emotion. However, intent is a moot point when considering emotion in relation to soundscapes since they are unintended (or sometimes half-designed, e.g. servicescapes) in comparison to music. What is more, sound is only one aspect of *place*, albeit a crucial one. Where music transports the listener to a domain of imagined and abstract places, listening to soundscape recordings transports the listener to remembered and physical places. That soundscape quality influences health, in particular cardiovascular diseases, has been shown in extensive research projects (e.g. Berglund et al. 2006, Davies et al. 2009). Using physiological measures and films as stimuli, Ulrich et al. (1991) found that subjects could recuperate from induced stress more quickly through watching and hearing a filmed natural environment, than through a filmed urban environment. The study compared heart rate, skin conductance, and self-report responses. Placing subjects in different physical environments, Hartig and co-workers (2003) compared blood pressure response with self-reported stress recovery and directed attention restoration. The diastolic pressure levels were lower, recovery from stress more complete, and restoration faster in people sitting in a room with tree views compared to people in a viewless room. Likewise for people walking in physical environments, such as a nature reserve and an urban area, the former induced greater stress reduction, as indicated by lower blood pressure levels. Letting subjects listen to recordings of pleasant and unpleasant soundscapes, Hume & Ahtamad (2013) found different levels of heart and respiration activity. The decrease in heart rate was greater during more unpleasant soundscapes, while the rise in respiration rate was greater during more pleasant soundscapes. Such findings give insight in how the sonic environment affects health. The importance for urban planners and acoustic designers to create accessible and tranquil places, where city dwellers can recuperate, is underlined by several authors (e.g. Andringa 2009, Hellström 2011, 2012).

2. Experimental method

Aiming to investigate how physiological responses might be influenced by different sonic environments, an experiment was designed. As stimuli, 12 ambisonic recordings of Singaporean soundscapes were selected. Aspects of their acoustic features had been previously computed and perceptual quality rated in a separate study (Lindborg 2012, 2013). The selection was influenced by considerations of how a soundscape can represent a physical environment in the absence of other sensorial information. There are three recordings each from environments loosely categorised as nature, urban parks, eateries, and shops. As a whole, the set represents quotidian Singaporean environments, while each recording has high degree of intra-stimulus homogeneity. Since physiological responses evolve over time-scales ranging from quasi-instantaneous nervous reactions to very slowly accumulated metabolic adaptation, the duration of each experimental stimulus is paramount. In the present study it is 90 s, which is typical, according to a review (Kreibig 2010).

Figure 1 shows the 12 soundscapes plotted in the *SoundMass* - *VariabilityFocus* plane (SM-VF), introduced in the study mentioned above. Two orthogonal dimensions, derived from a Principal Component Analysis, explain 76.2% of the variability in a large set of low-level features (Lartillot 2010). SM describes both loudness and spectral shape: negative values for 'loud, earthy, narrow-range' sounds and positive values 'soft, evanescent, broad-range' sounds. VF indicates the dominant register of amplitude pulsation: negative values describe

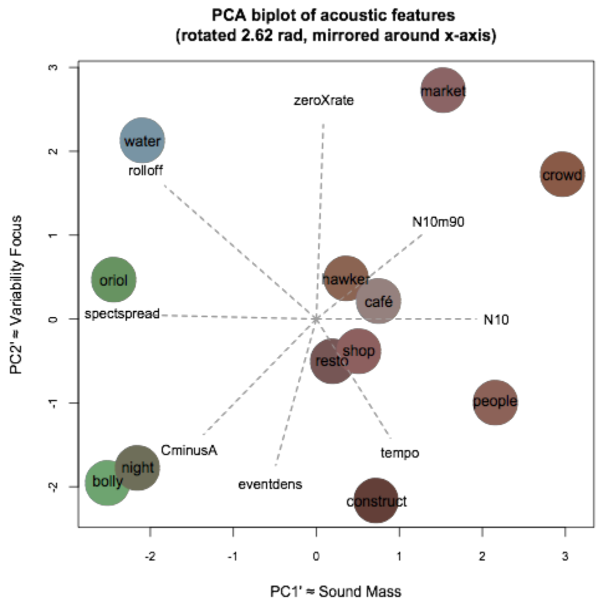

Figure 1. Soundscapes in SM-VF

'thumping, booming, machine-like' sounds and positive values 'chirpy, sizzling, whizzing' soundscapes. Serendipitously, the stimuli are well spread out in SM-VF, with two in each quadrant and four near the centre (Lindborg 2013).

Figure 2 shows the 12 stimuli in the *Pleasant ness* - *Eventfulness* plane (PL-EV). The axes are the orthogonal dimensions of perceived qualia, explaining 73.0% of the variability in ratings on the "eight adjectives" scales section of the Swedish Soundscape Quality Protocol (Axelsson et al. 2010, 2011).

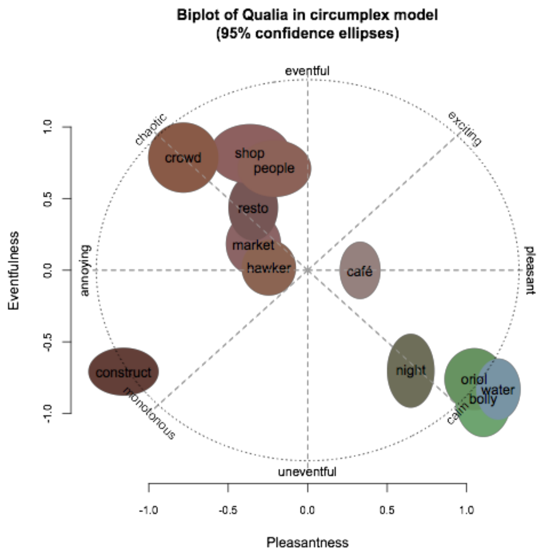

Figure 2. Soundscapes in PL-EV. The radii of ellipses correspond to 95% confidence intervals.

Noting that 11 out of 12 soundscapes are close to the "\" diagonal, for the purpose of the present study, a single derived bipolar dimension was introduced, tentatively labelled *Calm-to-Chaotic* (CaCh). Values were calculated by rotating PL-EV by -π/4 rad and keeping only the Y' axis. Table 1 lists the stimuli features used in the present study, i.e. SM, VF, and CaCh.

Table 1. Derived acoustic features (SM and VF) and perceived qualia (PL and EV), which were replaced with a *Calm-to-Chaotic* (CaCh) dimension.

	SM	*VF*	*PL*	*EV*	*CaCh*
1:market	1.53	2.73	-0.34	0.18	0.37
2:hawker	0.36	0.48	-0.24	0.02	0.19
3:construct	0.73	-2.17	-1.16	-0.71	0.32
4:café	0.75	0.21	0.33	0.00	-0.23
5:bolly	-2.51	-1.95	1.11	-0.90	-1.42
6:night	-2.15	-1.77	0.65	-0.70	-0.95
7:resto	0.19	-0.50	-0.34	0.44	0.55
8:shop	0.51	-0.38	-0.36	0.81	0.83
9:oriol	-2.44	0.47	1.05	-0.76	-1.28
10:water	-2.09	2.13	1.20	-0.83	-1.44
11:crowd	2.97	1.73	-0.78	0.79	1.11
12:people	2.16	-0.99	-0.21	0.71	0.65

17 healthy volunteers, 10 female, participated in the experiment, one by one. Age ranged between 20 and 53 years; median age was 26 years. The experiment was explained to each participant and a general health check was conducted. No participant reported feeling unwell or in an unusual emotional mood, and none had eaten a large meal, exercised heavily, or smoked in the hour preceding the experiment. Blood pressure was measured and no participant's results were unusual for them. One participant was on prescription for a blood pressure controlling medicine, and one participant was knowledgeable about having below-average pressure. The participant then filled out a 'general participant data' (GPD) form including daily habits in terms of work & study, sleep & rest, sport, art, music, games & TV, and socialising. Lastly, they completed the Ten-Item Personality Index (TIPI) and the Profile of Mood States for Adults (POMS). These data revealed nothing remarkable and will not be further discussed. Each participant received a cinema voucher as a token of appreciation.

A great number of psychophysiological measures can potentially provide evidence of SNS and PNS activity. In the present study, a ProComp Infiniti biofeedback system (Thought Technology 2011) was used to capture and transmit responses by WiFi to a computer. Five sensors were placed on the participant following the manufacturers instructions.

- EKG electrodes were placed on the participant's forearms, with the negative lead on right, and positive and ground leads on the left arm. EKG measures cardiovascular activity. SNS activation leads to an increase in heart rate, whereas PNS dampens it. The raw response is measured in micro-volts (μV) and sampled at 2048 Hz.
- A *Thoracic Respiration* (TR) sensor was strapped around the chest of the participant. The response is captured as a relative measure and sampled at 256 Hz.
- *Skin Conductance* (SC) was captured by sensors on the proximal phalanxes of the second and fourth finger. SNS activation stimulates secretion from sweat glands, which increases the skin's electrical conductivity. The response is measured in micro-Siemens (μS) and sampled at 256 Hz.

- *Peripheral Temperature* (PT) was measured by a termistor attached to the third finger of the left hand. PT will vary according to the amount of blood perfusing the skin, which is influenced by SNS. As a person gets stressed, the fingers tend to get colder. The response is measured in degrees Celsius (˚C) and sampled at 256 Hz.
- A *Blood Volume Pulse* (BVP) sensor was attached at the tip of the left hand index. The sensor uses photoplethysmography, i.e. infra-red light detection of skin colour. Changes are due to blood flow variation and indicate SNS activation levels. The response is captured as a relative measure and sampled at 2048 Hz.

The participant was blindfolded, and instructed to keep the left arm relaxed at the side of the body or slightly bent at the elbow, and to remain standing or walking throughout the experiment. Participants could freely move within a triangular area (side=6m), demarcated by a string at chest-height, inside the *WBS* 3D audio installation at IMI, NTU (Lindborg 2011). This rig consists of 9 full-range loudspeakers mounted in a prism shape at three different heights, enabling 3D reproduction of ambisonic recordings at the same Sound Pressure Level as at the original location. The data smoothing method assured that occasional jerky physical movement would not invalidate measurements. However, on two separate occasions, participants needed to be briefly reminded not to hold the left arm in a lifted-up position, e.g. supported by the right arm, or resting on top of the head. When the participant was ready, the experiment started. A 60 s baseline in silence was followed by a 'warm-up' stimulus of 90 s for the participant to get used to the situation. These data were not used in the analysis. Then the 12 soundscape stimuli, each 90 s long, were played back in randomised order. Finally, the fourth stimulus was repeated as a 'control'. To clarify, if we label the stimuli with numbers 1...12 and do not randomise, the sequence following the baseline would be: {8, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 4}. Note that the soundscape presented in the eighth position in the stimulus sequence was identical as the one used as 'warm-up'. Total duration of the experimental session was 60+14*90 seconds = 22 minutes.

3. Data analysis

Commercial software (Thought Technology 2011) was used to visualise several potentially useful 'virtual channels' derived from the raw signals. A set of 31 channels was selected, downsampled to 256 Hz, and exported to R for further analysis. Smoothing of data was made by computing the running median, with window size determined

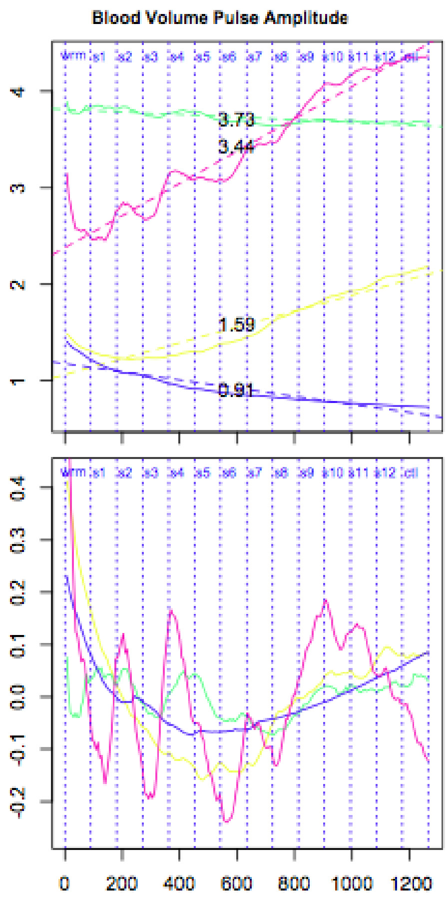

Figure 3. Examples of raw (left) and detrended responses (right). The dashed detrending lines in the left plot all coincide with a horizontal line at y=0 in the right plot. X-axes unit is seconds. The vertical lines represent stimuli onset time. Note that the plots show raw data, and that soundscapes were presented to each participant in a different order.

by Turlach's method. Each channel was then further downsampled to 5 Hz, to yield 450 data points for each 90-second stimulus. In the present analysis, five psychophysiological response channels are considered: *Skin Conductance* (SC, µS), *Peripheral Temperature* (Temp, ˚C), *Blood Volume Pulse Amplitude* (BVPA, relative), *Heart Rate by EKG* (BPM, beats/minute), and *Mean Thoracic Respiration Amplitude* (TRA, relative). Data were stored in an array containing 535,800 values. In order to minimise the influence of long-term signal variation on time-scales longer than the stimuli, linear regression de-trending was applied to each signal channel of the whole session (excepting baseline, but including 'warmup' and 'control'). The residual fluctuation around the regression line was assumed to be related to the physiological response to the soundscape. See Figure 3 for an illustration of the data transformation.

The variations in a channel signal can be attributed to various causes. During an experiment, a participant goes through metabolic, biological, and cognitive processes that have nothing to do with the sound stimuli. A certain amount of the variation will be caused by fatigue, hunger, distraction, and so forth. What we are interested in is that part of the variation which is caused by an ANS-induced response to the soundscape. A great number of techniques can potentially provide evidence of ANS activity. Table 2 presents an overview of the physiological measures used in the present study; the body function of which they register the activity; how such functions and organs are hypothesised to be controlled by ANS; and what emotional state the measures might thereby typically indicate.

Table 2. Hypothetic relations between physiological measure, ANS activity, and emotional state.

measure	body function	SNS activation causes:	PNS dampening causes:	physiological measure *increase* indicates:
BPM	heart rate	increase	decrease	stress
BVPA	peripheral blood flow	decrease	not innervated (increase)	relaxation
TRA	respiration amplitude	decrease	increase	relaxation
SC	sweating	increase	not innervated (decrease)	stress
Temp	peripheral temperature	decrease	not innervated (increase)	relaxation

4. Results

Table 3 presents the main results for 12 soundscape stimuli across 17 participants: mean (with confidence interval) and slope (Pearson's *r*) of detrended responses in 5 physiological channels.

Table 3. Main results.

	SC		*Temp*		*BVPA*		*BPM*		*TRA*	
	m ±ci/2	*r*	m	*r*	m	*r*	m	*r*	m	*r*
1:market	-0.036 ±0.076	-0.561	0.058 ±0.18	-0.978	0.014 ±0.066	-0.913	-0.115 ±0.64	0.653	0.011 ±0.019	0.196
2:hawker	-0.023 ±0.073	-0.951	-0.046 ±0.26	0.962	-0.058 ±0.078	0.849	0.109 ±0.81	-0.94	0.006 ±0.034	-0.889
3:construct	-0.057 ±0.077	0.623	0.075 ±0.21	-0.896	-0.050 ±0.05	-0.782	0.077 ±0.44	0.273	-0.009 ±0.019	0.726
4:café	0.019 ±0.11	0.639	0.125 ±0.22	-0.99	0.041 ±0.059	0.309	0.342 ±0.41	-0.365	0.002 ±0.018	-0.837
5:bolly	-0.031 ±0.10	0.853	0.167 ±0.20	0.936	0.056 ±0.064	0.898	-0.067 ±0.62	0.939	0.015 ±0.025	0.441
6:night	0.028 ±0.10	0.592	-0.055 ±0.35	-0.935	-0.020 ±0.09	-0.95	0.045 ±0.52	-0.833	-0.012 ±0.022	-0.881
7:resto	0.009 ±0.081	0.077	-0.072 ±0.19	-0.814	0.020 ±0.06	-0.984	0.53 ±0.57	-0.791	0.026 ±0.034	-0.673
8:shop	0.026 ±0.094	0.698	-0.062 ±0.25	0.949	-0.005 ±0.075	0.957	0.000 ±0.63	0.933	0.000 ±0.05	-0.894
9:oriol	-0.051 ±0.10	-0.471	0.144 ±0.26	0.998	0.029 ±0.051	-0.616	-0.46 ±0.50	0.229	-0.013 ±0.023	-0.723
10:water	-0.009 ±0.13	-0.801	0.079 ±0.19	0.866	0.002 ±0.068	0.963	-0.348 ±0.47	-0.922	-0.004 ±0.044	0.882
11:crowd	0.000 ±0.10	0.852	0.09 ±0.25	-0.955	-0.017 ±0.067	-0.844	-0.124 ±0.68	0.956	-0.024 ±0.024	0.924
12:people	0.009 ±0.091	-0.901	0.104 ±0.31	-0.766	-0.004 ±0.084	-0.932	-0.234 ±0.46	0.836	-0.013 ±0.033	-0.816

5. Analysis and Discussion

A multivariate linear regression analysis was performed with the 10 derived physiological responses as dependent variables (stratified), and with 2 acoustic (with interaction) and 1 rated feature describing the stimuli. Four relationships were significant at the alpha=0.05 level. They are illustrated in Figure 5.

- *Temp.r* onto *SM* (ß=-0.475, p=0.018*)
- *Temp.m* onto *CaCh* (ß=-0.410, p=0.038*)
- *BPM.r* onto *VF* (ß=-0.163, p=0.037*)
- *SC.r* onto *SM:VF* interaction (ß=0.185, p=0.0088**)

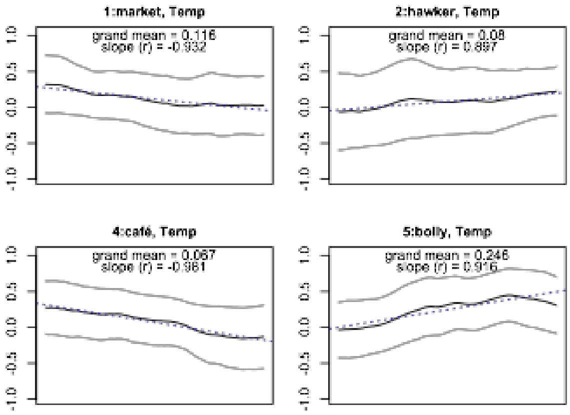

Figure 4. *Peripheral Temperature*: mean across participants (black) with confidence interval curves (grey), and linear regression of the means over time (dashed blue line). Y-axis unit is Δ˚C (distance to detrending line) and time is on the x-axis.

The change in *Peripheral Temperature* was negatively correlated to *SoundMass*, with a moderately sized effect of almost half a standard deviation. In other words, while being in 'loud, earthy, narrow-range' soundscapes such as the urban environments *11:people* and *12:crowd*, participants responded with a lowering of peripheral temperature. This is an indicator for SNS activation which typically leads to emotional stress. Also, temperature was lower the more chaotic the soundscape was, such as in *7:resto* and *8:shop*. Conversely, while being in 'soft, evanescent, broad-range' sonic environments such as the rural parks *5:bolly* and *9:oriol*, participants responded with an increased peripheral temperature. This is an indicator for reduced SNS activation (and possibly of PNS dampening) which typically leads to emotional relaxation.

A closely related aspect of *Peripheral Temperature*, the mean, was negatively correlated with the *Calm-to-Chaotic* rating, and of a comparable effect size. In other words, while being in calm soundscapes, participants responded with a higher average peripheral temperature, linked to ANS-induced relaxation in the same way as above. Conversely, while being in chaotic soundscapes, they responded with a lower temperature, which is linked to stress.

The change in *Heart Rate* (BPM) was negatively correlated to *VariabilityFocus*, with a small effect size of 0.16 standard deviations. In other words, while being in soundscapes where the amplitude variation was mainly in the low register, be it a machine-dominated street environment such as *3:construct* or a rural park with some machinery such as *5:bolly*, participants responded with an increase in heart rate. This is an indicator for SNS activation which typically leads to emotional stress. Conversely, while being in soundscapes where amplitude variation was mainly in the high register, be it in an almost pristine natural environment such as 10:water or in an urban 'old-style' marketplace such as *1:market*, participants responded with a lowering of heart rate, an indicator for PNS dampening which typically leads to emotional relaxation.

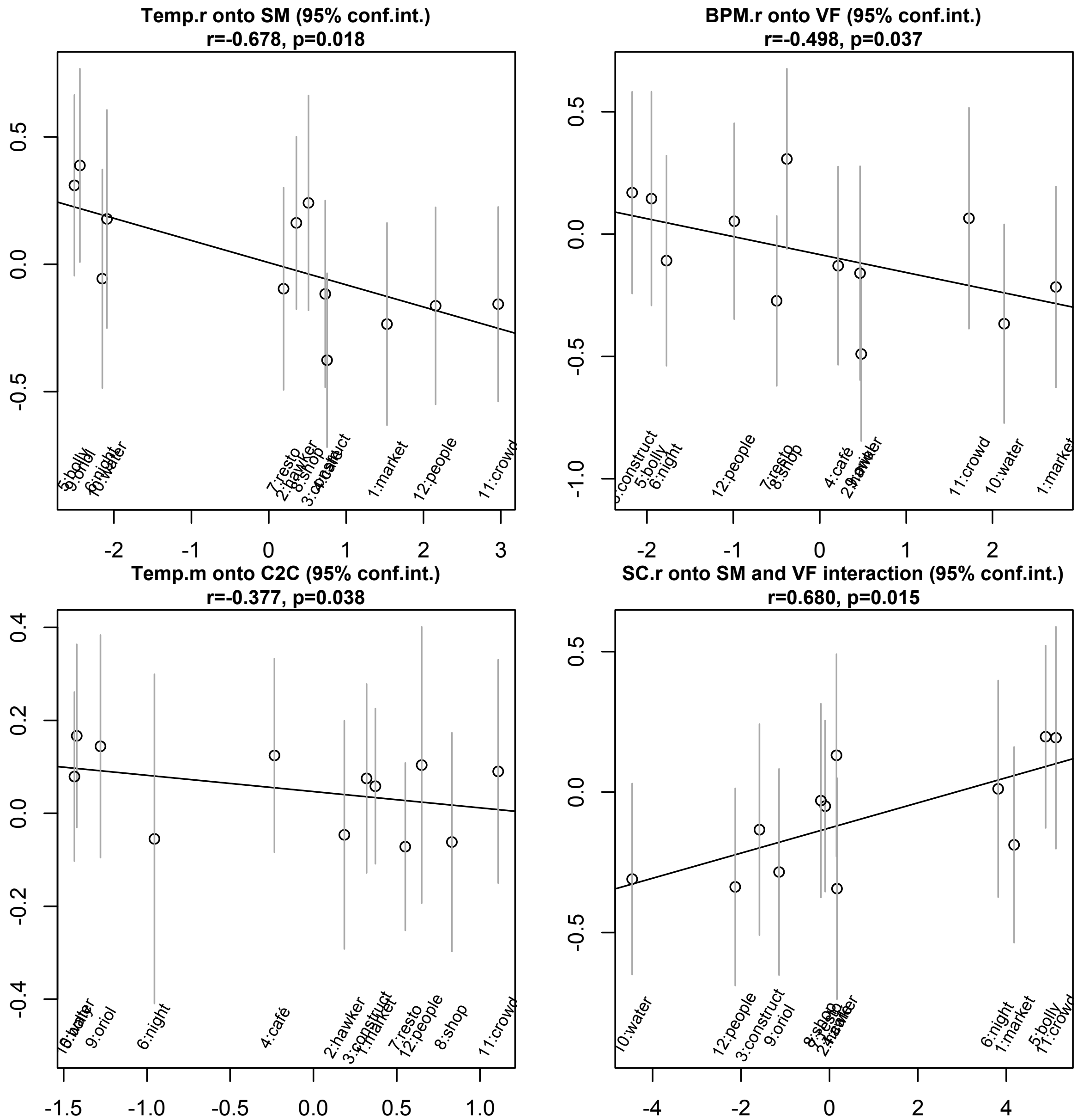

Figure 5. Significant regressions of physiological responses (y-axes) onto acoustic and perceptual features of soundscapes (x-axes).

Lastly, there was a significant interaction effect of *SoundMass* and *VariabilityFocus* on the way *Skin Conductance* changed during soundscape exposure, with a small effect size of 0.18 standard deviations. This interaction expresses the acoustic differences relative to the diagonals of the SM-VF plane. Low values are for soundscapes on either extreme on the "\" diagonal, and high for those on the "/". In somewhat loose terms, an increase in SM:VF interaction expresses high-VF soundscapes getting more massive, and low-VF ones becoming less massive. At the same time, high-SM sounds lower their VF, while less-massive sounds increase it. Such differences were positively correlated with an increase in *Skin Conductance*, an indicator for SNS activation which typically leads to emotional stress. We are not able at this point to describe in simple words what is meant by this interaction effect of acoustic features. More research is needed to investigate such interaction effects, and to identify the acoustic features that best predict emotional responses to soundscapes.

6. Conclusion

We have presented an empirical study of physiological responses to soundscapes. From a review of research in neurophysiology, music emotion, and soundscape perception we identified a set of hypothetical patterns of how autonomic nervous system responses relate to emotional states. Our aim was to investigate the nature and strength of such relationships in the context of soundscapes. A controlled experiment yielded evidence of significant regressions between peripheral temperature, heart rate, and skin conductance onto soundscapes described by acoustic and perceptual features. The results support the assumption that sonic environments induce involuntary nervous responses in ways that are congruent with results and models from research in music emotion.

Because the autonomic nervous system is complex, including peripheral feedback, accumulation, and long-term adaptation, looking for linear relationships between stimuli and physiological responses may not be the best way to create models for the prediction of emotional responses to acoustically rich sounds. Coutinho & Cangelosi (2011) criticise generalisations of results in the linear paradigm, and instead endorse connectionist models such as recurrent neural networks to model temporal development of sound perception. Further, an important aspect of soundscapes that we have not addressed is that they exist in three spatial dimensions; auditory scene analysis is key to a parsimonious description. Yet another limitation is that sound is but one aspect of place, and so a truly ecologically valid investigation must take multisensorial integration into account. Bringing these perspectives together in a model for soundscape emotion is a theme for future research.

Considering the practical implications of this research, it must be underlined that people do perceive differences in soundscape quality, and that their physiological responses are affected by the sonic environment. The present study has a limited scope but clearly highlights the existence of direct relationships between soundscapes and factors known to bear upon people's health. Singapore's transformation over barely two generations into an affluent, densely populated, air-conditioned, and traffic-dominated city-state has brought many societal changes that are laudable, but has also had negative effects, and the deterioration of soundscape quality represents one of the unknown knowns. The biological functioning of people living through such radical environmental changes remains abiding. The onus is on decision-makers to take soundscape research into serious consideration when determining cost-efficient and sustainable urban development.

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HOW CAN ACCOMMODATION BE ENHANCED? THE ROLE OF ANALYTICAL AND EMOTIONAL MUSIC RECEPTION

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Abstract

The dual-process model of development regulation (Brandtstädter & Rothermund, 2002a) proposes that accommodation (flexible goal adjustment) contributes to well-being and successful development. A cognitive mindset characterized by a divergent thinking mode should facilitate accommodative processes. Two studies were conducted to examine the relationship between accommodative mechanisms and music reception. Study 1 (training study; N = 79) investigates whether such a mindset can be induced by attentive-analytical music reception (simultaneously focusing various musical parameters). Two groups of students were trained to listen to music or view art in a complex way. Results showed group differences in the preferences for the stimuli presented. These preferences were correlated with accommodation. The findings from Study 2 (cross-sectional; N = 470) showed a significant relationship between attentive-analytical music reception and accommodation. Furthermore, the interplay between analytical and affective music reception seemed to play an important role in this process. Further studies are needed to examine how the training could be implemented into fields of practice in which developmental regulation processes are relevant (e.g., support groups, psychotherapy, adult education settings, and lifelong learning).

Keywords: personal goals, accommodation, music reception

1. Introduction

The life cycle of each individual is usually characterized by a high degree of openness (Brandtstädter & Rothermund, 2002a) in which personal goals play an important role. Personal goals, in that they represent ideal states of one's own self (Austin & Vancouver, 1996) promote a discrepancy between this ideal and the person's perceived actual state (Brandtstädter, 2011). To reduce this discrepancy, actions toward the goal are initiated. In this sense, personal goals are central in motivating actions and providing orientation to the individual. Various studies have found connections between the commitment to personal goals and positive emotions such as well-being (Brunstein, Maier, & Dargel, 2007).

During the life course, personal goals are often constrained, for instance, by functional losses, diseases, financial and social difficulties. The discrepancy between the actual and the ideal state of the self may exceed a critical point, thus leading to stress, negative emotions, and lowered levels of well-being (Brandtstädter & Rothermund, 2002a). The dual-process model of development regulation (Brandtstädter & Renner, 1990) proposes two modes for reducing discrepancies between actual and desired developmental outcomes: assimilation and accommodation. Assimilative strategies (such as improving one's competences, reinforcing goal commitment, or asking for help) subsume intentional efforts and actions to achieve personally valued but threatened goals. When, however, certain goals become infeasible, assimilative strategies become dysfunctional because resources are being invested pointlessly. At this point, the dual-process model stresses the importance of accommodative processes. These, in general, aim to replace blocked goals and establish alternative ones. As accommodative processes are the focus of the present study, they will be described in more detail in the following. Accommodation reduces the discrepancy between actual and ideal state by flexibly adjusting the latter to the changed situational demands. Previously attractive goals that became unachievable lose subjective value while alternative goals gain in importance. Essential for this process is a shift in the cognitive mode (Brandtstädter & Rothermund, 2002b). Whereas attention is focused on one specific goal in the assimilative mode, the focus broadens once accommodative mechanisms become active. As a result of this shift in attention, alternative goals become available, can be evaluated, and finally replace unachievable ones. Furthermore, the accommodative mode is characterized by divergent thinking. This means that a negative situation can be regarded from different perspectives which in turn may lead to a positive reinterpretation. The individual realizes that resources are now available to pursue other equally valued goals and positive aspects of the situation can be detected. Because accommodative processes cannot be intentionally controlled by the individual (Brandtstädter & Greve, 1994; Greve & Wentura, 2007), they are difficult to train. Thus, to be able to activate accommodative processes (which could be valuable when unavoidable losses occur), it is essential to look for conditions that would facilitate accommodative mechanisms. What are the preconditions of accommodation? Brandtstädter and Rothermund (2002a) refer to self-complexity (Linville, 1987; Rafaeli & Hiller, 2010), which renders persons less vulnerable to depression. High self-complexity as characterized by a multi-faceted picture of oneself might be a positive factor because it provides the individual with a higher number of alternative goals, and thus, enhances flexible goal adjustment (Brandtstädter & Rothermund, 2002a). In addition to their sheer number, Leipold, Jopp, and Staudinger (subm.) stress the interconnectedness of the self-aspects as a relevant factor. If goals are imbedded in a connected structure, they become more easily accessible (Anderson, 1983).

Taken together, accommodative mechanisms are characterized by divergent thinking, and a broad focus of attention. High complexity in the structure of personal goals facilitates replacement of unachievable goals because alternative ones are available.

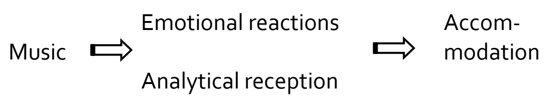
In addition to these cognitive aspects of accommodative mechanisms, Brandtstädter (2011) describes the influence in particular of positive emotions on accommodation. According to Fredrickson (2006), positive emotions broaden the focus of attention, which has already been mentioned as being essential for accommodative mechanisms.

Comparable to accommodative mechanisms, cognitive as well as emotional aspects also play an important role in the course of music reception (Krumhansl, 2002). In certain forms of music reception, a cognitive mode similar to that of accommodation might occur. For example, Hargreaves and Colman (1981) describe two forms of objective music reception. Whereas objective-analytical music reception denotes a listening style that aims at grasping different technical and stylistic aspects of a piece of music, objective-global music reception focuses on the piece of music and its structure as a whole. Objective-analytical reception focusses on various parameters and therefore the overall impression of the piece of music - as a result of objective-global reception - is a complex one. This process of establishing a complex representation can be compared to the previously mentioned accommodative mechanisms, namely, regarding a negative situation from different perspectives. In both cases divergent thinking and a wide focus of attention lead to a complex impression of an object.

In a sample of adolescents, Behne (1997) found an analytical and concentrated form of musical reception which he called distancing listening. The analytical distance described here between the listener and the piece of music might also be an indicator for a cognitive aspect of this form of musical reception. Distancing listening does not aim automatically to experience various affective reactions while listening to music.

Hargreaves and Colman (1981) subsume emotional aspects of music listening under the term "affective reception". Here the listener focuses on the perceived affective reactions while listening. The focus of attention thus lies on the listening subject. This point is further elaborated by Thoma et al. (2012), who found that mood-congruent music is preferred in emotional situations. Thus emotional aspects play a crucial role in music reception.

Using this theoretical background the main research questions of the present paper focus on connections between music reception and accommodative mechanisms. We investigated the relationship between cognitive-emotional music reception and accommodation (flexible goal adjustment).



Loepthien and Leipold (2013) found a positive relationship between attentive-analytical music reception and accommodation. This connection could be explained by the aforementioned similarities in the cognitive mode. As these cross-sectional results do not allow causal interpretations, Study 1 examines whether training participants in attentive-analytical music reception or in a complex form of art reception has a positive influence on accommodative mechanisms. The art reception training was introduced as a condition that was comparable but differed in the perceived stimuli. The importance of comparison conditions that also contain a form of training have been previously stressed (e.g., Jäncke, 2008; Schellenberg, 2005) and realized (e.g., Moreno et al., 2011). In detail, we investigated the complexity of the individuals´ judgments after the training session and whether affective reactions to music pieces and pictures lead to differences in accommodation.

Study 2 is cross-sectional and examines whether the interplay between the two forms of music reception in question sheds further light on previous findings. Thus, we expect that both an attentive-analytical listening style and the emotional reaction to music are crucial for accommodative goal adjustments.

2. Study 1

2.1. Sample

The participants of Study 1 were students of the University of Hildesheim.
N = 79
Music training: N = 38;
Art training: N = 41
Age: M = 23 years (18-47 years); SD = 6
Gender: female = 92%

2.2. Procedure

Two training conditions were used to examine the hypothesis. Whereas in the first, participants were instructed in attentive-analytical music reception, in the latter they received instructions in complex art reception. Both conditions aimed at training the participants to mention several parameters when they listened to music or looked at pictures (for examples used see table 1). For the music training these parameters were:

- Melody
- Harmony
- Rhythm
- Dynamic

The parameters of the art training ("modes of seeing") referred to painting styles:

- Balance between colours
- Perspective
- Linear, hard-edged vs. paint-like, soft-edged
- Relatedness of objects (unity vs. multiplicity)

For each of the parameters the participants received separate training. Each of the training sessions was followed by the presentation of a new example and the following tasks: Participants were asked to judge the picture or the music piece with regard to the parameters. Subsequent to each parameter judgement, they used two Likert scales to rate how difficult this task was, and how much they liked the picture or the music. After focusing on the parameters separately the participants were confronted with two new examples to focus on the parameters simultaneously. Participants were then asked to write in free text about their impression of each of the last example's parameters. Because we did not expect the participants to be as familiar with the criteria for art judgments as for the 4 music parameters, the art group received a sheet (memory aid) with examples of the 4 parameters. These parameters seem not as common to the participants as the music parameters.

Both training sessions took on average 42 minutes (M = 42.0; SD = 3.8). The assessment took place in group sessions with an average of 5 participants.

Table 1. Music and art examples used in Study 1.

Music		Art	
Melody	Wolfgang Amadeus Mozart: Piano Sonata, C major, KV 545, 1st movement	Color	Paul Klee: Little Tree in Bushes
	Wolfgang Amadeus Mozart: from: The Magic Flute: In diesen heil'gen Hallen		Fernand Leger: Landscape with Cows
	The Beach Boys: God only knows		Paul Klee: Colored Flower Bed
Harmony	Example based on: Johann Sebastian Bach, Präludium No. 21, Well-Tempered Pianoforte I, BWV 866	Perspective	Gerrit van Vucht: Pomp Still Life
	Alexander Skrjabin: Vers la flamme, op. 72		Paul Cézanne: Still Life with Cherries
	Simon and Garfunkel: Bridge over Troubled Water		Jean-Baptiste Camille Corot: L'Église de Marissel
Rhythm	The Beatles: Eight Days a Week	Contour	Lucas Cranach the Elder: Portrait of an Unknown Lady
	Nieves Quintero: La Cumparsita		John Constable: The Haywain
	The Dave Brubeck Quartet: Take Five		Peter Paul Rubens: Polder Landscape with Cattle Herd
Dynamic	Ludwig van Beethoven: Piano Sonata op. 10, No. 3, 2nd movement	Relatedness	Peter Paul Rubens: Hay Harvest near Mecheln
	Björk: It's oh so Quiet		Oberrheinischer Meister: The Garden Eden
Overall	Derek and the Dominos/Eric Clapton: Layla, CD-Version and Live/Unplugged Version	Overall	Paul Cézanne: Two Versions of Monte Saint-Victoire seen from Les Lauves
	Franz Schubert: Piano Trio No. 2, E flat major, D 929, 2nd movement		Henri Matisse: Plum Blossoms in Front of Green Background

2.3. Measurements

Accommodation was assessed using the Ten-Flex scale (Brandtstädter & Renner, 1990). This instrument measures the dispositional tendency to face goal blockages by either tenaciously pursuing goals (assimilation) or flexibly adjusting personal goals to a new situation (accommodation).

Assimilation (e.g., "I usually reinforce my efforts extensively when faced with difficulties"; α = .83).

Accommodation (e.g., "When I am faced with insurmountable obstacles I prefer to look for a new goal."; α = .81).

Goal complexity: To measure the complexity of the personal goal structure a card-sorting task (Linville, 1987) was used. Participants were asked to name personal goals. After that they were given 42 cards containing adjectives, (e.g., cheerful, impatient, determined, etc.) The adjectives had to be sorted to the goals when they described how the participant felt while thinking about the goal. Two indicators of complexity (von Eye, 1999) were used: 1. the number of goals; and 2. their degree of connectedness, resulting from how many similar adjectives were used to describe the goals (overlap). Both items were combined to one variable; α was .76.

In addition, two measures from the training sessions were used to assess the emotional reactions to the music or pictures respectively and the complexity of the free-text paragraphs.

Preference: Participants were asked to indicate how much they liked the 4 examples for which they had judged the quality of melody, harmony, rhythm, and dynamic. The participants of the art group were asked how much they liked the pictures. We computed the sum score and interpreted this as general emotional reaction to music or art.

Text complexity: Two students of the University of Hildesheim were trained to rate the complexity of the free texts describing the parameters of the final examples. They used 5 Items with 6 point Likert scales (1 = "not complex at all" – 6 = "very complex") the sum of which provided this variable.

Task difficulty: The perceived difficulties with training tasks served as control variables. Because the sample consisted of musical and artistic laypersons, it was interesting to know whether the tasks were a strain for the participants. This was obviously not the case. The evaluations ranged on average from easy to mid-grade levels. We computed the sum score of the four parameters in each group. High values indicate that the task was perceived as quite simple.

2.4. Results

In a first step, we examined whether the musical training led to more accommodation and goal complexity. No treatment differences were found in these measures. We found, however, differences in text complexity and preferences, two measures that were assumed to mediate the influence of complex art or music reception on participants´ goal complexity and accommodation. We used a path analysis to illustrate the group effects and the significant relationships between mediating training effects and general goal structure (i.e., goal complexity and accommodation; see Figure 1). Participants receiving the training in complex art reception wrote significantly more complex texts than the participants in the music condition. Text complexity predicted the complexity of the participant's goal structure. The latter, in turn, is positively connected to accommodative mechanisms.

Figure 1 also shows preference differences. On average, the musical stimuli were liked significantly more than the stimuli used in the art group. Higher preferences significantly predicted accommodation.

Assimilation was also included in the analysis for heuristic purposes. This regulation process was significantly predicted by goal complexity and the perceived difficulty of the training tasks. The easier the tasks were for the participants, the higher were their values on the scale measuring assimilative strategies.

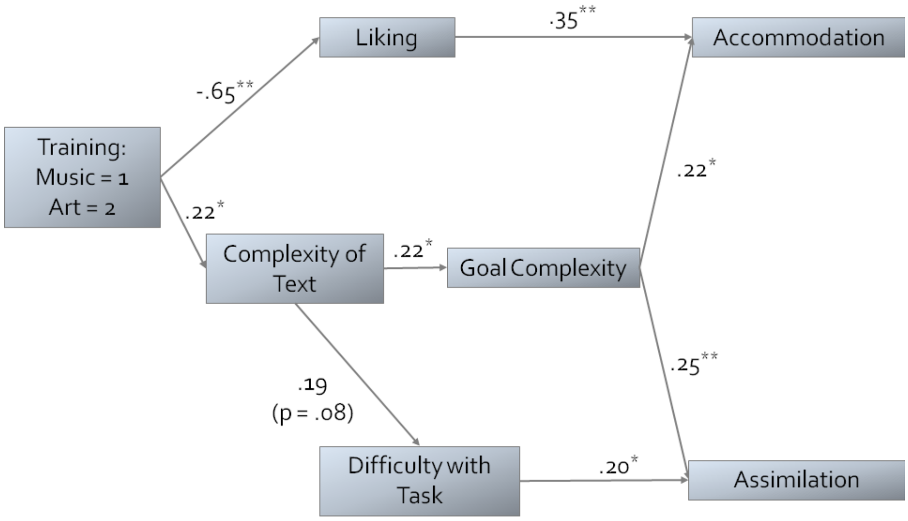


Figure 1. Path analysis (N = 79). The values indicate standardized and significant path coefficients.

3. Study 2

A previous study by Loepthien and Leipold (2013) showed a direct relationship between attentive-analytical music reception and accommodation. We have interpreted this effect by arguing that complex cognitive structures (e.g., goal complexity, cognitive complexity) are preconditions of accommodation. As music is an important part of life for many people and does affect their emotions, in the present study we investigated whether emotional reactions possibly contribute to the development of accommodation. We expect that the correlation between analytical listening to music and accommodation is stronger if individuals are emotionally affected by music.

3.1. Sample

N = 470
Age: M = 38 years (19-96 years); SD = 19
Gender: female = 68%
Musical expertise: 45% play an instrument
Educational level: Most participants (70%) had a high level of education with 13 years of schooling; 17% had a medium level with 10 years of education, and 13% had a lower level of education.

3.2. Measures

As in Study 1, accommodation was assessed by the TenFlex (Brandtstädter & Renner, 1990).

To assess music reception, two scales from an instrument by Leipold and Loepthien (Leipold & Loepthien, 2008) were used, measuring the amount of emotional and attentive-analytical music reception.

Emotional listening consists of 4 items (α = .77, e.g., "Sad music often makes me cry", "Music is a matter of feeling").

Attentive–analytical listening consists of 5 items (α = .84; e.g., "I try to understand the formal structure of a piece of music.").

3.3. Results

Regression analyses were used to examine the relationship between accommodation and emotional and attentive-analytical music reception separately while controlling for the musical expertise of the participants. The results showed that this regression model explained 4.6% of the variance ($R^2 = 4.6$, $F(3,466) = 7.48$, $p < .01$). Attentive-analytical music reception significantly predicts accommodation ($\beta = .24$; $p<.01$) as well as emotional music reception ($\beta = -.14$; $p<.01$).

Another regression analysis was conducted to further analyze the connection between accommodation and the interaction between both music reception styles and musical expertise. The regression model was expanded by adding the interaction terms to the regression model. This enlarged model explained 5.6% of the variance ($R^2 = 5.6$, $F (6,463) = 4.59$, $p < .01$). The interaction between both reception styles was nearly significant ($\beta_{analytical \times emotional\ listening} = .09$; p=.059). As can be seen in Figure 2, emotional music reception moderates the correlation between attentive-analytical music reception and accommodation. This connection is highest for participants who show high values for attentive-analytical as well as emotional music reception.

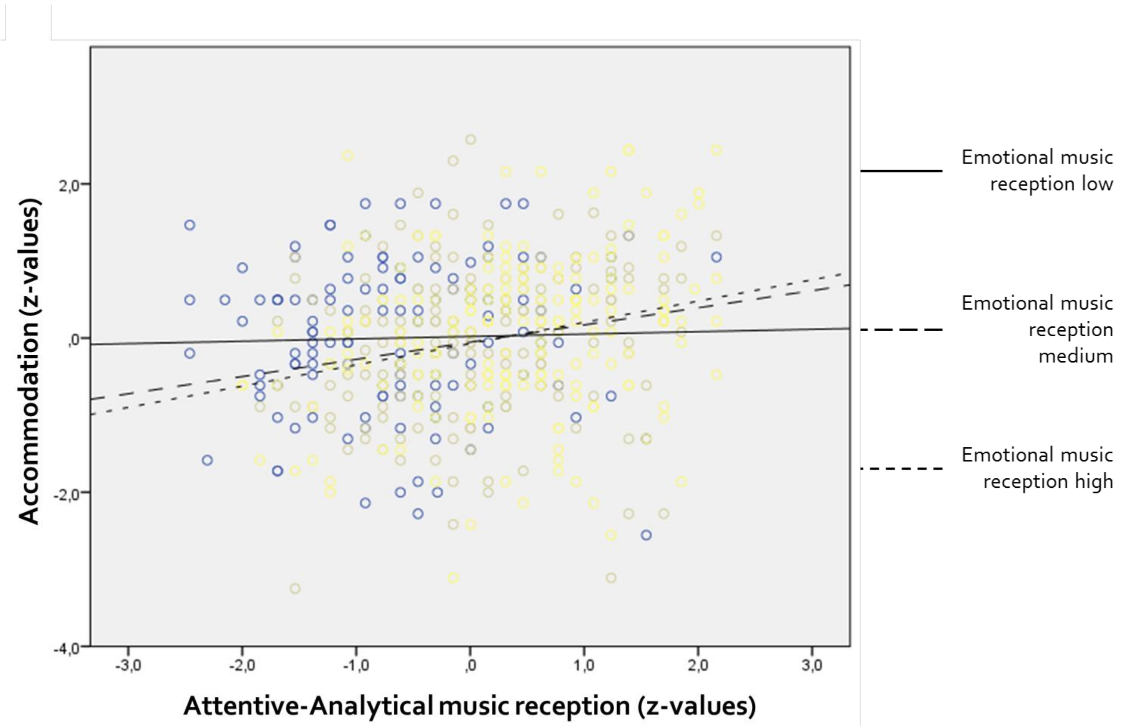


Figure 2. Regression analysis for accommodation: Emotional listening moderates the relationship between attentive-analytical listening and accommodation.

4. Discussion

In general, both studies indicate relationships between music reception and accommodative regulation processes. The results of Study 1 suggest that music may influence accommodation via affective evaluations. The preference for the music was higher than for the pictures. Participants who liked the examples had significantly higher values on the scale measuring accommodation. A possible explanation for this result might be that participants were put in a positive mood if they liked the stimuli. According to the broaden-and-build theory of positive emotions (Fredrickson, 2006), such a positive emotional state broadens the focus of attention and therefore facilitates accommodative mechanisms (Brandtstädter, 2011). If the focus of attention is wide, alternative goals become available and replace blocked life-plans. However, the present study did not measure changes in participants' mood during the course of the training. Further studies have to examine more closely whether and how the stimuli do influence participants' mood, which in turn facilitates accommodative mechanisms.

Study 1 also showed a significant connection between the structure of personal goals and accommodative mechanisms, namely, the higher the complexity of the goal structure, the higher accommodation was. This result is in line with the assumptions of the dual-process model which assumes that a multifaceted self structure renders alternative options to be more accessible (cf. Rafaeli & Hiller, 2010). However, we found that training participants in complex art reception enhanced the complexity of their personal goal structure as measured by the text complexity.

An interesting path was found from the training condition to assimilation, linked by text complexity and perceived task performance. Assimilation was significantly predicted by less difficulty during the training. This might be due to a possible influence on participant's self-efficacy (Bandura, 1997) which is beneficial for assimilative strategies (Brandtstädter, 2011).

The results of Study 2 shed more light on previous cross-sectional studies of the connection between accommodation and complex music reception (Loepthien & Leipold, 2013). The regression analysis suggests that the interplay of attentive-analytical and emotional music reception plays an important role in accommodative mechanisms. High values in attentive-analytical music reception significantly predicted higher flexibility in adjusting personal goals. This association was moderated by emotional listening. Participants who emphasize emotional aspects during music reception showed a higher correlation between attentive-analytical music reception and accommodative processes. These results show the importance of examining the interplay between cognitive and emotional aspects of music reception for research. The importance of both cognitive and emotional processes for developmental regulation has been discussed by Labouvie-Vief (2005) in the dynamic integration theory. This theory claims that structural aspects of thought (e.g., cognitive differentiation, complexity), in short, the processes of cognitive development as introduced by Piaget, are important characteristics of successful development. Logical analysis and problem solving abilities and the related adaptation of cognitive schemata constitute a domain traditionally called epistemology. The underlying processes refer to the question of what we can know. The ability to analyze a piece of music, for instance, to listen attentively, and to see various parameters, possibly deals with schema differentiation and complexity and thus provides a cognitive basis for accommodation (flexible goal adjustment).

These rather cognitive, logical processes, however, are perhaps not comprehensive enough to characterize processes of coping, problem solving, or development regulation in adulthood. They do not necessary entail feelings, hopes, desires, and emotions. Many of the problems adults have - one can also say some of their identity projects and attitudes - are value-loaded and refer to emotionally *hot* matters (Labouvie-Vief, 2005). Thus, emotions are dynamic and arise out of social relations or social problems, which one cannot or will not solve by logical arguments or epistemological facts. Of course, emotional reactions may have specific causes, but they are not under immediate personal control like the knowledge about well-tried problem-solving strategies.

The role of emotions in the light of the dual-process model of development regulation is manifold (Brandtstädter, 2011). Positive emotions can lead to planned actions; they are part of self-evaluations (high self-esteem), and indicate personal importance. They are a central part of development regulation and influence the dynamic between goal pursuit and flexible goal adjustment. Depressive states, for instance, indicate that problems have not been solved for the individual, although an inevitable loss (e.g., a severe disease) has been acknowledged.

Emotional reactions towards music are not limited to short-term affective fluctuations that occur while we listen to a song and feel happy or sad. Emotional listening can also indicate that music is of great importance for the self–- as is the case for many individuals. To this effect, music is a reminder of what Harry Frankfurt (1982) has called the importance of what we care about. For many people, music is personal matter, an ideal, and a source of meaning and, as such, a part of accommodation. Against this background, attentive-analytical listening is not a mere cold cognitive process that hinders feelings or "authentic interpretation", but rather a level of processing that can be learned to a degree – and we assume that this effort could be helpful in hearing differences, progressions, aesthetic qualities – or perhaps a part of the beauty of the music.

We know that our data are not specific enough to test these assumptions, rather, we believe that the role of music in the process of coping and development regulation is manifold and that it would be worthwhile to invest in research to understand how individuals cope with challenges and how music can contribute to adaptation.

A complete understanding of the general psychological mechanisms of goal-adaptation processes requires knowledge about the interaction between relevant factors (e.g., attention, information-processing, motivation, evaluation, as well as sociocultural constraints) that contribute to the changes in adaptation. Of course, further studies are needed to analyze more precisely the processes underlying the connection between music reception and accommodation. For example Study 1 should be enhanced by a listening condition that triggers emotional listening. In addition, studies with a longer time-span for the training need to be conducted. Also, research with a more representative sample is needed. As accommodative mechanisms gain importance across the life-span (Brandtstädter & Greve, 1994), it would be particularly worthwhile to include a broader age range in the sample. Future research expanding the results reported in the present paper is beneficial because music reception might be a way to positively influence accommodative mechanisms.

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THE EMOTIONALITY OF SONIC EVENTS: TESTING THE GENEVA EMOTIONAL MUSIC SCALE (GEMS) FOR POPULAR AND ELECTROACOUSTIC MUSIC

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Abstract

In the present study the Geneva Emotional Music Scale (GEMS-25) and its German offshoot, the GEMS-28-G were tested for measurement invariance across different types of musical stimuli. Additionally, the comparability of scores across the different language versions was checked. While alternative scales are often based on general dimensional or categorical emotion theories and are thus "stimulus-neutral", the domain-specific likert-type emotion scale GEMS is designed to especially capture the emotions evoked when listening to music. Within the study, an online survey was administered (n = 245) using a stimuli set of 20 excerpts from musical pieces. By analyzing the data with structural equation modeling (SEM), we tried to verify the reliability of the scales in terms of measurement invariance towards popular/classic music as well as towards the genre of electroacoustic music, employing the latter as an extreme case of a "non-conventional musical style". We subsequently also tested for measurement invariance across languages. Concerning music styles, measurement invariance of the original GEMS-25 was achieved only at the "configural level", while the GEMS-28-G could reach at least "weak factorial invariance". This demonstrates that only for the German version the contextual meaning of the construct remains constant across different musical genres with a reasonable fit. Nevertheless, researchers should be cautious when comparing GEMS factor scores achieved with very heterogenic musical styles in future studies, regardless in which language.

Keywords: emotion measurement, structural equation modeling, measurement invariance

1. Introduction

The measurement of music-induced emotions is a growing field within music psychology, with a multitude of basic questions to be answered. A debate is still going on concerning the nature of the emotions related to music. Some claim that music does not evoke emotions as experienced in everyday situations, but that listeners respond affectively to music (Hunter & Schellenberg, 2010).

Different approaches are available for measuring emotions in general, including the measurement of bodily functions, the use of real-time user responses or surveys based on self-reports (Desmet, 2003). The latter have a long tradition in the capturing of everyday sensations. Some authors express uncertainty that theories developed for non-music-related emotion measurement are adequate for use in music related questions and its aesthetic context (Vuoskoski & Eerola, 2011, p. 160). Although the two-dimensional circumplex model and the discrete emotion model have been extensively used (ibid.), the need for a music specific instrument describing more aesthetical contexts has become obvious (Zentner, Grandjean & Scherer, 2008). This is due to the fact that emotions related to the listening of music seem to differ from those we experience in everyday situations.

To overcome the shortcomings of generic scales in music emotion research, the *Geneva Emotional Music Scale* (GEMS) has been introduced by Zentner, Grandjean, and Scherer in 2008. In a series of experiments, 45 items were selected to measure the perceived feelings. The items are organized in nine factors and three super factors. The resulting scale - as well as shorter adaptions containing 25 and nine items - was evaluated in further tests and the model showed a significant fit for classic music pieces (ibid.). Making it available in an international context, the original French GEMS was adapted to English language by Zentner and co-researchers. For a research project in German language, an adaption of the GEMS-25 has been conducted by Lepa (in preparation), namely the GEMS-28-G. Being rather new measurement tools, both scales, the English and the German, are still in the need of being tested regarding their validity and reliability to either affirm their suitability or disclose their weak spots.

Typical test designs for measuring musically induced emotions apply generic musical stimuli, mainly well-established music genres like popular and classical music. Since the GEMS is designed to capture the emotions induced by music in general and without regarding the genre, the results of an experiment with non-conventional music are crucial for defining the limits of the measurement instrument. Vuoskoski and Eerola conducted a test of the GEMS using "*ecologically valid and emotionally diverse stimulus material*" (Vuoskoski & Eerola, 2011, p. 160) and could demonstrate the suitability of the scale for music in a wider sense. Since music as a cultural technique is always in constant change (especially during the 20th century, the boundaries of what is considered as music were redefined), it is of interest whether tools for measuring musical emotions can account for these changes.

As a consequence, we focused on testing for scale invariance with different musical stimulus material (for the concept of measurement invariance see Section 3), in particular using the genre of electroacoustic music[1]. Electroacoustic music clearly marks the boundary between what is regarded as music in the common sense and sound art, which would not be categorized as music if listened to by laymen.

It is of fundamental interest, whether the emotions evoked when listening to avantgarde music can be measured in the same way as those evoked from popular music genres. Thus the experiment presented in this paper can be regarded as one of many experiments defining the genre limits, in which a music specific emotion measurement is reasonable.

Our experiment aimed at two different research questions, namely the testing for invariance and of the respective model fit for the GEM scale for (1) different stimulus material (i.e. popular/classical music and electroacoustic music) and (2) over independent test groups using the English and the German versions of the measurement scale. Consequently, within our study measurement invariance was tested across measurement occasions (stimuli) and, in a second step, across groups (languages) at a common set of hierarchically structured levels of invariance constraints (Widaman & Reise, 1997): (a) configural invariance, (b) weak factorial invariance (equal factor loadings), (c) strong factorial invariance (equal factor loadings and intercepts) and (d) strict factorial invariance (adds equal error residuals). The degree of invariance defines the premises for comparisons between resulting parameters of the scale (eg. factor means) when applied to different measurement occasions and the conclusions that can be drawn from them.

This paper is further organized as follows: In Section 2 the GEM scale as well as the test environment and procedure are explained in detail. The evaluation procedure and related methods are presented in Section 3. Results are presented in Section 4 and discussed in Section 5. The paper ends with a final conclusion in Section 6.

[1] *The term electroacoustic music refers to a modern form of Western art music and compositional practice that makes use of electric sound (re-)production. Therefore it includes tape music, electronic and computer music. For further information on electroacoustic music refer to Böhme-Mehner, Mehner & Wolf (2008).*

2. Experimental Setup

2.1. Measurement

In our present experimental setup we made use of the German translation of an extended[2] GEMS-25, the GEMS-28-G as introduced and evaluated by Lepa (in preparation). This scale consists of 27 labels (adjectives) representing the nine categories of GEMS-9 with three items per dimension. These dimensions condense into three top-level factors (cf. Table 2).

In order to address our research question adequately, we made the survey accessible to non-German speakers by using the English version consisting of equivalent terms of the extended GEMS-25 on which the German translation was based on. In this context, it has to be considered that shifts in meaning of terms may occur, as nuances of the original scale could have been "lost in the translation" as pointed out by Vuoskoski and Eerola (2011), who developed a Finnish translation of the English attributes.

The item batteries containing the German and the respective English adjectives can be found in Table 2. For rating the intensity of the given items, the original 5-point (Likert) scale ranging from 1 (not at all) to 5 (very much) was used (cf. Table 1). The respective scale was designed to be balanced, non-forced choice and even interval scaled.

2.2. Procedure

Our approach (being based on a within-subjects design) was to present two excerpts (one of each stimuli group) to the participants to be evaluated in terms of induced, felt emotions on the provided rating scale. In order to make the test available for a large number of participants and to avoid the effort of evaluating paper questionnaires, we decided to use the online survey application *LimeSurvey* that was adapted to our specific requirements. An audio player was implemented to play back the sound excerpts within the survey. Moreover, both the stimuli and the respective item list for each sound excerpt had been randomized before presented to the individual listener to avoid any kind of systematic sequential effects and response biases. Furthermore, the two musical excerpts to be presented to the individual subject were also chosen randomly resulting in 100 (= 10^2) different stimuli combinations.

The testing procedure within the online survey was structured in five parts being presented on consecutive screens:

(1) *Introduction:* Participants were instructed regarding the testing procedure and their task to rate the felt emotions in context of the presented music.

(2) *Sound system setup:* For optimized listening conditions, we provided an audio setup consisting of an audio player with a *neutral* musical excerpt[3] and instructions to adjust volume, eliminate noise sources and get into a comfortable listening position.

(3 - 4) *1st and 2nd music excerpt:* In these parts the auditory stimuli were rated according to their affectional impact, in other words, the intensity of the felt emotions on basis of the emotion labels provided by the GEM scale.

(5) *Personal questions on participants*: In order to allow the statistical analysis of the sample data, the participants were asked to provide sociodemographic information and to describe their relationship to music and individual music listening habits.

2.3. Stimuli

As auditory stimulus material we used two categories of music excerpts: The first group, labelled as *anchor music*, consisted of ten excerpts of purely instrumental popular and classical music. The pieces were chosen to represent a variety of ordinary music genres most listeners should feel familiar with. The second group of stimuli was a compilation of ten different pieces of electroacoustic music. Choosing the excerpts, the goal was to represent a spectrum as large as possible of respective

[2] *Two adjectives from the original extended GEMS-45 version (cf. Section 1), "blue" and "nervous" were added to the GEMS-25 scale for achieving comparability.*

[3] *A song excerpt representing a bright mood and being normalized to a peak level of -2 dB with respect to the test stimuli to be rated in order to add slightly more presence to the latter.*

musical aesthetics, moods and production techniques.

All excerpts from both groups had a duration of two minutes with a soft fade-out at the end of each excerpt.

The sound excerpts were encoded with the lame mp3 codec (320kBit/s, 44.1 kHz, Stereo) in order to reduce file size and to ensure streaming via the Internet (with a negligible loss of audio quality).

2.4. Participants (n = 245)

The survey was spread via different mailing lists and online interest groups, related to musicology, sound art as well as non music specific groups. In this way, we were able to reach a target audience beyond a sample consisting exclusively of students being involved with the specific problem. Altogether, 245 participants took part in the survey. More than half of them (55.5%) were German speakers, 45.5% participated in the English version of the survey. Around 57% of all participants were male; the average age of the samples (ranging from 15 to 71 years) was 28.5 years (SD = 7.5). Regarding their educational level, almost two-thirds (63.3%) of the participants stated to have a higher education degree, a further 31.4% graduated from college. Concerning musicological knowledge, the largest group of 42.5% indicated having a good understanding of music, while laymen and music experts comprised each 28.6%. Their average music listening time was 110.7 minutes (SD = 99) per day. In matters pertaining to the experiment, 88.5% of all participants rated the testing conditions as good or even very good, only 2.2% reported having bad conditions of participation.

3. Method

Following the method of data evaluation in Zentner et al. (2008), the acquired data underwent a confirmatory factor analysis (CFA) The experimental questions to be answered can be summarized as follows: Is the measurement tool invariant across different musical stimuli and, if so, to what extent? Furthermore, can measurement invariance be observed across groups of different languages?

The test results allow conclusions concerning the reliability of the model over a wide range of possible musical contexts and stimuli, in order to further evaluate the method proposed by Zentner et al. (2008).

3.1. The Factor Model

The basis of the analysis is the factor model shown in Table 2b. It specifies the loading structure of the 27 adjective labels, the items, in nine first-order latent variables (factors), which themselves load onto three second-order factors. This model tries to explain the variability and correlation observed in the item covariance matrix based on the assumption that they are caused by fewer, unobserved variables (the factors) whose scores are dependent on a linear combination of the item scores, their likewise difficulty (i.e. the item intercept value) and an item-specific error term (Backhaus, Erichson, Plinke & Weiber, 2006). Each of the items is associated with a specific factor loading, which shows the extent to which the property referred to by the observed variable (in this case the adjective characterizing the felt emotion) contributes to the concept described by the higher order factor (here a mood, disposition or emotional state).

3.2. Measurement Invariance

Being confronted with the issue whether the measurement tool provides reliable results for different kinds of stimuli and independent groups of test subjects, testing for measurement invariance is the procedure of choice (e.g. Geiser, 2010; Widaman & Reise, 1997; Meredith, 1993). It involves testing for identical (equivalent) constructs across measurement occasions or groups to assure a comparability of measures. On this premise, the same constructs are being assessed and a meaningful comparison of statistics (such as means and variances) of each measurement can be performed. As mentioned earlier, measurement invariance can be tested at different levels representing increasing measurement model constraints of a nested model set. In our work, we followed the hierarchical set of model tests described by Widaman and Reise (1997), consisting of four levels of invariance constraints:

(a) The first, basic level of measurement invariance is called *Configural Invariance*. As its name implies, it refers to the same configuration of factor loadings. The factor loadings can differ for each measurement occasion or group. When this level of nonmetric invariance is met, the latent variables, which are present within each construct, are similar, but not identical (Widaman & Reise, 1997, p. 292).

(b) The second level of invariance (and first form of a metric factorial invariance) is called *Weak Factorial Invariance*. In addition to the requirement of configural invariance, each item's loading to the respective factor (indicating the strengths of the linear relation between a factor and the associated items) is restrained to be equal for each measurement occasion. Accordingly, with constant factor loadings the scale unit is identical in each construct, though the scale origins are not necessarily the same.

Table 1. 5-point rating scale (both in German and in *English*)

1	2	3	4	5
überhaupt nicht	eher nicht	mittelmäßig	ziemlich	sehr stark
not at all	*not really*	*more or less*	*quite*	*very much*

Table 2a & b. Emotional labels with first and second-order factors (both in German and in English)

German		
Items	**1st order factors**	**2nd order factors**
Bewegt	Bewunderung	Erhabenheit
Verzaubert		
Verträumt		
Fasziniert	Transzendenz	
Überwältigt		
Gefesselt		
Gelassen	Beruhigung	
Entspannt		
Relaxed		
Sensibel	Sensibilisierung	
Ergriffen		
Entrückt		
Nostalgisch	Nostalgie	
Sentimental		
Romantisch		
Kraftvoll	Stärke	Vitalität
Energetisiert		
Triumphierend		
Munter	Anregung	
Heiter		
Fröhlich		
Traurig	Traurigkeit	Unbehagen
Melancholisch		
Schwermütig		
Fahrig	Anspannung	
Gereizt		
Nervös		

English		
2nd order factors	**1st order factors**	**Items**
Sublimity	Wonder	Moved
		Filled with wonder
		Allured
	Transcendence	Fascinated
		Overwhelmed
		Feeling of transcendence
	Peacefulness	Serene
		Calm
		Soothed
	Tenderness	Tender
		Affectionate
		Mellow
	Nostalgia	Nostalgic
		Sentimental
		Dreamy
Vitality	Power	Strong
		Energetic
		Triumphant
	Joyful Activation	Animated
		Bouncy
		Joyful
Unease	Sadness	Sad
		Tearful
		Blue
	Tension	Tense
		Agitated
		Nervous

When this level of invariance holds, the relationship between factors and other external variables is comparable across occasions and groups. Still, no comparison of factor means is valid, due to a possibly different scale origin.

(c) The third level of invariance is *Strong Factorial Invariance.* This form of invariance postulated that not only the factor configuration and item loadings on the underlying factor are invariant over time or across groups but also the intercepts of the measured variables are equal. According to Widaman and Reise (1997, p. 294), this level of invariance is required for a meaningful comparison of mean differences of the latent variables over time or across groups. Thus, differences in factor means can be identified as true differences between measurement occasions, not being artefacts of measurement.

(d) The fourth and last level of invariance is called *Strict Factorial Invariance*. In testing this form of invariance, additionally to the three preceding constraints, the measurement residual (or measurement error) associated with each measured variable is restrained to be equal over time/across groups. When this level of invariance is achieved, all group differences are exclusively due to group differences on the common factors. Strict factorial invariance, however, is seldom found to hold for a variety of reasons (cf. Widaman & Reise, 1997, p. 296).

3.3. Evaluation

The confirmatory factor analysis was performed using the free statistics software *R* and the package *lavaan* for multivariate analysis. A matrix carrying the data for both measurement occasions (stimuli) was produced. For each language, the structural equation model which expressed the structure of the first and second-order factors with respect to the items (cf. Table 2) was defined in *lavaan*. The first step was a test for autocorrelation between the model parameters taken at the two occasions (corresponding to the different stimuli categories) of the experiment. This was achieved by gradually imposing less constraints to the Basic Model (α) - allowing uncorrelated error variances (β), uncorrelated factors between different occasions (γ), uncorrelated factors within an occasion (δ) - and observing the fit of the model and its change in respect to the prior model. The model by which the fit does not deteriorate significantly is selected as the most parsimonious and equally potent to continue to the next stage of measurement invariance testing. Such a model contains less parameters and has the advantage of being less complex and computationally costly. However, it should be mentioned that a model with more restrictions is also prone to be more difficult to fit.

We operate on a nested model where additional structural constraints were imposed in each step, as shown in the previous paragraph. To determine the level of measurement invariance present, the fit is tested again as in the case of autocorrelation by means of a likelihood ratio test (LR-test) between the fit of the current model in respect to the previous one. If this value is below a certain threshold, the two measurement models differ significantly from each other, which can also be observed by a noticeable deterioration of the fit in the case of imposing more constraints. In that case, the previous model is retained and the corresponding constraints specify the level of invariance. Finally, we test in the same way as mentioned above if the scale measures reliably between groups of speakers of different languages, in order to assert the measurement invariance of the scale for different language groups. All the tests were performed for the first-order factor model, as well as the expanded version with the second-order factors.

At this point, a short discussion about the model fit indices used in this study is necessary. The most commonly used indices for model fit comparison are the chi-square (χ^2) function value, the root-mean-square error of approximation (RMSEA), the standardized root-mean-square residual (SRMR), the Bayesian information criterion (BIC), the Akaike information criterion (AIC) and the comparative fit index (CFI). For a detailed description of fit indices and their properties see Hu and Bentler (1999), Backhaus et al. (2006), Bentner (1990) and Hooper, Coughlan and Müller (2008). As Zentner et al. (2008, p. 505) mention in the discussion part of their study, these indices can be separated into two categories based on the sensitivity towards weakly specified factor covariances (SRMR) and towards imperfect factor loadings (RMSEA, CFI and others, cf. Fan & Sivo, 2005). In this paper, we decided to use a combination of three indices as well as the chi-squared function value and two information measures (BIC, AIC) (cf. Tables 3 - 8) in order to draw conclusions about the goodness of fit.

Caution is called for absolute fit indices such as χ^2 and SRMR, as sample and model size have an influence on them that can be misleading (Hu & Bentler, 1999). However, a combination of good results for at least one of the RMSEA and CFI and the SRMR is a good indicator for a reasonable model fit.

Table 3. Results of autocorrelations and fit comparison for first-order factor model (German data)

Model (n = 136)	Par.	χ^2	df	p(χ^2)	p(LR)	RMSEA	SRMR	CFI	AIC	BIC
α) Basic Model	*288*	*2053*	*1197*	*.000*	-	*.073*	*.083*	*.791*	*20071*	*20910*
β) Non-Correlated Errors	*261*	*2088*	*1224*	*.000*	*.1479*	*.072*	*.083*	*.789*	*20052*	*20812*
γ) No Inter-Correlations	180	2295	1305	.000	< .001	.075	.137	.758	20098	20626
δ) No Intra-Correlations	108	3473	1377	.000	< .001	.106	.211	.488	21131	21446

Table 4. Results of model fit test for nested measurement models, first-order (German data)

Model (n = 136)	Par.	χ^2	df	p(χ^2)	p(LR)	RMSEA	SRMR	CFI	AIC	BIC
a) Basic Model	*342*	*2053*	*1197*	*.000*	-	*.073*	*.082*	*.791*	*20179*	*21175*
b) Eq. Item Loadings	*324*	*2075*	*1215*	*.000*	*.2432*	*.072*	*.083*	*.790*	*20165*	*21109*
c) Eq. Item Intercepts	297	2329	1242	.000	< .001	.080	.189	.734	20366	21231
d) Eq. Error Variances	243	2494	1296	.000	< .001	.082	.189	.707	20422	21130

Table 5. Results of autocorrelations and fit comparison for first-order factor model (English data)

Model (n = 109)	Par.	χ^2	df	p(χ^2)	p(LR)	RMSEA	SRMR	CFI	AIC	BIC
α) Basic Model	*288*	*2047*	*1197*	*.000*	-	*.081*	*.095*	*.740*	*15674*	*16449*
β) Non-Correlated Errors	261	2131	1224	.000	< .001	.082	.095	.723	15703	16406
γ) No Inter-Correlations	180	2333	1305	.000	< .001	.085	.160	.686	15744	16228
δ) No Intra-Correlations	108	3482	1377	.000	< .001	.118	.241	.356	16749	17040

Table 6. Results of model fit test for nested measurement models, first-order (English data)

Model (n = 109)	Par.	χ^2	df	p(χ^2)	p(LR)	RMSEA	SRMR	CFI	AIC	BIC
a) Basic Model	*342*	*2047*	*1197*	*.000*	-	*.081*	*.093*	*.740*	*15782*	*16703*
b) Eq. Item Loadings	324	2130	1215	.000	< .001	.083	.105	.720	15829	16701
c) Eq. Item Intercepts	297	2362	1242	.000	< .001	.091	.211	.658	16007	16806
d) Eq. Error Variances	243	2597	1296	.000	< .001	.096	.206	.602	16134	16788

Table 7. Results of model fit test for nested measurement models: language group comparison, first-order (popular music)

Model (n = 245)	χ^2	df	p(χ^2)	p(LR)	RMSEA	CFI	BIC
a) Basic Model	*1105*	*576*	*.000*	-	*.087*	*.856*	*18809*
b) Eq. Item Loadings	1153	594	.000	< .001	.088	.848	18758
c) Eq. Item Intercepts	1321	612	.000	< .001	.097	.808	19124
d) Eq. Error Variances	1474	621	.000	< .001	.106	.782	19227

Table 8. Results of model fit test for nested measurement models: language group comparison, first-order (electroacoustic music)

Model (n = 245)	χ^2	df	p(χ^2)	p(LR)	RMSEA	CFI	BIC
a) Basic Model	*1068*	*576*	*.000*	-	*.084*	*.816*	*18292*
b) Eq. Item Loadings	1141	594	.000	< .001	.087	.796	18266
c) Eq. Item Intercepts	1309	612	.000	< .001	.096	.740	18632
d) Eq. Error Variances	1380	621	.000	< .001	.100	.738	18654

4. Results

The test results are presented in Tables 3 - 8 (*italics* denote the models which achieved acceptable fit indices). Altogether, the achieved model fits cannot be described as satisfying, a result that can be attributed to the combination of relatively small sample size (regarding this kind of analysis) and high model complexity. However, this does not constitute a problem for the study at hand, as the absolute values of the fit indexes are not of importance for the investigation of measurement invariance, only their relative differences between the nested models.

The autocorrelation test showed that for the German version the change in model fit is negligible when the error correlations are set to zero. Therefore these parameters could be let aside, creating a less computationally costly and simpler model. However, we discovered that the improvement was only marginal (a positive change in fit indices of 1% in the test for measurement invariance and the ability of conducting alikelihood ratio test actually impaired, for both the first and the second-order factor model. We therefore used the basic model configuration (all parameters correlated). For the English version of the scale the autocorrelation test was not conclusive, therefore we retained the original model with the maximum amount of correlations in that case as well.

The test for measurement invariance provided similar results: For the German dataset, weak factorial invariance could be demonstrated, for both the first and the second-order factor model. For the English version only configural invariance was attested. One should note, however, that the overall fit in all cases was too low (CFI < 0.8) to meet the formal requirements for a good fit as proposed in Hu & Bentler (1999). Nevertheless, the German data set provided overall better fit indices than the English one (e.g. $CFI_{German,1st\text{-}order}$ 0.791 vs. $CFI_{English,\ 1st\text{-}order}$ 0.740 for the basic model, respectively for all other fit indices cf. Table 4 vs. 8).

Finally, the tests for measurement invariance across the language groups returned significant values for the LR-test in all cases (see the column under p(LR) in Tables 3-8), thus allowing to ascertain only configural invariance. In total, the results might be summed up as follows: for the first and second-order factor model, configural invariance is present across both stimuli and languages, whereas weak factorial invariance is only present in the case of the German scale across measurement occasions (stimuli). The results concerning the second-order factor model are not presented here, as the attained invariance levels are identical to those related to the first-order factor model and the index values do not differ substantially (cf. Section 5).

5. Discussion

Considering the results in Section 3, several major issues arise. Firstly, the overall fit index values and results of the likelihood ratio test were substantially better in the case of the German data (cf. e.g. Table 4 vs. 6). These differences can be traced back to the increased sample size (n = 136 for German, n = 109 for English) and ratio of amount of participants to items (5:1 for German, 4:1 for English). The amount of samples in the present study was sufficient for conducting a confirmatory factor analysis in all cases (Gorsuch, 1983; Fan, Thompson & Wang, 1999). However, the general rule holds that the greater the sample size, the more accurate the statistical evaluation, which in our case explains the poorer performance in the English language case.

With respect to the different language versions, our results also suggest that the German version of the items list is semantically closer to the original, French adjective model of Zentner et al. (2008). This might have resulted in a better comprehension of the adjective meaning, leading to the production of comparable results to the aforementioned study for the German version. Furthermore, with regard to the English version, only 9.2% of the participants in this case could be assumed to be native speakers (having accessed the online survey from Australia, Ireland, the UK and USA). It is debatable if the rest of the participants, presumably non-native speakers, could grasp the fine nuances in meaning between the adjective items, resulting in a systematic error in that case. This becomes apparent when observing the results of the measurement invariance test for the two language groups, which attested only configural invariance (cf. Table 7 and 8).

Another important point of the present study diverging from the work by Zentner et al. (ibid.) is the difference in test stimuli and test conditions. The pop music repertoire included musical excerpts from many different genres, whereas within the reference study basically classical music was featured. This could explain the overall lower fit indices observed in our case as the original items are presumably more appropriate for emotions evoked by classical music. Apart from that, the researchers used a listening context of live performance in their research, which lead to possible differences in nature and magnitude of felt emotions with respect to the listening situation in our study, as indicated as an important *contextual feature* by Scherer and Zentner (2001, p. 364).

Moreover, it should be mentioned that fit indices for the second-order factor model were inferior to those of the first-order model as the increased complexity makes it more difficult to fit. Yet, the results concerning the degree of measurement invariance are consistent between the respective first and second-order factor model, which adds to the general solidity of the factor model proposed by Zentner et al. (2008).

Concerning the main methodological question, the attainment of weak measurement invariance for the German data can be described as satisfactory if a study aims solely at analysing covariance structure models, since in this case it holds to compare variances or covariances between the latent variables and external variables such as, e.g. age and gender (as factor means are of no interest in this case). It is, however, not feasible to compare the factor means (and therefore neither the ratings of the stimuli can be compared nor conclusions about changes in factor scores over time can be drawn).

The absence of strong factorial invariance in all cases (over time and across groups) is caused by consistently different item intercepts in the case of electroacoustic music as compared to popular music. This result might be construed as an indication that participants tend to evaluate the former in a different way than popular music genres, suggesting that some item indicators might be superfluous or misleading. The presence of configural invariance in the case of English data shows that the model is not strictly invariant across stimuli, but that the measured emotions tend to have the same character ensuing from an equal factor configuration. The contextual meaning of the factor construct remains the same across stimuli. The factor loadings however are free to vary, implying that in this case the relationship between felt emotions and the factors to which they belong is not stable over stimuli.

6. Conclusions

Our study confirmed that the GEM scale may be used to measure invariantly across stimuli and languages at the configural level with a reasonable fit. But, as pointed out in section 4, configural invariance does not attest a high degree of reliability of the measurement scale. Thus, it only confirms the suitability of the model proposed by Zentner et al. (2008) for music induced emotion measurement on a basic structure level. Based on our data, comparing variances and covariances across measurement occasions should only be performed in the case of the German version. The reasons for this result can be traced back to the configuration of the scale, the different listening context or the lack of familiarity of the participants with these stimuli. More concrete results could be achieved by using excerpts with more specific character or musical form, or being representative of a specific mood. In this way it could be determined if the emotions evoked by electroacoustic music have an affinity to those evoked from very specific musical genres. Another approach would be testing for measurement invariance for subgenres of ordinary music in order to determine the scope in which the scale does measure invariably. Furthermore, it might be possible that modification of the model (e.g. by applying an explorative factor analysis in order to detect which items and factors can be excluded) could yield a factor structure which would serve as a common measurement instrument for a wider range of music styles. In this case, an extended research as to which items or factors could be modified should be undertaken, as well as new tests should be conducted to confirm the results. Such an approach is out of the scope of our study, but could serve as a starting point for future experiments.

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INDUCING RULES OF ENSEMBLE MUSIC PERFORMANCE: A MACHINE LEARNING APPROACH

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Abstract

Previous research in expressive music performance has described how solo musicians intuitively shape each note in relation to local/global score contexts. However, expression in ensemble performances, where each individual voice is played simultaneously with other voices, has been little explored. We present an exploratory study in which the performance of a string quartet is recorded and analysed by a computer. We use contact microphones to acquire four audio signals from which a set of audio descriptors is extracted individually for each musician. Moreover, we use motion capture to extract bowing descriptors (bow velocity/force) from each of the four performers. The gathered multimodal data is used to align the performance to the score. Then, from the aligned data streams, we obtain a note-by-note description of the performance by extracting note performance parameters. We apply machine-learning algorithms to induce human-readable rules emerging from the data. The dataset consists of three performances of Beethoven's quartet n° 4 in C minor by a group of professional musicians: a "normal", a "mechanical" and an "over-emphasized" execution. We run our analysis on the three conditions separately as well as jointly, deriving rules specific to each condition and rules of general domain. Apart from encoding knowledge of expressive performance, the results shed light on how musicians' roles in ensemble performance.

Keywords: ensemble music performance, machine learning, expressive music performance

1. Introduction

In western music tradition, the notation provides the height and the duration of each note in a fairly explicit way. However, intensity and tone quality are represented only approximately. This leaves to the performer enough freedom in deciding how to interpret the music's content. Deviations in timing are also introduced, which render the performance more human and expressive. Musicians always introduce such deviations, even when playing mechanically (Palmer 1997).

The phenomena have been studied in the past from a computational approach leading to models of expressive performance capable of emulating human expression. Previous research on expressive performance used machine learning techniques to build models from real data of piano performances (Widmer & Goebl 2004). Other instruments have been considered in few other works (L Mantaras et al. and Ramirez et al.) by also considering additional expressive transformations that are absent in piano technique (e.g. vibrato and glissando).

Despite the abundance of applications of machine learning to expressive performance, most works are focused on solo performance and do not address the problem of performing in an ensemble. In classical music ensembles, each performer interprets their own part as dictated by the score. Since it is the sum of the parts that makes the whole, relations among individual parts implicitly define the role and the task of each member within the group.

The problem of playing in ensemble has been studied by narrowing down music performance to very specific tasks. Some studies focus on synchronization on the task of tapping together (Repp 2005) or on very specific musical skills (Moore et al. 2010). In (Goebl & Palmer 2009) the synchronization among musicians is studied also taking into account the role and the auditory feedback.

The only work addressing expressive performance in ensemble is devoted to string quartets (Sundberg et. al 1989) but from an analysis-by-synthesis approach. This means that the rules that Sunberg defined were tested directly by creating synthetic performances and were not evaluated on real recordings.

In this work we use machine learning to derive rules of expressive performance from recording of string quartet performances. We aim to understand how relations among parts affect the performance of each musician. For this reason we extract a set of score contextual descriptors including information about the relationship of each note with other parts in the score. We use such score descriptors to predict several note level performance parameters. We compare the predictive power of the machine-learning algorithm in two cases: when relationships among parts are considered or ignored. We then discuss the results and present some rules derived by the system in the cases where relationship among parts proved useful for the prediction.

The rest of the paper is structured as follows. Section 2 describes the recorded material and the acquisition of the data. Section 3 introduces the descriptors extracted from the score and the parameters extracted from the performance. We then explain our method in Section 4, present the results in Section 5 and discuss them in Section 6. Finally, in Section 7, we conclude providing directions for future work.

2. Data acquisition

We recorded a professional string quartet executing Beethoven's quartet n° 4 in C minor (opus 19 n°4, allegro-prestissimo movement).

After the quartet had played their first version ("normal") we asked for a "mechanical" and an "exaggerated" execution. The three performances were 15 min. long in total. Within this time, we collected more than 10k individual notes.

Acquired data include four individual audio tracks (one for each musician) coming from piezoelectric contact microphones. Additionally, we acquired bowing motion data via an EMF motion tracking system as carried out in (Maestre 2009). From the bowing motion data we obtain time series of bow velocity (Maestre 2009) and bow force sampled at 240Hz (Marchini et al. 2011). From the audio we extract time series of energy and pitch.

The extracted signals together with the score are given as input to a dynamic programming algorithm (Maestre 2009) to produce a precise note-by-note segmentation of the performance. Note boundaries are inspected manually to correct eventual segmentation errors.

The score was segmented into phrases the help of a professional musicologist leading to an average phrase length of four bars. As in other works of expressive performance modelling (Widmer & Tubodic 2003) we removed the main effect of tempo modulations to study only residual deviations of timing on note duration. The main effect of tempo modulation is obtained by fitting a parabolic tempo curve to the sequence of onsets of all instruments on each phrase. From this we calculate a value of tempo in beat per minutes (BPM) for each note that we later use as a reference for computing deviations on the duration of the performed note.

3. Descriptors

On each note we compute score contextual descriptors and parameters of the performance. The former will serve as features vector for the machine-learning algorithm while the seconds as learning tasks.

3.1. Score Contextual Descriptors

We define two types of score contextual descriptors: horizontal and vertical.

Horizontal note descriptors are computed based solely on a musician's individual part,

Table 1. Feature set with the smallest context length provided to the machine-learning algorithm.

Horizontal Descriptors
• nominalDuration • previousInterval • nextInterval • previousNoteRatio • nextNoteRatio • metricalStrenght • melodicCharge • narmour • nextNarmour
Vertical Descriptors
• harmonicCharge • isHighestMC • otherMusician1_nominalDuration … • otherMusician1_nextNarmour … • otherMusician2_nominalDuration … • otherMusician2_nextNarmour … • otherMusician3_nominalDuration … • otherMusician3_nextNarmour

ignoring the parts of the other musicians. These include both properties of the note itself, and also properties of the neighbouring notes (preceding and subsequent) in the part. Different temporal context windows sizes are considered by adding more or less neighbouring notes to the feature set.

Melodic contour is represented by melodic intervals of one note to the next and by Narmour implication realization class on each group of three notes (Narmour 1990).

Note salience includes the melodic charge, which is defined as the smallest number of steps to get from the tonic to the note in the circle of fifths (a number from zero to six).

Rhythmic information is represented by the metrical strength and rhythmic contour. Metrical strength depends on the position of the note relative to the bar and is encoded by an integer number from 0 to 5 from the strongest to the weakest metrical position. Rhythmic contour is characterized by the ratio between nominal durations of a neighbouring note and the note itself.

Vertical note descriptors include information from the score about the notes played by other musicians concurrently with the note being characterized. Each concurrent note is picked from others' part by selecting the note simultaneous (if any) to the characterized note or the one active at the beat where the characterized note is started. Vertical descriptors are then formed from the horizontal attributes of those picked notes (one for each other musician).

Additionally within vertical descriptors we include harmonic relationships of the note with concurring notes: `isHighestMC` and `harmonicCharge`. The former is a boolean set to "yes" if the note presents the highest value of melodic charge among concurrent note. The latter is the harmonic charge (Friberg 1995) computed on all the notes active within the beat of the characterized note. We compute the harmonic charge on the list of notes by first estimating the chord root note and then computing the average melodic charge of all the notes respect to the root note. To compute the chord root note we use the implementation from the open project music21 (http://mit.edu/music21/).

Table 1 depicts a list of 29 descriptors divided in horizontal and vertical representing the totality of descriptors for the smallest context window size considered. We build larger feature sets by adding in an analogous way descriptors (both horizontal and vertical) referring to additional neighbouring notes by appending to the descriptor name the string: "`previous`", and "`next`" followed by the number of separating notes from the reference.

3.2. Performance parameters

We apply machine learning techniques to our data set in order to learn models for predicting note-level parameters of the performance. The performer parameters we focus on are: loudness, duration ratio, vibrato amplitude, and bow velocity. Note *loudness* is the maximum RMS value (in dB) within the note boundaries. *Duration ratio* is the ratio between the duration of the performed note and the score duration considering the fitted phrase arc tempo as a reference. *Vibrato amplitude* is extracted from the pitch curve within the note boundaries by taking only the part with the lowest aperiodicity. A spectral analysis is performed on the selected part, which looks for periodic components in the range 4-8Hz. If no such component is found the vibrato amplitude is set to zero, otherwise it is set to the corresponding amplitude value in pitch cents. *Bow velocity* is computed by taking the interquartile mean on the bow velocity values within the note boundaries (this means that the lowest 25% and higher 25% of the values are discarded to get only the central tendency for the note). The bow velocity is measured in cm/s can be either positive or negative depending on the bow direction.

4. Method

We used machine learning to predict the performer parameters using the introduced score contextual descriptors. We apply the C4.5 decision tree induction algorithm (Quinlan 1992) to obtain a regression tree predicting each of the performance parameters described above. We use the implementation of provided by the Weka machine learning software (Hall et al. 2009).

In order to test all the combinations of features we built a series of different datasets on which we run the algorithm independently. We form the mixed dataset by merging notes from the three expressive intentions into one unique dataset. Performing a regression on the mixed dataset means to find rules that are applicable to the three expressive intentions indistinctively.

For each task and for each musician we have 40 different combinations. Those are obtained by combining in all the possible ways two types of descriptors (horizontal or horizontal+vertical); the four expressive intentions datasets (normal, mechanical, exaggerated or mixed); and different temporal context windows sizes (from one to five neighbouring notes). Furthermore, considering the four learning tasks (loudness, bow velocity, duration ratio and vibrato amplitude) and the four musicians (violin 1, violin 2, viola and cello) we get a total number of 640 datasets.

For each dataset we run the algorithm and compute a value of correlation coefficient using 10-fold cross validation. We use the obtained correlation coefficient to quantify the predictive power of the decision tree algorithm on each musician, each task and each feature set.

5. Results

When training the system on the mixed intentions we obtain a mean correlation coefficient of 69%, 87%, 72%, and 76% on the tasks of loudness, bow velocity, duration ratio, and vibrato amplitude respectively. All the previous values have been computed averaging the correlation coefficients of all the musicians. Table 2 shows the complete set of values obtained on each individual dataset for expressive intentions. In general we see that on the mixed dataset we get a comparable correlation coefficient, when not better than the individual datasets. This means that musicians did not radically change their playing style in the three expressive cases but rather modulated differently the ranges of the deviations (which do not affect correlation).

Table 2. Average correlation coefficient for learning tasks (rows) and expressive intention (columns) pairs.

	Mechanical	Normal	Exaggerated	Mixed
Loudness	65%	68%	72%	69%
Bow Vel.	60%	60%	60%	87%
Duration	52%	56%	45%	72%
Vibrato	48%	77%	74%	76%

We run an ANOVA test on the correlation coefficients finding a significant effect of the following factors: musician, learning task and intention ($p>0.05$). The effect of temporal window size was not significant ($p=0.76$), which means that the smallest considered window of three is sufficient. We thus discard the effect of the temporal window size and focus for a moment on the effect of adding vertical features to the horizontal (feature type).

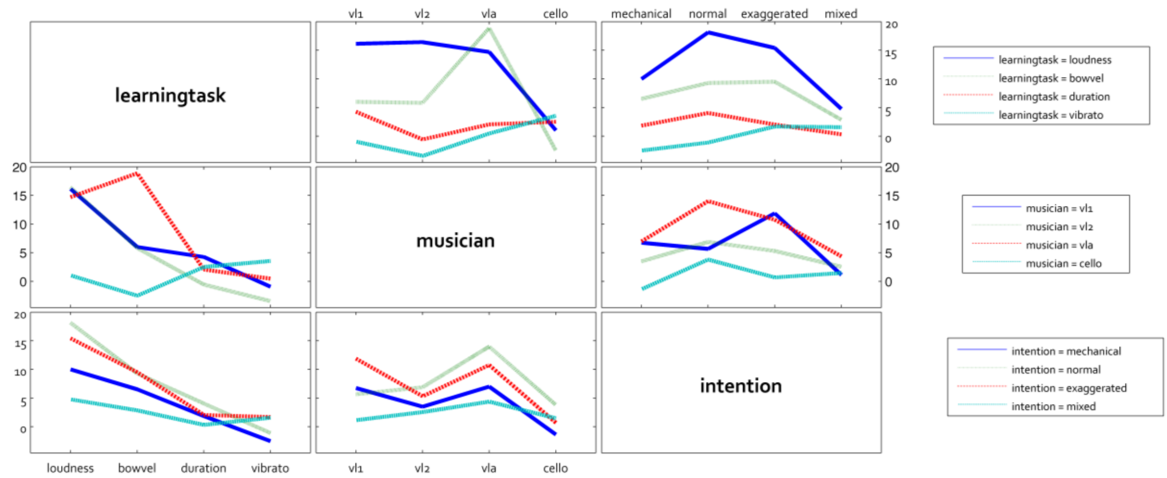

Figure 1 The increase in predictive power of the machine-learning algorithm is shown for the considered learning tasks, musicians and expressive intentions in percentage of improvement (PoI).

We now focus only on the improvement of predicting power when adding vertical descriptors to the feature set. We present the results in terms of *Percentage of Improvement* (PoI) respect to the baseline of only horizontal descriptors. An ANOVA test on PoI shows that this improvement is significantly positive for loudness and bow velocity whereas it is not significant for duration ratio and vibrato amplitude. The ANOVA also proves that the PoI depends not only on the learning task, on the musician and the intention, but also on the interaction between learning task and the musician (all $p<0.05$). This means that the PoI for each learning task follows different directions depending on the musician.

6. Discussion

In Figure 1 we see that we achieve the biggest PoI for loudness followed by bow velocity, duration and vibrato consistently across learning tasks. The second box of the first row of Figure 1 shows that whereas the violins have the highest amount of PoI for loudness, the viola surpasses the others in bow velocity.

The rules derived by the decision tree are sometimes difficult to interpret. We present here some rules derived on datasets where the machine learning algorithm performed significantly better when vertical descriptors where included. Generally the algorithm discovers a set 10-20 rules for each dataset. We report here only the two rules leading to the two more extreme values of the prediction.

We previously observed that the first violinist prediction for loudness seriously improves when adding the vertical features. Rules on the normal intention include the following:

```
IF
        nextNarmour=none > 0.5
        harmonicCharge <= 1.35
THEN
        Loudness_vl1 = 59.8 dB

IF
        vl2_narmour=IP > 0.5
        viola_narmour=VR_,IP,IR,D > 0.5
        cello_nominalDuration <= 1.5
THEN
        Loudness_vl1 = 83.3 dB
```

The first rule means the following: "if the note is the central of three notes that do not define a Narmour group and the harmonic charge is low than play it soft". Regarding the second rule, it is worth noticing how the context of where to play a note loud is defined solely by the properties of other musicians' notes. There is a difference of around 33 dB between the soft and the loud notes of this rule.

In the learning task of bow velocity the system achieves a very good correlation coefficient on the mixed dataset. The following two rules are part of the rules of general domain for the viola.

```
IF
        metricalStrenght_class=3
        vl1_nextNoteRatio <= 1.5
        vl2_interval <= 0.5
        cello_melodicCharge > 0.5
THEN
        BowVel_Viola = -43.4775 cm/s

IF
        nextNoteRatio > 0.75
        nominalDuration <= 0.75
        vl1_nextInterval > -1.5
THEN
        BowVel_Viola = + 49.2557 cm/s
```

Those rules define two contexts: whether to use a clear up-bow or a clear down-bow respectively. Both rules use relationships with other parts.

We have also shown how the PoI is not significant in learning the vibrato amplitude. Anyhow, the following two rules are derived by the system for the viola on the normal intention and use vertical descriptors:

```
IF
        harmonicCharge > 2.063
THEN
        vibratoAmp_viola = 2.97 p.cents

IF
        nextNoteRatio <= 0.75
THEN
        vibratoAmp_viola = 12.28 p.cents
```

The latters have to be applied in the order (the first that matches is applied) and thus they mean: "If the following note is consistently shorter, render the note vibrato except when the harmonic charge is high".

7. Future Work

The introduced approach has great potential for understanding roles in ensemble performance and collaboration among musicians.

We found a general improvement in the prediction of expressive deviation when considering the relationships among parts. The amount of improvement depended, however, on the specific performance parameter being predicted. Vertical relationships among parts proved useful for predicting individual musicians' behaviours on loudness and bow velocity.

By considering different expressive intentions we devised specific rules for each case and rules of general domain. A further question still unanswered is how well these rules scale on a larger dataset consisting of more pieces. Also it would be interesting to repeat the same analysis on more experimental conditions such as playing solo vs. playing in ensemble.

In this analysis we focused solely on score information to predict the expressive deviations. We did not consider how the sequence of introduced deviations affects future deviations (as in an autoregressive process). In future work, a more general analysis could also take into account this aspect as a feature and compare how much the introduction of this feature improves the prediction in respect of just score descriptors.

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EVERYDAY LISTENING TO MUSIC AND EMOTION AMONG COLLEGE STUDENTS

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Abstract

This study attempted to reveal the relationship between everyday listening to music and emotion among college students. Participants were 13 female and 2 male college students who were given booklets to record the following over an 8-day period: dates and times of their everyday experiences of listening to music, duration of listening, locations and contexts of listening, active or passive listening, emotions before and after listening, and tiles and artists to which they listened. Results indicated that the participants listened to music for 5 to 30 minutes while driving or riding in a car. Emotions reported both before and after listening to music were mainly 'happy', 'calm', and 'dull'. When participants listened to music actively, their emotions before and after listening to music were essentially the same as the above. With respect to the relation between emotions before listening to music and characteristics of the music they chose to listen to, when feeling 'sad', 'anxious', or 'lonely' before listening, they actively chose music having positive as well as negative affective characteristics. These results suggest that their music use in part reflects the iso-principle.

Keywords: everyday listening to music, iso-principle, active music listening

1. Introduction

Many studies had showed a close relationship between music and emotion so far. Sloboda and O'Neill (2001) concluded that music made listeners feel better in general in everyday listening to music by the experience sampling method (ESM). Adachi and Yoshimoto (2009) also suggested that strong relationship between everyday listening to music and emotion, and it was confirmed using a collective taking back method.

However, previous studies have not showed how emotion was changed when listening to music actively in an everyday life. Besides, iso-principle has been taken in music therapy and has been useful for patients. Its procedure is that patients firstly listen to music similar to patients' negative emotion, and gradually listen to music opposite to patients' initial negative emotion. But, it is not unclear whether iso-principle is taken in our everyday lives.

This study attempted to explore how emotion was changed by listening to music actively in everyday lives among college students. In addition, also whether iso-principle was used in everyday lives were examined.

2. Method

2.1. Participants

13 female and 2 male college students ranging in age from 18 to 31 years (M=22.93, SD=4.91) participated in this study.

2.2. Booklet

The booklet included following items. Participants were asked to fill those on each music experience. The booklet was A5-size.

1) Dates and times of their everyday experiences

Participants were asked to write a date and a time when they started to listen to music.

2) Duration of listening

They were asked to write duration of listening to music.

3) Locations of listening

They were asked to choose one from 'In a house', 'In a sidewalk', 'In a car (or in a train)', 'In a shopping mall', 'In a restaurant', and 'Others' as a location of listening to music.

4) Contexts of listening

They chose one from 'Just when waking up', 'Getting ready for being out', 'Walking or riding a bicycle or a car', 'Working part-time', 'Going shopping', 'Having a meal, 'Keeping house', 'Watching a TV', 'Studying or reading a book', 'Using a cellular phone or a personal computer', 'Taking a rest', 'Thinking of creating a diversion', 'Just when going to sleep', and 'Others' as a context of listening to music.

5) Active or passive listening

They chose one from 'I listened to it actively, 'I listened to it which other person chose', 'I listened to it of which selection was unrelated to my intention', and 'Others' as an active or passive music listening.

6) Emotions before listening

They chose one from 'Pleased', Happy', 'Sad', ''Anxious', ''Lonely', ''Angry', 'Dull', 'Tense', 'Calm', and 'Others' as emotion occurred before listening to music.

7) Tiles and artists of music

They were asked to write titles and artists of music which they listened to up to 5 on each listening experience.

8) Emotions after listening

They chose one from 'Pleased', Happy', 'Sad', ''Anxious', ''Lonely', ''Angry', 'Dull', 'Tense', 'Calm', and 'Others' as emotion occurred after listening to music.

2.3. Procedure

Participants were handed a booklet, and asked to carry it with them at all times and record their music experiences over 8-days. After the period was finished, booklets were collected directly.

3. Results and Discussion

The number of total recorded music experiences was 202. Participants recorded from 2 to 34 music experiences during 8-days (M=13.47, SD=8.24). The number of music experiences recorded per a day was from 0 to 6 (M=2.15, SD=1.44).

3.1. Dates and times of their everyday experiences

Participants started to listen to music at from 12 to 14 o'clock (24.75%) and from 6 to 8 o'clock (17.82%) frequently.

3.2. Duration of listening

They listened to music from 6 to 30 minutes (55.46%) and from 31 to 60 minutes (21.78%) frequently.

3.3. Locations of listening

They listened to music 'In a house' (52.48%) and 'In a car (or in a train)' (32.66%) frequently.

3.4. Contexts of listening

They listened to music when 'Walking or riding a bicycle or a car' (38.12%), 'Taking a rest' (10.39%), 'Keeping house' (7.43%), and 'Getting ready for being out' (6.93%) frequently.

3.5. Active or passive listening

The percentage of listening to music 'Actively' was 62.81%. 'Listening to music which other person chose' was 16.08% and 'Listening to music of which selection was unrelated to my intention' was 20.10%.

3.6. Emotions before listening

They felt 'Calm' (26.23%), 'Pleased' (16.83%), and 'Dull' (16.33%) frequently before listening to music.

3.7. Tiles and artists to which they listened

Many of music that participants recorded were J-pop.

3.8. Emotions after listening

They felt 'Calm' (36.63%) and 'Pleased' (36.13%) frequently after listening to music. The percentage of 'Pleased' was more than twice that before listening to music. Other emotions except 'Calm' and ''Pleased' were few after listening to music.

3.9. Relation between active music listening and emotions

Participants felt 'Calm', 'Pleased', or 'Dull' frequently before listening to music whether they listened to it actively or not. However, when listening to music actively, they felt not only 'Calm', 'Pleased', and 'Dull' but also 'Sad', 'Anxious', and 'Lonely' (Figure 1).

3.10. Relation between active music listening and emotions

After collecting the booklets, participants were asked to choose one from 'Pleased', 'Happy', 'Sad', 'Anxious', 'Lonely', 'Angry', 'Dull', 'Tense', 'Calm', and 'Others' as an image of each music. The following was only when participants felt negative emotions before listening to music (Table 1).

When participants felt 'Sad' before listening to music, they choose not only 'Pleased' music but also 'Sad' or 'Lonely' music. When participants felt 'Anxious' before listening to music, they chose not only 'Pleased', 'Happy', or 'Calm' music but also 'Lonely', 'Anxious', and 'Tense' music. Besides, when participants felt 'Lonely' before listening to music, they chose not only 'Pleased', 'Happy', or 'Calm' music but also 'Lonely' music. On the whole, when participants felt negative emotions, they chose both types of music that had a positive image and that had a negative image.

As a result, many college students listened to music moderately in everyday lives including riding in a car. They listened to music when feeling pleased, calm, and dull, and their positive emotions were kept or negative emotions were regulated to positive emotions by listening to music. Therefore iso-principle was supported partly in everyday music listening.

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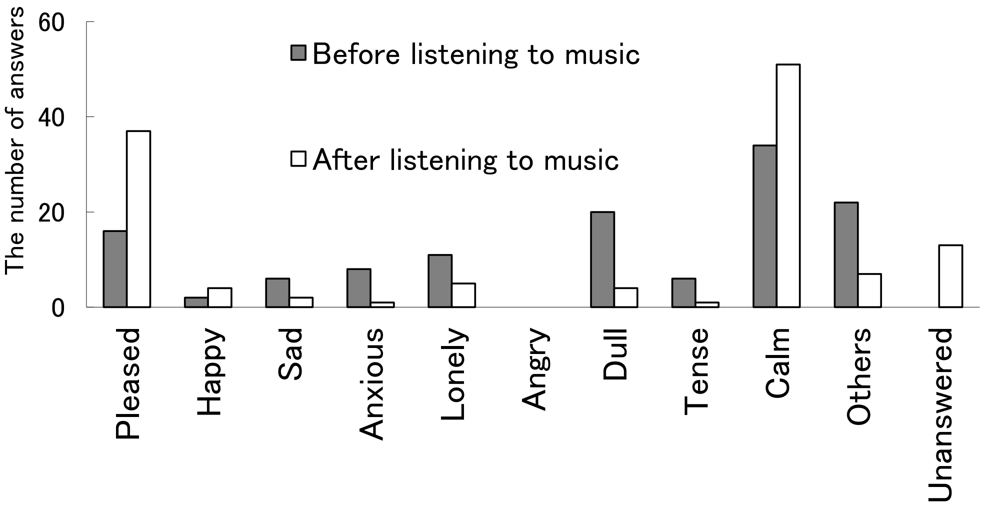

Figure 1. The Number of answers for emotions before and after listening to music when participants listened to actively

Table 1. Emotions before listening to music and images of music

Emotion before listening to music	Number of selection	Image of music	Number of selection
Sad	6	Pleased	2
		Sad	2
		Lonely	2
Anxious	8	Pleased	1
		Happy	1
		Calm	2
		Lonely	2
		Anxious	1
		Tense	1
Lonely	11	Pleased	3
		Happy	1
		Calm	4
		Lonely	1
		Unidentified	2

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INFLUENCE OF MUSICAL CONTEXT ON THE PERCEPTION OF EMOTIONAL EXPRESSION OF MUSIC

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Abstract

Factors determining and influencing the perception of emotional expression of music include those related to music itself, to the listener, and to the context. Among the latter there is also music, as we rarely listen to a single piece. A simple experimental study has been carried out into the effect of music listened to immediately beforehand on the perception of the emotional expression of a musical piece. The following variables were involved: type of emotional expression of music conceived in terms of a most basic *sad-joyful* dimension, initial and final mood of the listeners, their professional musical education vs. lack thereof, age, and gender. The subjects were students of three age groups: 9, 15, and 20-23 year olds, both from non-music and music schools. Each group listened to a sequence of two short pieces of music of the opposite emotional expression in two experimental conditions: *sad-joyful* and *joyful-sad*. The perceived expression of the listened music, as well as the initial and final mood of the subjects, were recorded with a simple self-report measure. The results demonstrated that the perception of emotional expression of the musical piece was entirely independent of the influence of the preceding music. The initial mood played no role. This was the case consistently in the musically educated and non-educated subjects, in all age and gender groups. Three patterns of changes in mood during the session of listening were also described: mood increase, mood decrease and mood stability. The latter proved to grow among musically educated with age.

Keywords: emotional expression, perception, mood

1. Introduction

Music evokes subjective experience. This is the essential reason why people listen to it. Music which doesn't is regarded as bad or even as not music at all. The experience evoked by music is of a very particular nature, specific to itself. It is most often referred to as emotion, but besides an affective content, it includes also a sensory (various aspects of sensation) and cognitive (ideas, mental imagery, memories, etc.) components.

The cognitive aspect of experience evoked by music is of great importance as the differentiation between feeling emotion aroused by music and the perception (a strictly cognitive process) of the emotional expression of music is strongly emphasized in the literature (Gabrielsson, 2002; Sloboda & Juslin, 2010; Hodges & Sebald 2011), the differences between these being, however, to some extent fuzzy, and the terms often used interchangeably. The relationship between them is also a subject of scientific inquiry (Juslin, Liljeström et al., 2010; Hodges & Sebald 2011). This is one essential thing about the experience evoked by music.

Another essential thing about it is that it can be as vivid, and can elicit as strong a response, as the experience evoked by the real life events (cf. Davies, 2010).This quality, in fact ultimately unexplained, makes the subject all the more worth of interest. Philosophers, psychologists, musicologists and the musicians themselves have gone to great lengths in their attempt at identifying the essential factors determining the nature of the experience evoked by music.

The scientific interest in the emotional expression of music dates back as early as the late 19th century. In a pioneering study Gilman (1891, 1892) found some degree of agreement among the listeners as to the expressiveness of the music they listened to. He also attempted at connecting various kinds of expression to some structural features of the musical pieces. Then a period of active research ensued. In 1940 Schoen reported over 300 studies devoted to the topic. The next more than half a century was a time of some stagnation or perhaps incubation, as is often the case with important ideas in science. Only the last decade or so has witnessed the return of research into the emotional expression of music. On the contrary, scientific exploration of the emotions induced by music did not emerge until the 1990s (Sloboda & Juslin, 2010; Juslin, Liljeström et al. 2010). Soon, the studies also emerged on the interrelation between perception of the emotional expression of music and feeling emotion aroused by music (Hodges & Sebald, 2010).

Today's theoretical ideas and empirical investigation into the field of the experience evoked by music roughly fall into two broad categories dealing with: 1. the properties of music possibly connected to the various emotional expression, such as melody, harmony, mode, rhythm, etc., 2. the properties of the listener, such as musicality, musical education, musical preferences, general ability (intelligence), special abilities, cultural and educational background, age, gender, etc. Furthermore, the third category seems to have emerged quite recently dealing with 3. the contextual factors affecting the experiences evoked by music. This category covers the elements not included in the first two. They can be referred to as the environmental, situational and circumstantial factors. Their importance has been all the more appreciated as the evidence from research in the first two categories accumulated.

There is a variety of contextual factors which can play a role. The traditional classification can be applied involving physical factors (the place where music is listened to, the acoustic quality of the sound, the presence of other physical stimuli), social factors (the presence of other people with the listener, their role), cultural factors (the culturally developed musical taste, the cultural norms for expressing emotions), and others. Sloboda (2010) proposed several more domain-specific factors, such as the frequency of occurrence of musical experiences and ordinariness vs. specialness of the context or the experience. The empirical studies on contextual factors are not common yet. Some of them include such factors as additional variables (e.g. Juslin, Liljeström et al., 2008), others address them directly (e.g. Dibben, 2004).

Research into the contextual factors can be a valuable contribution to our understanding of the experience evoked by music, its nature and function. They can be also of practical importance for psychologists, music therapists, as well as for musicians themselves, including composers and performing musicians.

2. Problem

The current study addressed the question whether the music listened immediately beforehand affects the perception of the emotional expression of a musical piece. Such music can be called a musical context. People rarely listen to a single, isolated piece of music. This follows both from the very nature of music, which frequently consists of a number of movements following one after another, as well as from the very popular habit of listening to large amounts of music at a time. Therefore this problem concerns both the purely musical events and the listening to music in everyday life.

There were three main purposes of the study:

1. To answer the question concerning the musical context posed at the beginning of the preceding paragraph.
2. To determine whether the initial mood of the listener, his/her musical education or lack thereof, age and gender play a role in the possible influence of the musical context.

3. To determine whether a mood of the listener changes along with the possible changes in perception of the emotional expression of the musical piece under the influence of a musical context.

The following hypotheses were formulated:
1. There is some influence of musical context on the perceived emotional expression of a musical piece and the mood of a listener. The direction and details of this influence weren't specified.
2. There is asymmetry in the influence of musical context, i.e. it possibly changes the positive emotional expression into negative one in a different way than the negative into positive. The same holds for the mood. The details also weren't specified.

The emotional expression *joyful-sad* has been adopted for the study. It is regarded as the most basic one, recognizable very early in life (McPherson, 2006; Nawrot, 2003; Terwogt & Van Grinsven, 1991).

3. Method

3.1. Subjects

The subjects were 344 students of two types of schools: the general education schools and music schools, both at the three levels of education: primary, secondary and tertiary (university). The level of education served as an indicator of age, hence there were three age categories, respectively, children, youth and adults. The whole sample has been divided into six subgroups according to the type of school and the level of education (age). There were in total 6 subgroups. The characteristics of the subjects is presented in Table 1.

Table 1. Characteristics of the subjects participating in the study.

	General education (non-music) schools			Music schools		
Level of education (age)	N	Gender	Mean age (y. o.)	N	Gender	Mean age (y. o.)
Primary (children)	56	M 31 F 25	8,75	61	M 20 F 41	8.90
Secondary (youth)	54	M 17 F 37	15.00	52	M 19 F 33	14.94
tertiary (university) (adults)	64	M 19 F 45	20.96	57	M 15 F 42	21.24

3.2. Material

The material consisted of three short fragments of the musical pieces selected for their emotional expression:
1. Neutral piece: Johann Sebastian Bach *Fantasia in G major* BWV 572, duration time 1 min. 15 sec.
2. Joyful piece: George Haendel *Arrival of the Queen of Sheba*, duration time 1 min. 30 sec.
3. Sad piece: Peter Tchaikovsky *Symphony No 5 E minor*, Op. 64, Part 2 *Adagio cantabile*, duration time 1 min. 30 sec.

3.3. Measuring instrument

All the measurements collected during the study were performed on a 7-point two dimensional scale made up of large facial expressions with the appropriate captions in Polish. The following points went from left to right: *very sad, quite sad, sad, neither sad nor joyful, quite joyful, joyful, very joyful*. *Very sad* was assigned score 1 and *very joyful* score 7. The same scale served both for measuring the emotional expression of music and the subjects' mood and was used by all the participants.

The scale was printed in a special answer booklet on separate sheets. Each sheet served for one measurement (see the procedure described below). The scale is presented on Figure 1.

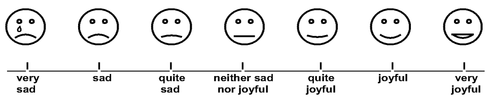

Figure 1. The measuring scale

3.4. Procedure

Each group was divided into two parts and assigned randomly to one of two experimental conditions: a *joyful-sad* condition, in which the joyful piece preceded the sad one, and the *sad-joyful* condition, in which the sequence of pieces was reversed.

The procedure involved 6 stages:

1. The subjects received the booklet, entered the obligatory information (a nickname, age and gender), and listened to the instruction read by the experimenter.
2. Marked on the scale their current mood (before listening to music).
3. Listened to the neutral piece and undertook no action. The purpose of this stage was to introduce the subjects into the listening of music.
4. Listened to the joyful/sad piece, depending of the experimental condition, and marked on the scale the perceived emotional expression of the piece.
5. Listened to the sad/joyful piece, opposite to the preceding one, depending on the experimental condition, and marked on the scale the perceived emotional expression of the piece.
6. Marked on the scale their current mood (after listening to music).

A single session with one group lasted 10-15 min. The research was carried out in Warsaw from November 2012 to January 2013.

4. Results

4.1. Perception of emotional expression of music

The mean rates of emotional expression ascribed by the subjects to the joyful and sad pieces of music, both preceded by the neutral piece and by the piece of the opposite emotional expression, were compared using the Student's *t*- test. The comparisons were made first for the whole sample of subjects participating in the study, and then with reference to the remaining variables involved in the study: the initial mood, musical education vs. lack thereof, age, and gender. For the comparisons including mood the subjects were divided into three subgroups: those who rated their initial mood 1-3 were categorized as sad, 4 as neutral, and 5-7 as joyful. It is important to note that in the whole sample only 10.5% reported their mood as sad (of these only 2.6% out of the youngest group), 19.2% as neutral and 70.3% as joyful. Students of general education schools were labelled as nonmusicians, and those of music schools as musicians.

The results of the comparisons for the joyful piece are presented in Table 2, and for the sad piece in Table 3.

Table 2. Mean rates of emotional expression of the joyful musical piece preceded by pieces of neutral and the opposite emotional expression.

Joyful preceded by neutral			**Joyful preceded by sad**		
Whole sample			Whole sample		
6.31^{a}			**6.34^{a}**		
Initial mood			Initial mood		
sad	neutral	joyful	sad	neutral	joyful
6.07^{b}	**6.19^{c}**	**6.37^{d}**	**6.05^{b}**	**6.13^{c}**	**6.45^{d}**
Nonmusicians	Musicians		Nonmusicians	Musicians	
6.20^{e}	**6.41^{f}**		**6.31^{e}**	**6.38^{f}**	
Age			Age		
Children	Youth	Adults	Children	Youth	Adults
6.41^{g}	**6.11^{h}**	**6.38^{i}**	**6.46^{g}**	**6.22^{h}**	**6.33^{i}**
Males	Females		Males	Females	
6.20^{j}	**6.35^{k}**		**6.35^{j}**	**6.34^{k}**	

Student's *t*-test for difference between means
$^{a\text{-}k}$ *n.s.*

Table 3. Mean rates of emotional expression of the sad musical piece preceded by pieces of neutral and the opposite emotional expression.

Joyful preceded by neutral			**Joyful preceded by sad**		
Whole sample			Whole sample		
2.99^{a}			2.99^{a}		
Initial mood			Initial mood		
sad	neutral	joyful	sad	neutral	joyful
3.38^{b}	2.92^{c}	3.04^{d}	2.80^{b}	$2{,}50^{c}$	3.03^{d}
Nonmusicians	Musicians		Nonmusicians	Musicians	
2.71^{e}	3.27^{f}		2.71^{e}	3.26^{f}	
Age			Age		
Children	Youth	Adults	Children	Youth	Adults
2.63^{g}	3.22^{h}	3.13^{i}	2.46^{g}	3.15^{h}	3.38^{i}
Males	Females		Males	Females	
3.00^{j}	2.98^{k}		3.06^{j}	2.95^{k}	

Student's *t*-test for difference between means
$^{a\text{-}k}$ *n.s.*

All the differences between the mean rates of the emotional expression of both pieces of music turned out to be insignificant. This is very clear-cut result. Neither of the variables affected the rates. The mean rates for the joyful piece range from 6.05 to 6.46, and for the sad piece from 2.46 to 3.38, which, as for the ratings made on a 7-point scale, means a remarkable stability and consistency of the measured relationships.

4.2. Mood

The second part of the analysis of the results concerns the mood of the subjects and its change during the listening session. Three patterns of changes in mood could be noticed: mood increase, mood decrease, and mood stability. Table 4 presents the percentage of subjects who underwent them during listening to the two different sequences of musical pieces: joyful-sad and sad-joyful.

Table 4. Percentage of subjects who underwent changes in mood in two experimental conditions according to age.

Age	Change in mood	*Joyful-sad* experi-mental condition	*Sad-joyful* experi-mental condition
Children	Increase	31.15%	53.57 %
	Decrease	31.15%	12.50%
	Stability	37.70%	33.93%
Youth	Increase	14,.55%	29.40%
	Decrease	60.00%	35.30%
	Stability	25.45%	35.30%
Adults	Increase	9.84%	23.33%
	Decrease	40.98%	21.67%
	Stability	49.18%	55.00%
Total	Increase	18.75%	35.12%
	Decrease	43.75%	22.62%
	Stability	37.50%	42.26%

In the *joyful-sad* condition nearly equal number of participants from the youngest group fell into each of the three patterns of mood change, the majority of the 15 year olds underwent mood decrease, while the adults' mood for the most part remained unchanged. In the *sad-joyful* sequence most of the youngest felt mood increase, the 15 year olds were distributed nearly equally across all the categories, and the adults, again, mainly remained stable. In Table 5 these data are split into two additional categories: nonmusicians and musicians.

Table 5. Percentage of subjects who underwent changes in mood according to age and type of school

Age	Change in mood	*Joyful-sad* experimental condition		*Sad-joyful* experimental condition	
		Nonmusicians	Musicians	Nonmusicians	Musicians
Children	Increase	22.60%	40.00%	44.00%	61.30%
	Decrease	32.20%	30.00%	16.00%	9.70%
	Stability	45.20%	30.00%	40.00%	29.00%
Youth	Increase	15.50%	13.70%	28.60%	30.43%
	Decrease	61.50%	58.62%	39.30%	30.43%
	Stability	23.00%	27.58%	32.10%	39.14%
Adults	Increase	6.25%	13.80%	28.13%	17.85%
	Decrease	50.00%	31.00%	25.00%	17.85%
	Stability	43.75%	55.20%	46.87%	64.00%
Total	Increase	22.73%	14.61%	37.81%	33.00%
	Decrease	39.77%	47.19%	18.29%	27.00%
	Stability	37.50%	38.20%	43.90%	40.00%

Table 5 shows that among the adult musicians the stability of mood was substantially more frequent than among younger musicians.

In the next step the comparison was made between the mean rates of initial and final mood reported by the subjects, according to the experimental condition and age. These results are contained in Table 6.

Table 6. Mean rates of initial and final mood according to experimental condition and age

Age	Change in mood	*Joyful-sad* experimental condition		*Sad-joyful* experimental condition	
		Initial mood	Final mood	Initial mood	Final mood
Children	Increase	4.68^{a}	6.26^{a}	4.97^{b}	6.40^{b}
	Decrease	5.89^{c}	4.42^{c}	6.14^{d}	4.71^{d}
Youth	Increase	4.13^{e}	5.25^{e}	3.93^{f}	5.27^{f}
	Decrease	5.16^{g}	3.82^{g}	5.17^{h}	4.00^{h}
Adults	Increase	4.17^{i}	5.17^{i}	4.14^{j}	5.29^{j}
	Decrease	5.44^{k}	3.96^{k}	5.62^{l}	4.46^{l}
Total	Increase	4.45^{m}	5.82^{m}	4.51^{n}	5.85^{n}
	Decrease	5.43^{o}	4.01^{o}	5.50^{p}	4.29^{p}

Student's *t*-test for difference between means
$^{a\text{-}c,\, e\text{-}h,\, j\text{-}p}\ p < .001$
$^{d}\ p < .01$, ^{i} *n.s.*

All the differences between the mean rates, except one, are statistically significant, the vast majority of them at the high level. The one exception is likely to be caused by too small number of subjects in the compared subgroups.

The mean rates of the mood split into the categories of nonmusicians and musicians are not presented here, as some of the comparisons turned out impossible to make, again, due to too small number of subjects.

The last comparison involved the initial mood of the subjects. Only two categories of the initial mood were taken into account, the *neutral* and *joyful*, as the sad category contained insufficient number of subjects for the comparisons to be made. Table 7 presents the percentage of subjects who underwent changes in mood according to two categories of initial mood.

Table 7. Percentage of subjects who underwent changes in mood according to two categories of initial mood

Change in mood	*Joyful-sad* experimental condition		*Sad-joyful* experimental condition	
	Initial mood neutral	Initial mood joyful	Initial mood neutral	Initial mood joyful
Increase	22.20%	15.20%	43.33%	30.00%
Decrease	27.80%	52.00%	3.33%	29.00%
Stability	50.00%	32.80%	53.34%	41.00%

About 50% of the subjects with initial neutral mood remained stable in both experimental conditions, whereas in the *joyful-sad* condition nearly equal parts of them underwent mood increase and decrease, and in the *sad-joyful* condition the latter group dramatically diminished in favour of the group with mood increase. On the contrary, the subjects with initial joyful mood in the *joyful-sad* condition for the most part underwent mood increase, and in the *sad-joyful* condition the majority remained stable, the rest of the group falling in nearly equal proportions into the groups of mood increase and decrease. There is clear evidence of the relationship between the initial mood and the subsequent changes in mood.

Finally, Table 8 and Table 9 present the mean rates of the initial and final of the subjects according to the initial mood in two experimental conditions.

Table 8. Mean rates of initial and final mood in *joyful-sad* experimental condition according to initial mood

Change in mood	Initial mood neutral		Initial mood joyful	
	Initial mood	Final mood	Initial mood	Final mood
Increase Decrease	**4.00**[a] **4.00**[c]	**5.50**[a] **3.00**[c]	**4.65**[b] **5.59**[d]	**5.96**[b] **4.13**[d]

Student's *t*-test for difference between means
[a, b, d] $p < .001$
[c] *n.s.*

Table 9. Mean rates of initial and final mood in *sad-joyful* experimental condition according to initial mood

Change in mood	Initial mood neutral		Initial mood joyful	
	Initial mood	Final mood	Initial mood	Final mood
Increase Decrease	**4.00**[a] *	**5.46**[a] *	**4.64**[b] **5.58**[c]	**5.93**[b] **4.30**[c]

Student's *t*-test for difference between means
[a,b, c] $p < .001$
* lack of data due to insufficient number of observations

All the comparisons made in the last two tables are statistically significant on a very high level. The only exception is likely due to too small number of subjects in the compared subgroups.

The data for the subjects with initial sad mood would be of interest.

5. Discussion and conclusions

Musical context proved not to influence the perception of the emotional expression of a musical piece, at least that conceived in terms of a dimension *joyful-sad*. Also, neither of the factors which could have seemed to be involved in the expected change of perception of the emotional expression played part. The initial mood, musical education, as well as age and gender made no difference. Quite naturally, therefore, no asymmetry was found, too. The hypotheses haven't been confirmed for this part of the data. This a clear-cut result, well grounded in the consistent empirical data.

Simple as this result may seem at first glance, it makes quite serious a contribution to our knowledge of the contextual factors in the experience evoked by music. First of all, it demonstrates that listeners needn't necessarily change their perception of the emotional expression of music, even if they emotions change. Additionally, it confirms the basic position of this emotional dimension, which may in fact play a crucial role in human life, maybe acting as a kind of a signpost.

While the perceived emotional expression of a musical piece remained perfectly stable, the mood of the listeners changed. Although the current study wasn't designed to precisely measure the mood and its changes, which were only the controlled variables, it can be inferred that the changes occurred due to what happened between the two measures of the mood, i.e. under the influence of the listening to music or, to put more pertinently, under the influence of the musical context. Some characteristics of this influence on the mood of the listeners have been grasped, namely its dependence of the joyful vs. neutral initial mood, as well as of the musical education and its level, and probably, of age. Certain asymmetry can be clearly observed in the relationship between the initial mood and the influence of the musical context on the mood change. Here, both hypotheses have been confirmed.

By the way, it should be noted here, that one of the defining characteristics of mood is that it can be long lasting. This characteristics couldn't be addressed in a short empirical investigation. However, it would be interesting to examine the mood in the longer time range, as well as other types of affect or emotion.

One important conclusion of the current study is that the independence of cognition and emotion in music listening has been once again confirmed. It is frequently described in the literature on the musical emotions (Hodges & Sebald, 2011, Sloboda & Juslin, 2010). It is also probably one of the most essential features of human mind. This finding makes therefore a modest contribution to answering one of most basic questions of contemporary psychology.

Among concluding remarks the indications for further research are in order. First of all, subsequent analyses on the current material should be made, including some cross comparisons, e.g. of the perception of two pieces of opposite emotional expression according to musical education, gender and age, which went beyond the scope of this report. Then a study would be desirable precisely measuring the possible influence of the musical context on both the perception of a musical piece and the emotions accompanying it, whatever methodological difficulties such a study could encounter. Finally, other types of musical emotions should be investigated, both in terms of quality, less basic than *joyful-sad*, and, as mentioned above, in terms of formal characteristics.

The investigation of the musical context of the experience evoked by music seems significant and promising.

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THE RELATION BETWEEN EMOTIONAL VALENCE AND PERFORMANCE MOTION OF THE KEYBOARD INSTRUMENT

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Abstract

This study examined relations of the emotion and part of the upper body during the keyboard instrument performance. The study showed the trace from the lateral direction to watch movement. As a result, there was a difference in the emotional expression of the performance in the head and upper arm. In this way, we understood that the part except the hand was important to emotional expression in the keyboard instrument performance. The future investigation is going to analyze the front.

Keywords: emotion, motion capture, keyboard instrument

1. Introduction

Emotional expression is important to performance of the music. Thompson's study measured the piano performance using an optical motion capture (Thompson, 2012). The study examined four different performance conditions. Expressive intention is drawing attention, like in this study.

Davidson found that head movement is important for observers to discriminate between pianist's performances with different expressive intentions (Davidson, 1994). Castellano examined emotion and motion by the pianists using the video. The results showed that both were sensitive to emotional expression, especially the velocity of head movements (Castello, 2008).In this way, there is the study that mentions the importance of the part of the body.

This study examined relations of the emotion and part of the upper body during the keyboard instrument performance.

2. Experiment

2.1. Subject

We measured a keyboard performance in the classroom of the university. The player was one professional pianist. The keyboard was CASIO CTK-810.

2.2. Experiment summary

The performance task used simple music for the beginners. We showed a performance task in Figure 1. The key is C major. He performed by expressing emotion of five emotion (happiness, tenderness, anger, sadness, fear) used Juslin (Juslin, 2001) and emotionless for a task. After hearing four beats of sound, we requested to perform by the M.M. = 90. He performed the same melody on the both hands.

Figure 1. Performance task

2.3. Environment of the measurement

In motion capture, reflective markers are attached to a person's upper body and multiple infrared cameras are used to detect the positions of these markers in three-dimensional space. These positions are output as a temporal series of absolute spatial coordinate values. The experimental apparatus was configured using a Motion Analysis MAC3D motion capture system with 6 Raptor-H cameras (frame rate 100 fps, shutter speed 1/2000 s). We used a total of 34 markers in the upper body and keyboard instrument (Figure 2).

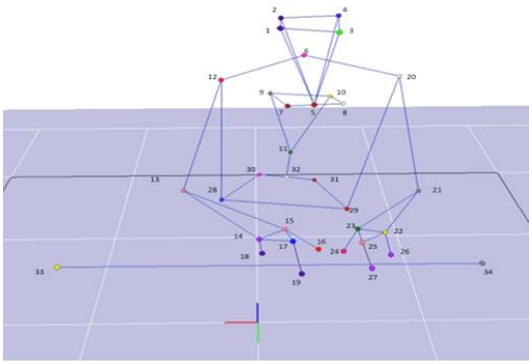

Figure 2. Marker adhesion position

2.4. Analytical approach

The analysis section was from the beginning of the first sound to the last sound. To investigate how pianist moves the upper body, we calculated their center of gravity. This was calculated by modeling the upper body as a collection of 8 parts (head, torso, upper arms, forearms, hands), using the center of gravity position of each part Pgi(xg(i), yg(i), zg(i)) (i = 1, 2, ..., 8), the mass center ratio m(i) and the position data of each part of the body obtained from the motion capture data. The center of gravity position Pgi(xg(i), yg(i), zg(i)) of each body part is calculated using Eq. (1). Here, the positions Psi(xs(i), ys(i), zs(i)) are the start positions of each body part, and the positions Pei(xe(i), ye(i), ze(i)) are the end positions of each body part.

$$\begin{bmatrix} x_g(i) \\ y_g(i) \\ z_g(i) \end{bmatrix} = (1 - m(i)) \begin{bmatrix} x_s(i) \\ y_s(i) \\ z_s(i) \end{bmatrix} + m(i) \begin{bmatrix} x_e(i) \\ y_e(i) \\ z_e(i) \end{bmatrix}$$

(1)

3. Result

First, we showed the trace of each part in 3D. We showed figure 3 to the trace of the emotionless.

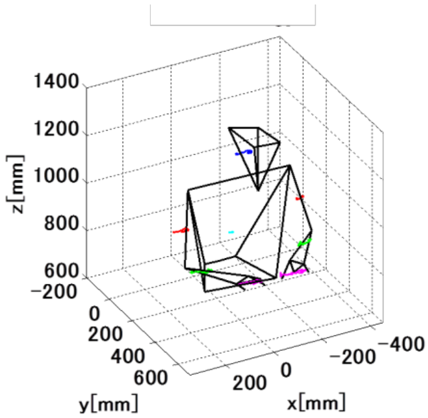

Figure 3. The trace of the emotionless in 3D

The study showed the trace from the lateral direction to watch movement. We showed the results in each emotion (Figure4-9).

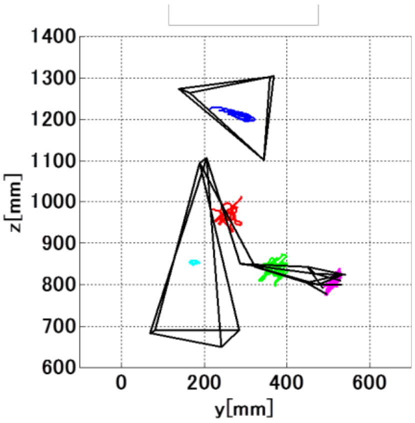

Figure 4. The trace of the happiness from the lateral direction

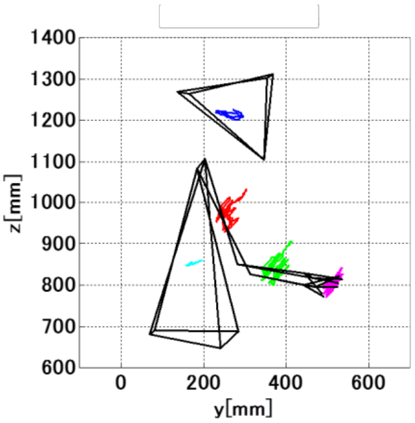

Figure 5. The trace of the tenderness from the lateral direction

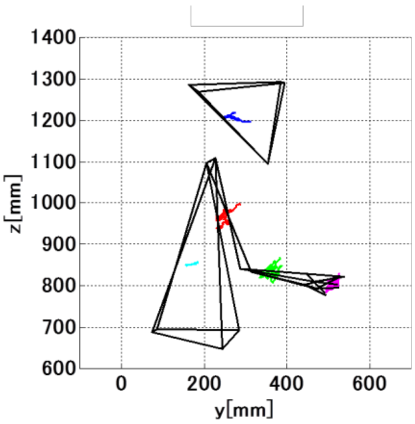

Figure 6. The trace of the anger from the lateral direction

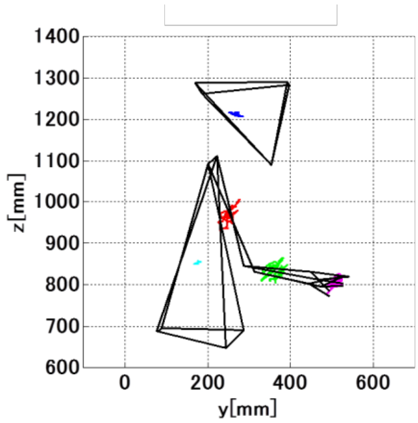

Figure 7. The trace of the sadness from the lateral direction

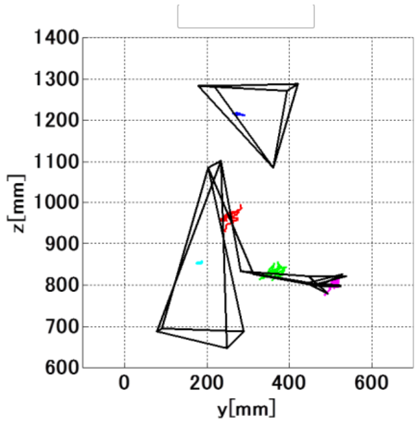

Figure 8. The trace of the fear from the lateral direction

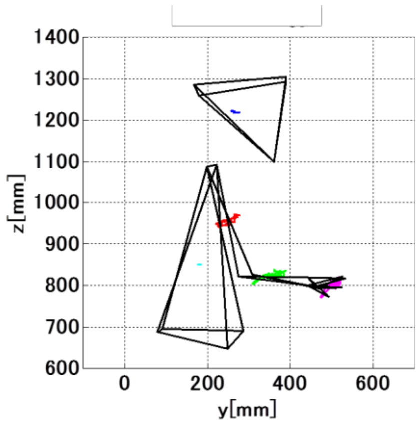

Figure 9. The trace of the emotionless from the lateral direction

From the figure, movement was big in order of happiness, tenderness, anger, sadness, fear, emotionless. The positive emotion was big movement, and the negative emotion was small movement. The difference of trace of the body part was big in the head and upper arm. On the conversely, the difference was not over the forearm, hand and torso. From this, the difference of the performance in emotion emerges in the head and upper arm. In other words, the head and upper arm are important to emotional expression of the performance.

4. Conclusion

This study examined an association between emotion and movement of the body part during the keyboard instrument performance. As a result, there was a difference in the emotional expression of the performance in the head and upper arm. In this way, we understood that the part except the hand was important to emotional expression in the keyboard instrument performance. The future investigation is going to analyze the front.

5. Acknowledgment

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PHYSICALLY EXPERIENCED REACTIONS AND MUSIC: A QUESTIONNAIRE STUDY OF MUSICIANS AND NON-MUSICIANS

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Abstract

Studying physically experienced reactions such as chills, tears, and racing heart (sometimes generally referred to as thrills) represents an important approach to music and emotion. A questionnaire study methodologically based on Sloboda's influential article (1991) partly confirms the results but disagrees with them in some findings. More frequent physical reactions during music listening in women reported by previous studies were confirmed only for respondents older that 30 in this study. In partial accordance with some of previous studies, more frequent physical reactions in professional musicians than in amateur musicians and non-musicians were found and goose-pimples and chills appeared to be the two most frequent reactions. Another study based on modified questionnaire was focused on musicians only and aimed at the difference between thrills experienced during listening to music and during music-making. The results show that for some musicians these two situations represent similar experiences (with regard to the reactions), while for most musicians the two situations are quite diverse. These results suggest that musicians' reports about chills and similar reactions may be influenced by their experience during performance. This contamination of questionnaire responses can be to a certain extent based on reactions connected to stage fright. The highly consistent frequency of occurrence of different examined reactions, and language nuances are discussed.

Keywords: chills, emotion, music

1. Introduction

Physically experienced reactions to music (sometimes referred to as thrills) have proved to be an important research topic related to music and emotion (for an overview, see Huron & Margulis, 2010).

Among the physical reactions, chills (frisson, shivers down the spine, usually accompanied by piloerection) appear to represent specific and well identifiable reactions and have been recently studied with relation to music as well as other domains (e.g., Grewe, Katzur, Kopiez, & Altenmüller, 2010; Benedek & Kaembach, 2011; Maruskin, Thrash, & Elliot, 2012).

In one of the few earlier studies, Sloboda (1991) pointed to connections between music structure and different physically experienced reactions. Sloboda's paper influenced many recent research studies, mostly in the sense of focusing the interest to structural and acousical features. Thus, music structure is now being studied in connection with empirical investigation of listeners' experience. This is something Meyer (1956, pp. 1-22) considered to be inapplicable in practice at his time.

Methodologically, recent research on chills has preferred the “in-the-lab” approach, in which chills experienced during the research procedure are studied (e.g., Rickard, 2004; Grewe, Nagel, Kopiez, & Altenmüller, 2007; Guhn, Hamm, & Zentner, 2007; Grewe, Koppiez, & Altenmüller, 2009; Yasuda, 2009; Benedek & Kaembach, 2011). However, research based on data relating to participants' recollections of previous chills experiences represents an important approach for studying real-life chills experiences in strong experiences and everday life (e.g., Gabrielsson, 2011; Maruskin et al., 2012). Feelings related to body are usually easily recollected and described by participants (compared to emotional responses to music in general). Physical reactions are a common component of strong experiences with music (Gabrielsson, 2011).

Schönberger (2006) used a questionnaire similar to that of Sloboda (1991), exploring 12 physical reactions (see **Figure 1** for complete list) and added an open ended question—inspired by Gabrielsson—regarding life's strongest experience with music.

For each subject, Schönberger (2006) summed results of all 12 reactions' overall frequencies and called this value as thrill-score. He found it was significantly higher for women than men. Sloboda (1991) referred about significantly more frequent tears in women.

Women as more apt to experiencing chills are reported by some other articles (e.g., Panksepp, 1995; Benedek & Kaembach, 2011), but some studies found no sex differences (e.g., Grewe et al., 2009) and consensus hasn't been reached because different samples and methods may exhibit various gender-related tendencies.

Musical features similar to a soprano solo instrument emerging from orchestral background have been reported to be among the most common triggers of chills. Panksepp & Bernatzky (2002) offered an evolutionary explanation based on separation calls and thermoregulation. Huron's (2006) ITPRA theory represents a more general explanation. Maruskin et al. (2012) suggestet that chills as a psychological construct may encompass distinct types of reactions.

Existing research mostly hasn't focused on relation of chills to music training (music education, music experience, etc.). Few studies which allowed for comparison found no or little or unclear difference (e.g., Grewe, et al., 2009).

Study 1 was conceived as replication of Schönberger's (2006) research (which was itself a replication of that of Sloboda, 1991), while comparing professional musicians, amateurs and non-musicians (there were only non-musicians and amateurs in Schönberger's sample).

Study 2 was aimed at musicians only, it used a shortened and modified questionnaire and explored difference between physical reactions during listening to music and during performance.

Aim common to both studies was exploring language differences by using Czech-speaking sample. Maruskin et al. (2012) pointed to conceivable complexity of the chills phenomenon. Thus, semantic background of other language might contribute to examination of this issue.

2. Study 1

With respect to purpose and length of this paper, only basic or important results will be presented and only results relating to Study 2 will be explained in detail.

2.1. Method

Schönberger's (2006) method was followed as closely as possible. In translation of the questionnaire from German to Czech, account of Sloboda's (1991) original English expressions was taken. For clarity, these Sloboda's original expressions will be used in this paper, though closer translations would sometimes be possible. Participants were first asked to rate the frequency with which they had experienced each of the 12 physical reactions to music within the last five years. Five-point scale was used for overall reactions' frequency (never - rarely - occasionally - quite often - very often).

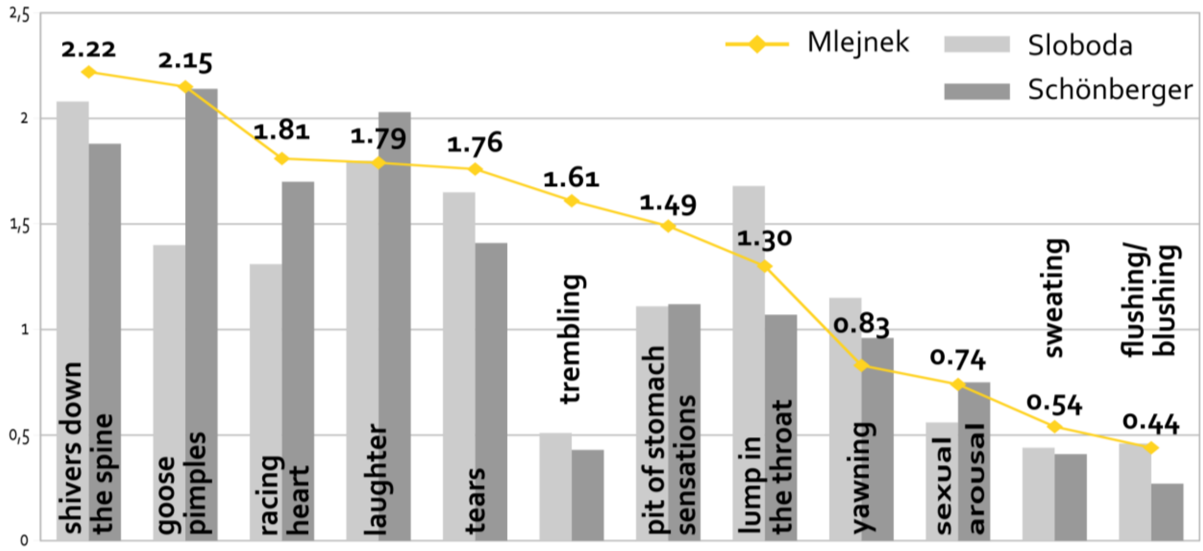

Figure 1. Mean scores of frequency of occurence of all twelve physically experienced reactions (0 = never, 4 = very often) in comparison with Sloboda's (1991) and Schönberger's (2006) results.

In the second part of the questionnaire, participants were asked to nominate up to 3 pieces of music (and particular segments if possible) which induce one or more of the 12 reactions listed. Additional questions followed each nomination (how many times the nominated piece of music was heard by the subject, assumed cause of the reactions, etc.). Further additional questions regarding general experience with physical reactions to music followed, closing with an open ended question about the strongest experience with music.

Data were collected with a web-based questionnaire. Links to it were posted at several Czech web forums related to music. The web was accessed 390 times, 174 questionnaires were filled in, 8 of them had to be excluded because of duplicity or incompleteness. In addition, about 45 paper-based questionnaires were distributed using snowball technique, 20 were returned. The questionnaire was time consuming (the paper version had 8 pages) and requested participants to recall detailed information about the music or even find scores or recordings.

We collected data from 186 subjects (166 from the web, 20 from the paper version), 99 women and 87 men. Age was inquired in 9 categories, 51 participants (27%) were between 16 and 19. There were 33 participants (18%) younger than 16, only 6 were older than 60. Over 3 fourths of the participants were under 30.

122 (66%) participants declared to play at least one instrument: 22 as professionals, 33 as amateurs, 25 checked the option "ordinary playing in private", 42 checked "occasional playing in private".

As the preferred music style, 28% of the subjects chose "pop/rock", 19% "classics before the 20th century" and 16% "metal". The remaining 9 style categories (including "other") didn't reach 10%.

2.2. Results

Mean overall frequencies of occurrence of all the reactions can be seen in **Figure 1** in comparison with Sloboda's (1991) and Schönberger's (2006) results. The most common reactions were shivers down the spine, goose pimples, racing heart, laughter, and tears (all had been experienced at least "rarely" by over 80% of the subjects during the last 5 years).

Internal consistency of thrill-score (defined by Schönberger as sum of all the 12 reactions' scores) for women and men did not differ significantly (Mann-Whitney U, $Z = -1.174$, $p = .241$). Women experienced only stomach sensations and sexual arousal significantly

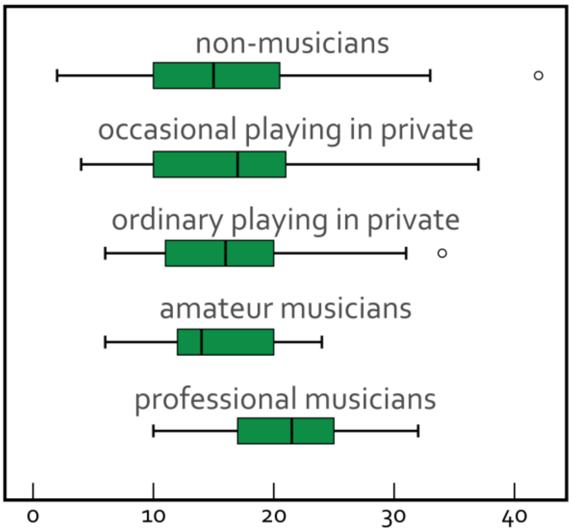

Figure 2. Box-plot of thrill-score by self-categorized musicianship.

more than men (Z = -2.509, p = .012 and Z = -2.466, p = .014, respectively).

However, interaction with age was found. For subject aged 30 or over, the thrill-score was significantly higher in women (Mann-Whitney U, Z = -2.218, p = .027). Correlation of age and thrill-score was -.35 (Spearman, p < .001). Music instrument players and non-players did not differ significantly in thrill-score. But professional musicians as a group had a higher thrill-score than the remaining subjects (Mann-Whitney U, Z = -3.692, p = .0002; see **Figure 2**). Of the most common reactions, professionals scored significantly higher in shivers (Z = -2.462, p = .014), goose-pimples (Z = -2.919, p =.004), racing heart (Z = -2.684, p = .007), laughter (Z = -1.989, p = .047), but not in tears (Z = -1.525, p = .127).

Thrill-score showed no link to preferred music style. Of the three most selected styles, pop/rock listeners scored higher than metal and classical music listeners only in laughter (p < .01).

Subjects who stated that they experience the reactions more frequently when listening to a recording did not differ significantly in thrill-score from those who stated that they rather experience them during listening to live performance. The former group scored significantly higher in shivers (Mann-Whitney U, Z = -2.539, p = .011) and trembling (Z = -2.696, p = .007) only.

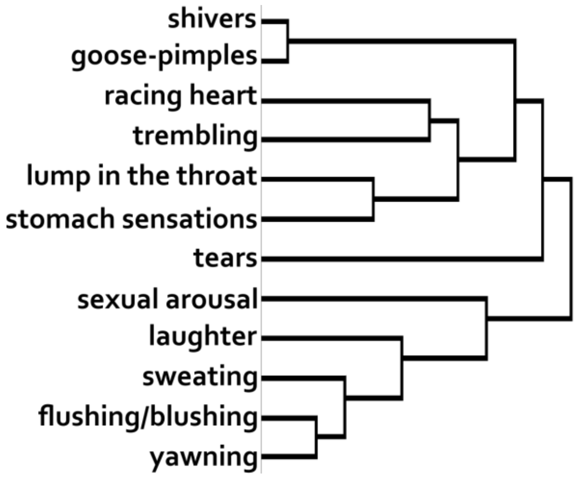

Figure 3. Dendrogram of cluster analysis of reactions selected by the participants for individual nominated pieces of music or segments. Distances between individual reactions have been determined by simple co-occurrence or non-co-occurence. If two reactions were selected at the same time for the same nomination, the distance between them decreased (-1). If one reaction was selected for that nomination but the other was not, the distance increased (+1). If none of the two reactions was selected, the distance stayed the same. Only order of clustering is represented, the dendrogram does not show the distances proportionally.

Highest correlation was between shivers and goose-pimples (.706, Spearman, p < .00001). Cronbach's alpha of thrill-score (i.e., internal consistency of this scale) was .779.

However, for exploration of relations between different reactions, data from the second part of the questionnaire were more suitable (i.e., data concerning specific nominated compositions or segments of compositions). We gathered 282 nominations (each participant was asked to give up to three nominations).

Again, highest correlation was between shivers and goose-pimples (.378, Spearman, p < .001). The second highest correlation was between lump in the throat and stomach sensations (.332, p < .001).

Cluster analysis of reactions reported with nominations can be seen in **Figure 3**.

Analysis of the nominated pieces and segments will not be presented here in detail, but some major results will be mentioned.

For each nomination, subjects were given an opportunity to give their own assumption of what caused the reaction. Out of the 15 nominations with only tears selected by the subject, there were 11 descriptions given. Of these, 3 were related to subject's episodic memory (e.g., "lost a good friend"), 2 were related to lyrics (e.g., "beautiful words"), 2 were unclear about the cause (e.g., "I don't know, strange feeling of happiness", "I don't know how to describe"), remaining 4 mentioned some musical or acoustical feature, but were mostly general (e.g., "sound of the violin") and 2 of them were mixed with other descriptions ("moving/touching" and "memories from the movie").

There were 33 nominations with only shivers and/or goose-pimples selected. Of these, 18 descriptions of the assumed cause were given. No related to personal episodic memory, 4 descriptions related to something extra-musical (e.g., "pride, patriotism", "I know the performer's story"). The remaining 14 descriptions referred to music: 4 related to interpretation (e.g., "amazingly played"), 6 descriptions related to a musical feature (e.g., "harmony, composition skill", "tempo"), 2 were quite unspecific but still related to music ("it's beautiful", "it's a good piece of music") and 2 descriptions rather referred to what that music can do to the listener (e.g., "it cheers me up or calms me down, depending on what I need at the moment").

Though subjects often selected several different reactions for a single nominated piece of music, the overall tendency implied above was clear: tears more often related to episodic memories or text, shivers and goose-pimples rather related to musical features. There were 16 nominations with tears selected together with shivers and/or goose-pimples (and no other reaction).

Similarly, subjects who nominated classical music saw the cause of the reactions rather in music as such, other music styles were more often related to episodic associations.

Two subjects nominated similar segment of the same piece of music – Tchaikovsky's violin concerto, entrance of the solo violin in the first movement. Both selected goose-pimples, shivers, laughter, and racing heart for this nomination, one of them trembling. The same concerto was nominated by one more subject, but no segment specification was given. There was no other segment nominated by two or more subjects.

Among nominations with well specified segments, in 12 descriptions of the nominations the word "entrance" appeared.

3. Discussion of Study 1 and implications for Study 2

Values of overall reactions' frequencies mostly copied Sloboda's (1991) and/or Schönberger's (2006) results (**Figure 1**). Because the three studies didn't use similar sample selection, the overall results should not be understood as comparison of the source populations.

Rather, the comparison might highly reflect language similarities and dissimilarities. For example, Czech word "chvění", used as translation for "trembling" ("Zittern" in German), is semantically very close to "shiver". This might explain why our value deviates from the other two. For Study 2, we decided to use two different Czech words for "trembling" and to further explore this issue.

In Sloboda's sample, women experienced tears significantly more frequently than men. Schönberger (2006, p. 92) found significantly more frequent tears and lump in the throat in women than in men and the overall thrill-score was higher for women. In our sample, women's answers were significantly higher than men's only for stomach sensations and sexual arousal, not for the thrill-score.

Twelve nominations using the word "entrance" in the description are in accord with often mentioned elicitors of frisson (Huron & Margulis, 2010, p. 594) and with Huron's (2006) theory based on contrastive valence.

Musicians are more apt to specify particular segments of music, and classical music may seem more suitable for that (e.g., measure numbers or sections descriptions can be used), but Study 1 has shown that quite precisely specified segments (e.g., by time in a particular recording) or whole pieces can be nominated by non-musicians and these nominations can reveal important information about the nature of physically experienced reactions.

More frequent physical reactions in professional musicians that in other groups was quite a surprising finding. We would rather expect non-musicians to differ from musicians. Since our sample was highly influenced by self-selection bias, the result should be taken with caution. However, several explanations can be suggested:

(1) Professional musicians don't experience more thrills relatively to time spent with music, they simply experience more thrills because they spend more overall time with music.

(2) Since professional musicians must be able to control the reactions so that these don't affect their performance negatively (Trainor & Schmidt, 2003, pp. 313-314), they can "let go" and experience the thrills more easily when listening to music (when they can afford it).

(3) Professional musicians are more involved in music listening, they pay more attention to it. This would be in accord with what Huron & Margulis (2010, p. 593) remarked: "susceptibility to music-induced frisson is correlated with musical interest".

Other explanations are supposable and we should expect more effects co-operating rather than a single cause. In Study 2, we tried to minimize self-selection bias to further explore this issue.

4. Study 2

The aim of the questionnaire research following Study 1 was further exploration of physical reactions to music in musicians. Some statements from the Study 1 questionnaire and several subjects' post-procedure feedback suggested that musicians, being asked about the frequency of physical reactions during music listening, may contaminate the rating by what they experience during music-making. Therefore, we decided to examine these two situations separately.

4.1. Method

The questionnaire was based on the first part of that used in Study 1, but it was designed to achieve high return rate and low time consumption so that self-selection bias was reduced (in comparison with the demanding questionnaire of Study 1). The 4 least frequent reactions were excluded. For trembling, Czech "chvění" was used in Study 1. This word expresses rather minute oscilation or vibration and might be close to shivering and frisson. We decided to add one more translation of trembling as another reaction. This was "třesení" which is closer to shake or tremor.

Thus, we obtained a list of 9 reactions. For each reaction, two 5-point scales (1 = never, 3 = occasionally, 5 = very often, 2 and 4 not labeled) were used, one for "during listening", one for "during playing or singing". At the beginning of the questionnaire, age, sex, and general education were inquired, as well as number of years of formal music education (basic music school and conservatory) and musicianship self-categorization ("playing or singing professionally", "playing or singing as an amateur", "playing or singing in private", "not playing nor singing"). Two further questions were added at the end of the questionnaire: "Do you ever listen to music with intention of evoking any of the reactions?" (similar 5-point scale) and "Do you have your own favourite passages in music pieces which often elicit any of the reactions?" (yes/no). This question was supplemented by a short empty line and a proposal to write which reactions these are. Open-ended question was used so that subjects could write down reactions not listed in the questionnaire if they wished. Finally, subjects were asked to write any comments on remaining space.

The questionnaire was printed on a two-sided A4 paper, using a large font and clear structure to be optimized for quick completion. This brief form of questionnaire was used to achieve hight return rate from objectively defined sub-groups of musicians. Thereupon we were able to compare self-categorization and this objective criterion. On the other hand, this was at the cost of receiving several incomplete questionnaires

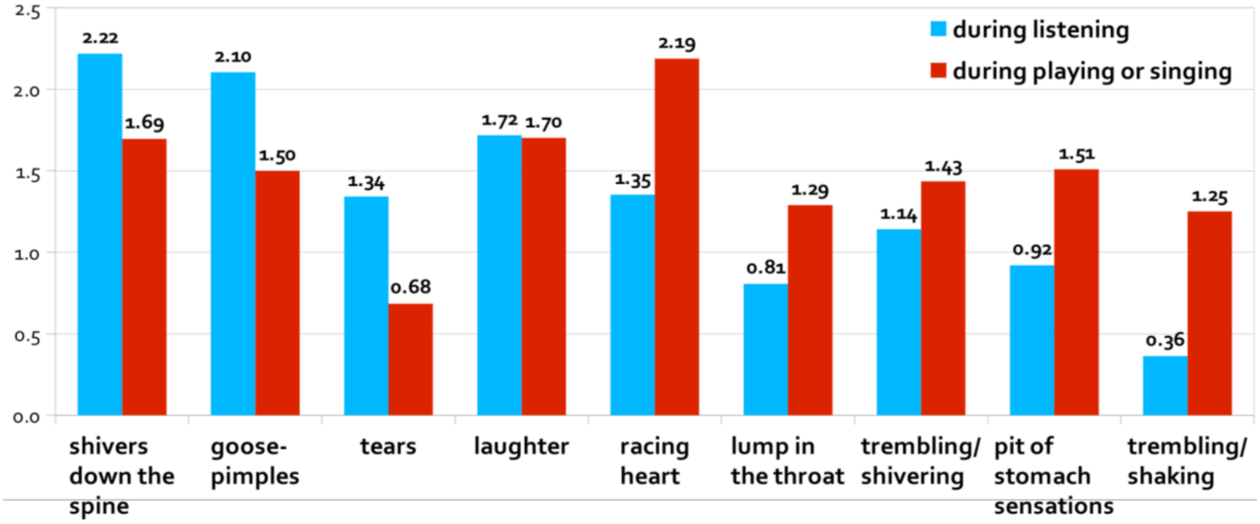

Figure 4. Mean scores of frequency of occurrence of all nine physically experienced reactions (0 = never, 5 = very often).

(missing values were treated by listwise deletion).

Three sub-groups were selected: (1) instrument players of a particular professional symphony orchestra based in Prague, (2) instrument players of a particular amateur orchestra based in northern Bohemia, and (3) music students of the Prague Conservatory (instrument players, singers, composers and conductors). The questionnaires were distributed during a rehearsal break (sub-groups 1 and 2) and during music history lessons (sub-group 3) and immediate completion was requested.

A total of 120 questionnaires was gathered. In the professional orchestra (sub-group 1), 35 questionnaires were distributed and 23 usable were returned (66%). In sub-groups 2 and 3, return rate was over 90% (32 and 65 usable questionnaires returned, respectively).

There were 54 women and 65 men in the sample (1 missing value). Highest sex disproportion was in the professional orchestra (8 women, 15 men). Age range was 14 to 88 (median = 21, mean = 27.9, SD = 15.3, 5 missing values).

All but 3 players of the professional orchestra categorized themselves as professional musicians. All but 5 players of the amateur orchestra categorized themselves as amateurs. Conservatory students selected as follows: 37 professionals, 24 amateurs, 3 "playing or singing in private".

In the amateur orchestra, 26 subjects (81%) had no conservatory education (i.e., zero years). In the professional orchestra, 18 subjects (78%) had complete conservatory education (6 years).

4.2. Results

Mean frequencies of occurrence of all 9 reactions can be seen in **Figure 4**. Scores of shivers, goose-pimples, and tears were significantly higher for listening situation than for playing or singing situation (Wilcoxon signed ranks test, $Z = -4.397, -5.191, -5.357$, respectively, $p < .001$). Scores of racing heart, lump in the throat, trebling/shivering, stomach sensations, and trembling/shaking were significantly higher for playing/singing situation ($Z = -5.251, -3.926, -2.123, -4.866, -5.957$, respectively, $p < .001$, for trembling/shaking $p = .034$). Scores of laughter were not significantly different between the two situations ($Z = 0.214$, $p = .83$).

In listening situation, women scored significantly higher than men in tears (Mann-Whitney U, $Z = -3.420$, $p = .001$), goose-pimples ($Z = -1.963$, $p = .0496$), and stomach sensations ($Z = -3.219$, $p = .001$). In playing/singing situation, women scored significantly higher than men in lump in the throat ($Z = -2.072$, $p = .038$), goose-pimples ($Z = -2.699$, $p = .007$), laughter ($Z = -2.027$, $p = .043$),

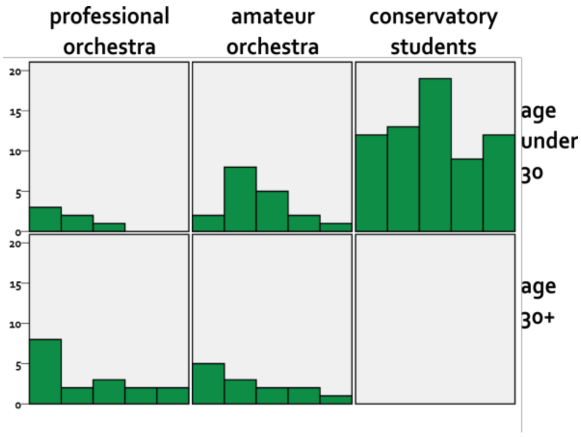

Figure 5. Histogram of frequency of listening to music with the intention of evoking any of the reactions. Bars represent the the 5-point scale from left to right (never to very often).

trembling/shivering (Z = -2.766, p = .006), and stomach sensations (Z = -3,484, p = .0005).

Professionals, as defined by self-categorization, scored significantly higher than amateurs in laughter in listening situation (Mann-Whitney U, Z = -2.362, p = .018) and lower than amateurs in stomach sensations in listening situation (Z = -2.169, p = .030).

Subjects aged 20 or over scored higher than subjects under 20 in tears in listening situation (Mann-Whitney U, Z = -2.301, p = .021) and laughter in playing/singing situation (Z = -2.075, p = .038). The only significant correlation of age was that with goose-pimples in listening situation (.258, Spearman, p = .009). For women, this correlation was even stronger (-.297, p = .031) and trembling/shaking in both situations correlated significantly with age as well (-.308 and -.313, respectively, p < .05).

27 subjects (15 women and 12 men) didn't distinguish between listening situation and playing/singing situation for shivers and goose-pimples (selecting the same number on the scale for both situations for both reactions). Moreover, 15 of them didn't distinguish between the two situations for tears as well.

27 subjects (5 women and 22 men) selected "never" for tears in both listening and playing/singing situations. Only two men selected "never" for shivers and goose-pimples in both situations.

Cronbach's Alpha of all 18 items (9 reactions in two situations) was .849, indicating a high level of internal consistency. Highest correlation was between the two translations of trembling in playing/singing situation (.618, Spearman, p < .00001). In listening situation, highest correlation was between shivers and goose-pimples (.524, p < .00001).

Frequency of listening with intention of evoking any of the reactions was not significantly different between professionals and amateurs as self-categorized (Mann-Whitney U, Z = -0.892, p = .372), though it was significantly different between sub-groups (Kruskal-Wallis, H(2) = 7.476, p = .024). However, due to demographically unbalanced subgroups, interaction with age should be assumed (see **Figure 5**). "Never" was selected by 30 participants (10 women and 20 men).

Only 10 subjects reported they don't have their own favourite passages which would often elicit any of the reactions (2 missing values).

Czech word for frisson (used as a translation for shivers in our questionnaires) appeared in 49 comments on the reactions elicited by favourite passages and was the most frequent word. Among words not included in the list of reactions but mentioned in this open-ended question were (here presented in close translation): relaxation (4 times), well-being (2), joy (2), happiness, sadness, dry throat, being moved/touched, thrill, tenderness, love, anger, and undescribable.

5. General discussion

Results of Study 2 suggest that musicians experience different mixtures of physical reactions during music-listening and during music-making. Shivers, goose-flesh and tears seem to be more common in listening situation. Racing heart, lump in the throat, stomach sensations and trembling—typical symptoms of stage fright—are more common when playing or singing.

Study 1 revealed little differences between men and women, while Study 2 found some of the reactions more in women. Since Study 1 was highly influenced by self-selection bias, gender differences may be covered by high importance of the chills phenomenon for the participants. In Study 2, which had a lower self-selection bias, tears in listening situation were more frequent in women, which is in accord with previous research (Sloboda, 1991; Schönberger, 2006). Shivers were not significantly more frequent in women. However, goose-flesh in both listening and music-making situations was, as well as trembling translated closely to shivering in music-making situation. These reactions often accompany chills, so our findings support gender differences reported by previous research (Panksepp, 1995; Benedek & Kaembach, 2011).

Stomach sensations and lump in the throat in music-making situation were more frequent in women, who report more distress from performance anxiety than men (Wesner, Noyes, & Davis, 1990).

Both Study 1 and Study 2 showed a high level of internal consistency of the used lists of reactions (Cronbach's Alpha was .779 and .849, respectively). This indicates that different reactions, relating both to listening and music-making, can be well conceived as a single construct ("how usual or important are for the individual physically experienced reactions with music").

This was probably at least partly imposed by the offer itself — mere exposure to the list of reactions tacitly suggests to the listener that experiencing this "menu" is somewhat normal.

Though, previous research has related chills to Openness to Experience (McCrae, 2007) and revealed that chills-responders are less thrill and adventure seeking and more reward dependent (Grewe et al., 2007). This relationship with general factors supports the idea that the internal consistency found in both Study 1 and Study 2 was not fully implied by the questionnaire itself. This is further supported by our finding from Study 2 that about a quarter of the participants (musicians) never listen to music with intention of evoking any of the physical reactions.

Gender differences, manifested rather equivocally between Study 1 and Study 2, seem to be better explicable by this aforementioned point of view, rather than by direct connection between gender and particular physically experienced reactions. This idea is furthermore supported by music stimuli related research reporting higher stress reactivity in women (Nater, Abbruzzese, Krebs, & Ehlert, 2006).

It should be noted that the idea of a single construct does not mean that the particular reactions are of the same basis. Language differences shown in comparison of Sloboda's (1991), Schönberger's (2006), and our research point at diversity of these reactions. This is in accord with other research considering language or cultural differences (McCrae, 2007).

Thus, the diversity of particular reactions seems to be masked by more general factors (e.g., personality traits, gender, age etc.), rather than directly explained by them. This concerns not only such dissimilar reactions as racing heart and tears. According to Study 2 results, shivers seem to be typical for listening situation and trembling seems to be typical for music-making. Though, the Czech translation used in both Survey 1 and 2 (referred to as trembling/shivering in Survey 2), which is semantically close to shivers, appears to lie in between, or, encompass both meanings. Maruskin et al. (2012) pointed to a similar manifestation of complexity of the chills construct.

Benedek & Kaembach (2011) related piloerection to the state of being moved or touched. In Czech, a special noun ("dojetí") is used for this state, corresponding roughly to German "Rührung" or "Ergriffenheit". As Benedek & Kalembach (2011) notice, there is no exact equivalent in English. In a research based on prototypical approach, Slaměník & Hurychová (2006) showed that this emotion is specific of Czech population.

To conclude, it seems contradictory that chills and other physically experienced reactions appear to be so specific as bodily symptoms, while being referred to by so many miscellaneous words which intertwine with each other and often mismatch between languages.

Just like sweating experienced by a techno fan will be of a different basis from sweating of a performing jazz saxophonist, chills may rise from various triggers, though they may manifest themselves as specific and almost uniform reactions.

Our study has pointed to the importance of studying physically experienced reactions with respect to extra-musical features, general inter-individual differences, and listening (or music-making) context. Though previously reported gender differences were partly confirmed in our research, the Czech-speaking sample offered comparative results suggesting caution in judging inter-group differences.

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THE EFFECT OF EXPERTISE IN EVALUATING EMOTIONS IN MUSIC

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Abstract

This study investigates the role of expertise in the listener judgment of emotion in music. Previous studies suggest that the most important factors are mode and tempo, respectively influencing valence and arousal. The effect is stronger when the two parameters converge (major mode combined with fast tempo and vice versa), whereas tempo predominates when they do not converge. An open question is whether and how these judgments vary with the expertise of the listener. Our hypothesis is that non-experts will base their evaluation mainly on tempo, disregarding mode, which is more complex to be aware of. On the other hand, experts will take advantage of both sources of information. The experiment involved 40 participants. Experts were students who attended at least five years at music school. Non-experts had no formal musical training. Valence (positive vs. negative) and arousal (high vs. low) were manipulated independently in a 2*2 within-subjects design. Seven short piano pieces were composed and manipulated using the four conditions, for a total of 28 snippets. For each snippet, participants were asked to rate the values of the experienced valence and arousal on a seven-point scale. Results confirmed that for both types of listeners arousal was determined exclusively by tempo. Valence was primarily influenced by mode. Non-experts were also influenced by tempo for valence evaluation, while experts were not. As regards valence, mode is predominant in cases of divergent conditions but only for experts. Implications of these findings for the design of computing systems to allow non-musicians to create music are discussed.

Keywords: music perception, music and emotion

1. Introduction

One of the most stimulating but complex tasks in music psychology is to define the mapping between musical parameters and emotions (Juslin, 2001). In this task, the goal is to investigate the most relevant musical factors whose changes have an impact on the emotions experienced by the listeners. These musical factors inherently belong to two different categories: compositional elements (e.g., mode, harmonic progression, key) and performing elements (e.g., velocity, *ritardando*, *vibrato*).

With regards to compositional elements, most research credits to mode and tempo the highest relevance in terms of emotion elicitation (Juslin, 2001; Gagnon 2003; Webster 2005). It is important to note that the studies that have found these impacts of mode and tempo have some deficiencies, putting in question the reliability of their results. Among the common deficiencies are: (a) a lack of control of the musical stimuli used in the experiments; (b) adoption of a dichotomous classification of emotions that oversimplifies the complexity of affective states; and (c) the understatement of the influence of expertise in the evaluation of the emotion.

With the present study we aim at overcoming these limitations by setting up an experiment that (a) better controls the stimuli by systematically manipulating the factors of interest, by avoiding any bias from the composers' intentions, and by insuring ecologic validity; (b) adopts an emotion classification approach that better takes into account the complexity of the domain; and (c) takes into consideration the listener's expertise. Our prediction is that music's impact on emotion is influenced, to a certain extent, by the listener's musical knowledge. In particular, experts, who can clearly perceive the difference between major and minor modes, may use this information to rate the emotional meaning in music.

In order to test this hypothesis, we set up an experiment with 40 participants equally distributed in two groups of experts and non-experts. The experimental material was created by one of the authors, a professional composer, guaranteeing a real control on the tested parameters and an ecological validity of the composed music. A widely used technique for testing the significance of musical factors on the listener's perception consists in manipulating the factors of interest (Gagnon, 2003; Webster 2005). Following this trend, seven similar melodies were composed, and, for each of them, mode and tempo were separately manipulated. Tempo was set to two very different levels (80 BPM for slow excerpts and 160 BPM for fast excerpts) and mode was set to minor and major. As regards the classifications of emotions, we followed a common approach that adopts the two-dimensional "circumflex model" (Russell, 1980). Russell postulates that the principal emotions can be placed in a Cartesian plane where the two dimensions are valence (positive vs. negative) and arousal (excitation vs. relaxation).

Results partially confirm what was suggested by previous studies as well as advancing novel findings. The most innovative finding shows that experts primarily use mode for evaluating valence while non-experts mostly use tempo. Confirming the conclusions of previous studies, mode is found to be exclusively responsible for determining valence while tempo has an influence on both dimensions. The paper is organized as follow: Section 2 describes the related works; in Section 3 we describe the design and the hypothesis of the experiment whose results are showed in Section 4 and analyzed in Section 5.

2. Related Works

In the last decades, different studies have attempted to discover the principal compositional elements that contribute to giving music a specific emotional connotation. Measuring and categorizing emotions is itself a demanding task that becomes even more challenging when it comes to mapping this domain onto music. There are been over 100 different experimental studies aimed at mapping different musical structures with emotional expressions (see Juslin, 2001 for a complete review). A general consensus among these studies is that the most significant compositional factors for conveying emotions are tempo and mode.

Many studies have analyzed emotions in the valence/arousal dimensions. Common findings suggest that (a) mode is mostly responsible for determining the valence, and (b) tempo has a major impact on arousal and a minor impact on valence. Thus, with regards to mode, positive emotions are associated with the major mode and negative emotions with the minor mode. With regards to tempo, high activation and, to a lesser degree, positive emotions are associated with a fast tempo; while low activation and, to a lesser degree, negative emotions are associated with a slow tempo. A number of studies have confirmed that tempo and mode are the most important elements associated with emotions in music, with a subtle predominance of tempo (Gundalach, 1935; Gagnon, 2003; Gomez, 2007; Juslin, 1997; Rigg, 1964).

What happens when tempo and mode combination suggest opposite emotion (divergent condition)? In 2003, Gagnon et al. (2003), confirmed that mode and tempo were the musical elements mainly responsible for eliciting emotions and they showed that these results were stronger in cases of convergent conditions, i.e., major mode combined with fast tempo or minor mode combined with slow tempo. When conditions were divergent, subjects seemed to rely more on tempo than mode. A limitation of this study is the dichotomous classification (happy vs. sad) to emotion measurement that cannot precisely deal with the complexity of affective states.

Back in 1935 Hevner found that major and minor modes were respectively mapped to happiness and sadness independently of musical training. More recently, Bigand et Al. ran an experiment aimed at testing the influence of expertise in emotional response to music (Bigand, 2005). Subjects, divided between experts and non-experts, were asked to group 27 musical excerpts by similarity of elicited emotions. From this experiment it emerged that the expertise did not strongly influenced the emotional response. Similar results emerge from the study of Robazza et Al. (Robazza, 1994). Eighty subjects were asked to rate the emotional elicited by different pieces of music. Expert end non-experts had similar results. Despite the relevant findings, these studies are not focused on investigating the effect of the singular structural factors but the emotional effect of music in general.

As regards stimuli selection, in the very first experiments on music perception music was performed live by professional musicians (Downey, 1897 and Gilman, 1891). The advent of modern recording and synthesis techniques allowed experimenters to select stimuli either by using existing tracks or by composing musical sequences. Pre-existing music may afford a good ecological validity, but it offers no control on the parameters that make up its structures (Bigand, 2005; Robazza, 1994). By contrast, short sound sequences have less ecological validity but the manipulation of the separate factors provides better control of the analyzed parameters (Gabrielsson, 2010).

Most of the research we have presented here uses a self-reported approach to communicate the experienced emotions while listening to music. Several studies used a list of adjectives in order to classify emotions. However, the dimensional model is the most common approach as it easily permits combinations and gradients of emotions by means of valence and arousal (Zentner, 2010).

2.1. Experimental hypotheses

In the present study we predict that the two factors that we manipulate separately, mode and tempo, will have differing impacts on people's emotional reaction. In addition, we predict that musical expertise will be a mediating factor on the impact of mode but not of tempo.

Mode. We expect mode to affect the emotional outcome only with respect to valence. More specifically, participants who hear music in a major mode should give higher valence ratings than participants who hear music in a minor mode.

*Tempo***.** We expect tempo to affect the emotional outcome both with regards to valence and arousal. More specifically, participants who hear music with fast tempo should give higher arousal ratings and higher valence ratings than participants who hear music with slow tempo.

*Expertise***.** As trained listeners can better perceive the difference between modes, we expect musicians to employ this knowledge when judging emotions in music. Therefore, we expect expert musicians to give higher valence ratings to music in major mode than music in minor mode, but for novice musicians to not differentiate between modes.

Divergent factors. We are particularly interested in the interaction between *mode* and *tempo*, and what happens when the two factors are divergent. Table 1 shows the convergent (major mode and fast tempo or minor mode and slow tempo) and divergent (major mode and slow tempo or minor mode and fast tempo) conditions. Since we predict that arousal ratings are impacted only by tempo, there should be no interaction effects for this dimension. However, we expect that valence will be affected by whether the factors are convergent or divergent. More specifically, participants should rate valence highest when both factors are convergent and positive (major and fast); lowest when both factors are convergent and negative (minor and slow); and somewhere in the middle when both factors are divergent (major-slow or minor-fast).

Table 1. Converging (same symbols) and diverging (different symbols) conditions of mode and tempo.

Mode / tempo	fast	slow
major	++	+-
minor	-+	--

In case of convergent conditions (major-fast and minor-slow) the perceived valence should be at its highest (lowest). On the other hand, an interesting question arises in case of divergent conditions. *Which factor will be prevalent?* Contrarily to what suggested by related works (Gagnon, 2003), we argue that expertise may have an influence on this result. As non-musicians are less familiar with mode, then tempo should greater impact their outcome, in which case, a significant difference is expected between major-fast and major-slow and between minor-fast and minor-slow. For musicians, mode should be prevalent, thus a significant difference is expected between major-fast and minor-slow and between major-slow and minor-slow.

3. Experiment

This experiment aims at studying the impact of mode and tempo in judgments of valence and arousal according to the listener's expertise.

3.1. Participants

A total of 40 participants took part in the experiment. Twenty participants were trained musicians with at least five years of music school (or comparable institutions); the remaining 20 had no formal music education. Their age ranged from 19 to 42 with an average of 24.7. There were 15 females (10 experts, 5 non-experts) and 25 males (10 experts, 15 non-experts). Three quarters of the participants (N=30) were Italian while the rest were from different European and Asian countries.

3.2. Experimental material

In order to measure the dimensions of valence and arousal, we used two Likert seven-point scales, which were presented on a computer screen.

One of the authors composed seven ad hoc musical excerpts or snippets, keeping the emotional connotation of the music as neutral as possible, by following common compositional rules such as identical harmonic progression and meaningful solo line. The snippets consisted of an accompaniment and a solo line, each organized in four bars of pseudo-ecological music, i.e., they could not be considered a song by themselves but could potentially be the first bars of a musical piece.

Each excerpt was then manipulated in order to create a minor and major mode version. Excerpts were also manipulated with regards to tempo, generating two versions for each mode-manipulated excerpt. The fast version played at 160BPM with a high density of notes in the accompaniment, while the slow version played at 80BPM with a low density of notes. Another parameter that influences the perception of the speed of a given piece is note density. Music with an high density of notes is generally perceived as faster as compared to a piece with identical BPM but lower notes density (Gabrielsson, 1973; Gabrielsson, 2010). To overcome this equivocation, we intensified the difference between the two different sets by using eighth notes in the accompaniment line in the 160 BPM pieces and quarter notes for the 80 BPM pieces. For simplicity, instead of referring to notes density, from now on we would just refer to *tempo*.

These manipulations generated 28 snippets[1]: seven excerpts * {major, minor} * {80BPM, 160BPM}.

3.2.1. Harmony

All the excerpts have the same harmonic progression, I - IV - V - I, which is one of the most common chord progressions in tonal music (e.g. baroque, classic, romantic and pop). The excerpts have different keys, to slightly differentiate the music and to reduce boringness.

3.2.2. Melody

The most significant notes of the melody are pitches of the chord, while less important ones can be notes of the scale. We regard as significant all the notes whose duration is one eighth note or longer or that are in a relevant position in the bar (e.g. first and last place). All the melodies have the same pitch range, in order to avoid the presence of higher or lower melodies. Relevant deviations in the range of the pitch,

[1] The 28 snippets can be found at goo.gl/Qg8LX

indeed, can have an emotional influence. The intervals used vary within an octave as ranging over the octave may impact emotional experience.

3.3. Procedure

Each experimental session ran in a silent room at the Department of Information Engineering and Computer Science at the University Of Trento, Italy. Participants sat in front of a laptop wearing AKG K550 headphones. The user interface was chosen to be as minimal as possible in order to draw participants' attention to the auditory stimuli only. To assign the desired value of valence and arousal, they interacted with the system through an USB mini number pad keyboard.

Before staring the experiment, each participant was informed about the task they had to complete by means of notes written in a piece of paper (in English and Italian). Participants were initially presented with four training excerpts in order to become familiar with the interface and the task. The 28 snippets were presented in a random order. At the end of each piece, subjects were prompted with a screen asking to report what emotion, in their opinion, that particular music wants to communicate. In details, they were asked to rate from 1 (*negative* or *relaxing*) to 7 (*positive* or *exciting*) the *positivity* of the music (valence) and the *activation* (arousal). This is aligned with some of the most significant experiments in music and emotions, where participants are asked to independently rate valence and arousal on bipolar scales. Between each other listening, the computer played a sequence of random notes; these sequences have been previously validated for masking the effects of previously played music (Bharucha, 1987; Hubbard, 1988).

In order to assess the homogeneity of the snippets, the participants were asked to rate each snippet from 1 to 7 with regards to how much they liked it, with 1 representing "*not at all*" and 7 "*a lot*". The snippets, which were presented in major mode and at 120BPM, were presented in random order by the computer.

The hypotheses were tested using a within-subject experiment.

4. Results

A repeated measures ANOVA was performed on valence and arousal ratings separately. In both cases, *mode* (major and minor) and *tempo* (fast and slow) were the within subject factors, and *expertise* (not-expert and expert) was the between subject factor. A repeated measure ANOVA was also performed on the data regarding the level of attractiveness of the seven snippets (within subjects) compared to the two categories of expertise (between subjects).

4.1. Valence

The analysis showed a significant main effect for *mode* [F(1,38)= 279 p<.001] and for *tempo* [F(1,38)=106.6 p<.001]. Major mode resulted in high valence (overall mean) while minor mode resulted in low valence (overall mean). As well, a fast tempo resulted in high valence (overall mean) while a slow tempo resulted in a low valence (overall mean).

However, the interactions between *mode* and *expertise* ($F_{(1,38)}$=27,6 p<.001) and *tempo* and *expertise* ($F_{(1,38)}$=10,9 p<.001) were also significant. Figure 1 illustrates the average values of valence in the four conditions (major-fast, major-slow, minor-fast and minor-slow) according to expertise.

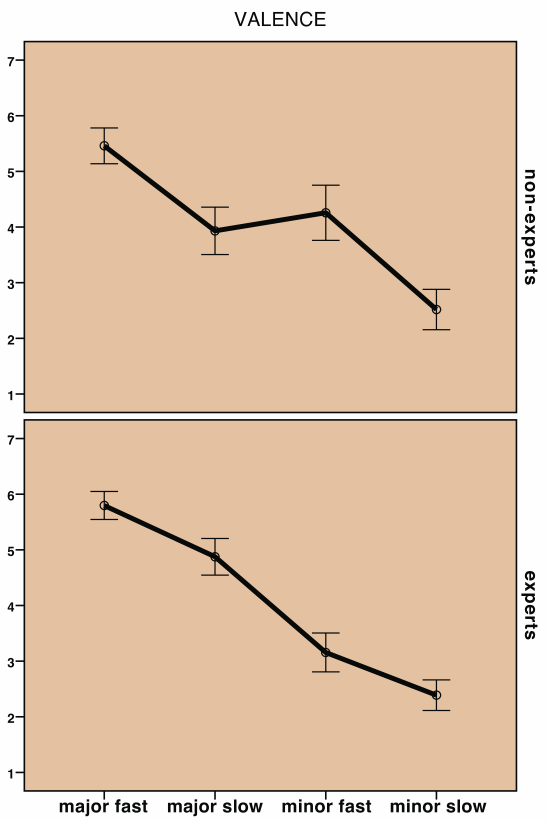

Figure 1. Average values and standard deviation of valence divided by expertise.

When listeners were experts, snippets that contained a major mode were judged as having a higher valence than snippets that contained a minor mode, no matter whether the snippets were convergent or divergent. However, when listeners were non-musicians, divergent snippets received similar neutral ratings, whether their mode was minor or major; convergent major snippets received a high valence rating while convergent minor snippets received a low valence rating.

4.2. Arousal

The analysis showed a significant main effect for *tempo* ($F_{(1,38)}$= 311.3 p<.001). A fast tempo resulted in a high arousal rating (here give the global mean) while a slow tempo resulted in a low arousal rating (here give the global mean). No significant interactions were found. Figure 2 shows the average arousal rating for the four conditions according to expertise.

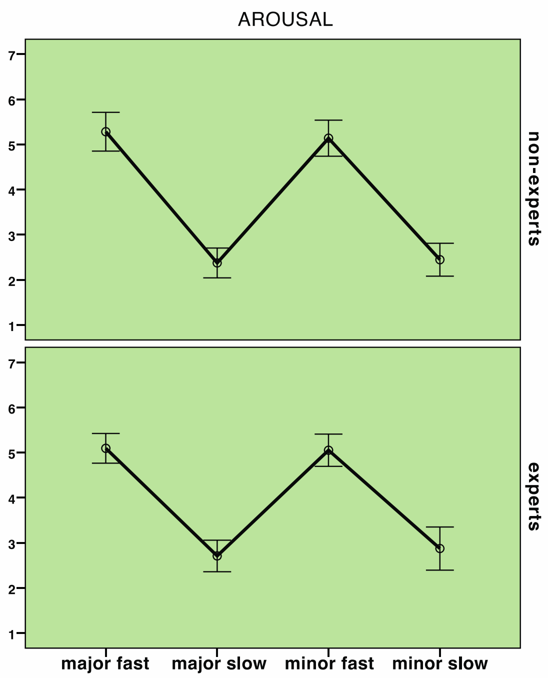

Figure 2. Average values and standard deviation of arousal divided by expertise.

4.3. Homogeneity

An ANOVA found no significant difference between snippets ($F_{(1,38)}$= 1.6 p=.178), nor any impact of expertise ($F_{(1,38)}$= .918 p<.495). The mean rating for each snippet varied from 3.4 to 4.2, with means varying from 3.1 to 4.3.

5. Discussion

Our results suggest that expertise has an impact on the emotional response to music. In particular, expertise mediates the impact of mode on ratings of valence but not of arousal. Our experts relied on mode above tempo when judging a piece of music on its valence. Our non-experts, on the other hand, appear to have been influenced by the combined impact of mode and tempo: in the case of convergent music, slow and minor music was judged with low valence while fast and major music was judged with high valence; however, when the information was divergent, non-experts rated the music halfway between the two convergent extremes. Figure 3 illustrates the divergent cases, showing that experts gave more importance to *mode* in these cases, while non-experts assigned approximately the same value to mode and tempo.

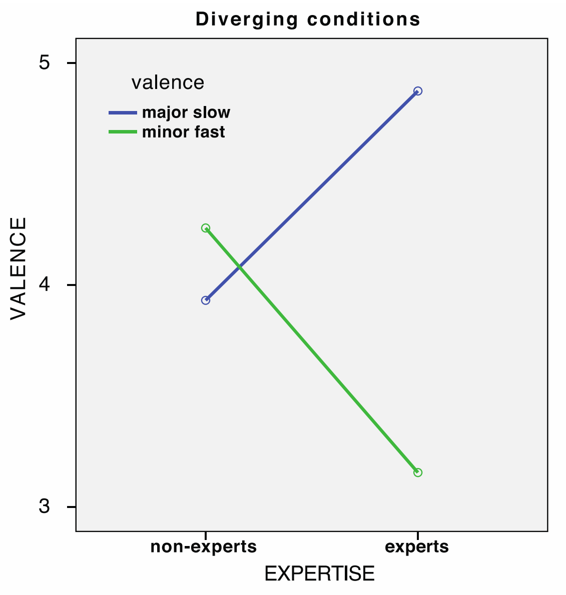

Figure 3. Expertise effect on valence in case of divergent conditions.

Arousal, by contrast, seems to be bounded only to *tempo*, disregarding *mode* and *expertise*. These results confirm past findings (Gomez, 2007; Juslin, 2001) in this area of research.

Our results show that all of the snippets were judged as similar on ratings of pleasantness. This supports the idea that the differences found were due to changes to the mode or the tempo and not to inherent qualities of the individual snippets themselves.

In summary, the acquisition of musical expertise has an influence on the emotional experience of people listening to music. As people go through formal musical training, they become particularly sensitive to mode. This result is particularly important in contexts of interactive musical systems that address a particular category of users. Performing art installations that aim at giving non-musicians access to musical compositions could make use of these finding for instructing the algorithmic generation system (Morreale, 2013).

6. Future works

The statistically identical response of non-experts to the valence scale in case of divergent conditions encourages new debates about the perception of valence for this category of users. The experiments showed that a major mode at 80 BPM has the same valence response to a minor mode piece played at 160 BPM with higher density of accompaniment notes. It is possible that different tempos could have had a different impact on our participants. Would intermediate BPM values lead to different valence judgments when combined with major and minor modes? Is there a BPM value that maximizes the difference on the perceived valence between major and major mode? How does expertise impact musical appreciation?

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MUSIC THERAPY AS AN EFFECTIVE INTERVENTION IN THE TREATMENT OF DEPRESSION IN A PATIENT WITH KORSAKOFF'S SYNDROME

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Abstract

The main aim of this study is to demonstrate the efficacy of the Music Therapy intervention and the possibility of influencing positively on depressive symptoms of a patient with this Syndrome making significant improvements in the general condition and in particular on the "activation versus apathy". The Music Therapy approach is mainly based on a sonorous music relationship between the patient and music therapist. Active Music Therapy facilitates the expressive process, increasing communicative-relational abilities and modulation and regulation of emotions. This approach is based on intersubjective psychological theories and allows "affect attunement" moments. After 24 sessions of Music Therapy treatment, a significant decrease in depressive symptoms and an increase in the level of activation vs. apathy were observed in the patient; these results are confirmed by the analysis of the clinical tests and remain constant even after a follow-up to a month. Four independent observers analyzed the Music Therapy process from a quantitative point of view through videotapes of each session. The Music Therapy treatment showed its effects on areas involved in emotional processing and regulation, such as the limbic and paralimbic structures. Music Therapy can be an effective intervention for improving the quality of life and supporting caregivers in the management of Korsakoff Syndrome.

Keywords: non-verbal music therapy, Korsakoff's syndrome, depression

1. The Music Therapy Approach

The Music Therapy approach is mainly based on a sonorous music relationship between the patient and music therapist. Active Music Therapy facilitates the expressive process, increasing communicative-relational abilities and modulation and regulation of emotions. This approach is based on intersubjective psychological theories and allows "affect attunement" moments (Stern, 2010). The proposed theoretical approach as the psychodynamic-relational music therapy provides an operational methodology based on the criteria of non-directivity towards the patient and an attitude of observation and listening, related to the concepts of neutrality and countertransference as in the traditional psychoanalytic work. From an operational view, in this methodological context, the music therapist implements all the strategies to promote the expression of the patient and his creativity, thereby facilitating a real expression of the self: a musical improvisation technical linked to non-verbal approach will be the peculiar style of this type of intervention (Navone,2009). Another important issue in Music Therapy is the definition of a temporal-spatial structure, along with the set of rules defining the therapeutic setting: these two elements, acting together, acquire a fundamental importance as facilitators of therapeutic actions, and as a consequence, of changes for better (Raglio, 2008).

The activities of Music Therapy in a relational view have to be structured in a suitable place, called setting, a place sufficiently insulated and acoustically protected that allow the development of a defined and repeated relational process over the time with continuity and regularity . The elements of continuity and regularity allow the patient to that identification between physical and mental place, in other words, the perception of that safe and stable psychological basis, where are built all psychotherapeutic rehabilitation and support interventions.

Music Therapy's non-verbal approach in psychiatric disorders, in schizophrenia and in the dementias (as in other diseases with an impairment of the communicative functions), is a viable hypothesis for the possibility of reactivating and expanding the archaic expressive and relational nonverbal abilities that persist across the individual's life span as modes of interpersonal experience. The Music Therapy philosophy is mainly based on this assumption.

A non-verbal Music Therapy approach was chosen, using both rhythmical and melodic instruments to promote intersubjective communication (Benenzon, 1981).

Through nonverbal behavior and sound-music performances, the patient conveys his/her emotions and feelings, establishes an ''affect attunement'' with the music therapist and is stimulated to modify the global emotional and affective status (Stern, 1985; 2004).

2. A single case study

This research was conducted at the residential psychiatry of the Mental Health Center, ULSS 4 Alto Vicentino.

The single study has been carried out by the author in collaboration with the clinical staff and health care of the structure and all the videos of Music Therapy sessions were individually analyzed by independent observers at the Music Therapy Center in Thiene (Vicenza), Italy.

The type of research falls within in the studies "single case study".

The main objective of the study was to find a correlation between the clinical trials, the extrasetting behavioral observations carried out by staff and some intrasetting indicators of Music Therapy non-verbal treatment, potentially relevant for the achievement of results.

Mr. P. participated in 24 individual MT sessions (30 minutes each) twice a week, over 4 months. The NPI, NPI-D and CSDD were administered at baseline, before treatment, after 12 sessions, at the end of the treatment, and at 1-month follow-up after treatment to evaluate depression and activation-apathy. Pharmacological therapy was not modified during treatment.

3. Intrasetting observation

Four independent observers analyzed the MT process from a qualitative point of view through videotapes of each sessions. The intrasetting observations were conducted session by session, using the following indicators:

1) Visual contact patient-therapist with 3 subclasses:

    - 1 a: The patient arises in visual contact with the MT during the interaction and musical sound or immediately at the end of this.
    - 1b: The patient arises in visual contact with the MT during verbalizations without sound-musical interaction
    - 1c: The patient arises in visual contact with the MT without verbalizing and in the absence of sound and musical interaction.

2) Variation of the intensity expressiveness of the Patient.

The patient changes, even if minimally, the intensity of his production both in ascending or descending order, in immediate reaction to the MT's proposal sound.

3) Actual time of sonor-musical interaction between patient and therapist.

The actual time in which MT and patient are involved in a synchronous way in any kind of sound and musical production.

4) Activation and Diversification of the patient than the instrumental mediator.

The amount of episodes in which the patient, either during an interaction to be individually make a change in the choice of the tools and / or diversified his production by changing instrumental mediator.

The quantitative variations in all these indicators from the beginning to end of treatment leads to suppose that the nonverbal and sonor-musical interaction, specific of Music Therapy intervention, can be particularly effective in the decreasing of depressive symptoms more correlated to Korsakoff's syndrome.

4. Summary of the results

In the patient were observed a significant decrease in depressive symptoms and an increase in the level of activation vs. apathy; these results are confirmed by the analysis of the clinical tests and remain constant even after a follow-up to a month.

The level of behavioral activation compared to the level of Apathy, characteristic of a depressive state, was monitored by administering (at the beginning and at the end of treatment) of the NPI NPI-D (Neuropsychiatric Inventory in Dementia; Cummings et al., 1994) with specific outcomes relevance to the areas 4-Depression, and 7-Apathy.

It was also observed a noticeable decrease of the score obtained by periodic administration of CSDD (Cornell Scale for Depression in Dementia, Alexopulos et al., 1988). This scale was administered at the base-line (p 16), at beginning of the treatment (p16), after 12 sessions (half- treatment p13), at the end of treatment 24 sessions (p 4) and after a follow-up of 30 days (p 2).

5. Conclusion

The Music Therapy treatment showed its effects on areas involved in emotional processing and regulation, such as the limbic and paralimbic structures (Koelsch, 2009).

The most significant impact of music therapeutic treatment takes place, in this pathological conditions that produce an extreme impairment of communication and of expressive processes of inside mental world (Navone, 2008); the music therapy intervention assumes a particular importance as rehabilitation tool for internal regulation of emotional states and for the redefinition of the patient’s intersubjective through a process of co-regulation and affective attunement with the therapist.

Music Therapy can be an effective intervention for improving the quality of life and supporting caregivers in the management of Korsakoff’s Syndrome.

6. Afterword about Korsakoff's Syndrome

Korsakoff's Syndrome is a syndrome that is characterized by amnesic disorders of memory in the short and long term in the absence of consciousness disturbances. The syndrome is associated with neurological disorders and at a frequent occurrence of moderate-severe Depression. This syndrome is within the mental disorders induced by alcohol and sometimes is an clinical evolution of Wernicke's Encephalopathy (Kopelman et al., 2009).

Korsakoff's syndrome typically affects males of 45-65 years with a long history of alcoholism. The females, however, which have a greater vulnerability to alcohol, tend to develop Korsakoff's syndrome before.

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AURAL-BASED DETECTION AND ASSESSMENT OF REAL VERSUS ARTIFICIALLY SYNCHRONIZED STRING QUARTET PERFORMANCE

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Abstract

In a musical ensemble musicians can influence each other's performance in terms not only of timing but also in other aspects of the performance such as dynamics, intonation, and timbre. The goal of this work is to test whether this influence can be perceived by a listener from an audio recording solely. We utilize a set of string quartet recordings where every piece is recorded in two experimental conditions: the solo condition, where each musician performs alone; and the ensemble condition, where the musicians perform together after a brief rehearsal. Using state-of-the-art audio analysis/synthesis methods, we artificially synchronize the recordings in the solo condition note-by-note, thus generating a set of pseudo-ensemble performances where there is no interaction between the musicians. We then carry out a series of listening tests: first, the subjects are tasked with comparing the quality of the performance and the degree of coordination for the two recordings, without knowing that one of them is artificially synchronized. Then, we reveal to the listeners that one of the two versions is artificially synchronized and ask them to point out which recording is which. The results suggest that listeners cannot easily discriminate between the real and artificially synchronized recordings; furthermore, the accuracy of their judgements appears to be affected by the listeners' level of musical training as well as the piece that is performed.

Keywords: ensemble performance, listening experiment, interdependence

1. Introduction

Ensemble music performance is a special case of goal-oriented social collaboration where communication is carried out nonverbally, with the performers' intentions being mediated through expressive gestures and the produced sound (Keller, 2008). One can safely assume that the first step in achieving coordinated action is rhythmic synchronization; however, depending on the instrument, the musicians can also coordinate their actions in other aspects of performance (such as dynamics, intonation, and timbre).

Using computational means to detect evidence of this interdependence between the performers has proven to be a difficult yet achievable task (Papiotis et al, 2012). Our motivation behind this article is to assess whether the same can be achieved by human listeners; such an investigation can help us understand which aspects of music collaboration are most salient from a listener's point of view, as well as identify the skills that affect the listener's perception.

Previous work on this subject is limited. Glowinski et al carried out an experiment where subjects were asked to decide whether a recorded segment was performed solo or in an ensemble by observing only the first violinist of a string quartet ensemble (Glowinski et al, 2012). Besides the perceived performance condition, the subjects also rated the musician's expressivity and the expressed emotions of the performance, while also describing which of the musician's body features (head motion, arm motion, etc.) they focused on in order to make their assessment. Results did not show significantly different assessments for the solo and ensemble conditions, although the expressivity and expressed emotion ratings showed some significant interaction with the two conditions (solo, ensemble).

Listening experiments have been employed in similar tasks. Examples include judging whether a recorded performance was composed or improvised (Lehmann and Kopiez, 2010), and whether different excerpts had been played by the same performer (Gingras et al, 2011). Finally, listening experiments have also been used to evaluate the simulation of an orchestral violin section from a single recording (Pätynen, 2011).

Our aim in this work is to assess how reliably can human listeners detect evidence of musical interdependence when listening to recorded performances of an ensemble. Our methodology is to carry out a listening experiment where listeners compare real string quartet recordings to artificially synchronized solo recordings of the same piece. We utilize short piece excerpts of varying characteristics and investigate how the listeners' judgements are affected by them as well as the listeners' own background.

The rest of this article is organized as follows: in Section 2, we describe the music material that was recorded for the listening experiment, the processing that is applied to the recordings, and the experimental process. In Section 3, we present the acquired results; finally, in Section 4, we discuss the implications of our findings and offer some concluding remarks.

2. Method

2.1. Material

The recordings used for the listening experiment consist of five short excerpts of string quartet pieces, performed by a professional string quartet. All pieces were part of the quartet's current repertoire, and each excerpt was manually selected for its different qualitative characteristics, which we assessed with the help of a professional string performer. Table 1 shows a summary of each excerpt:

Table 1. Summary of the excerpts used for the experiment and their most salient characteristic.

ID	Piece	Dur.	Characteristic
P1	Borodin – String quartet nr.2 in D Major, 3rd Movt.	00:58	Phrasing
P2	Borodin – String quartet nr.2 in D Major, 1st Movt.	00:46	Dynamics, Intonation
P3	Beethoven – String Quartet nr. 4 (op. 18), 1st Movt.	00:36	Dynamics
P4	Beethoven – String Quartet nr. 4 (op. 18), 1st Movt.	00:42	Rhythm
P5	Beethoven – String Quartet nr. 4 (op. 18), 3rd Movt.	01:21	Rhythm, Phrasing

Each piece excerpt was recorded in two conditions: *solo*, where each musician performed alone without any previous rehearsal, and *ensemble*, where the musicians performed together after a brief rehearsal period. No metronome signal was provided in any of the recordings. The *solo* and *ensemble* recordings of each piece excerpt were carried out on separate days.

2.2. Data acquisition & processing

An individual audio signal from each performer was acquired through a piezoelectric pickup fitted on the bridge of each instrument. The use of pickup signals from each musician allows for efficient post-processing with minimal artifacts (due to the absence of room ambience).

All recordings were automatically score-aligned using a dynamic programming routine and manually corrected to ensure that the annotated note onset times are accurate.

2.3. Artificial synchronization

Given that the recordings were carried out without a metronome, it was necessary to artificially synchronize the *solo* recordings; moreover, since our goal was to assess whether listeners can detect musical coordination based on factors other than rhythmic synchronization, it was also necessary to ensure that the *solo* recordings had exactly the same note onset/offset times as the *ensemble* recordings. We applied state of the art time scaling techniques (Bonada, 2000) to apply a non-linear time stretch to the *solo* recordings using the *ensemble* recordings as reference: for each individual instrument, the audio signal is partitioned using the note onset times as anchor points; then, the duration of each *solo* note is altered to match the duration of the corresponding *ensemble* note in the score; finally, the *solo* waveform is shifted to coincide with the *ensemble* waveform.

We carried out a pilot test to assess whether any audio artifacts are introduced by this procedure using music technology researchers as subjects, without encountering any. Earlier variants of this time-scaling algorithm have been also used in listening experiments without introducing any significant bias (Honing, 2006).

2.4. Post-processing

Given that bridge pickup recordings have a certain 'nasal' quality, all four pickup (bridge vibration) signals were respectively convolved with body impulse responses (Maestre et al 2013).

In order to reconstruct the stereo image of a string quartet's sound, the four recordings in each excerpt were panned from left to right as follows: violin 1 (60% left), violin 2 (20% left), viola (20% right), cello (60% right). Finally, the gains applied to each instrument's audio signal were manually set using stereo recordings of each excerpt as reference; the same gain was universally applied to all recordings.

2.5. Experiment

The listening experiment was carried out through an online survey system. Each subject was asked to use headphones in order to ensure similar listening conditions. Before listening to any recordings, the following personal information was gathered:

1. Age
2. Gender
3. Amount of (formal or informal) musical training (None, Up to 2 years, between 3 and 5 years, more than 5 years)
4. (Conditional to Training) Experience with bowed string instruments

After this step came Phase 1 of the experiment: the subject listened to the five recording pairs (*solo* and *ensemble*) in random order within the experiment (*solo* first or *ensemble* first), but the same order across all subjects. It is important to note that, at this time in the experiment, the subject was not aware that only one of the recordings is from a 'real' ensemble. The subject was tasked with listening to each pair of recordings and comparing them in terms of *Quality of performance* and *Degree of coordination*; there was also the option of considering both recordings equal.

In Phase 2, the subject was then informed that one of the recordings is real while the other is artificially synchronized. Then, the subject listened to the same five recording pairs again, this time with the task of choosing the recording he/she believed to be the real ensemble recording. Similarly to Phase 1, the subject could answer '*I am unable to decide*'. Finally, a comments' form was provided for each excerpt where the subjects could specify what helped them make their decision.

3. Results

We analyzed the responses of 74 subjects (51 males). The mean age of the subjects was 32 years old (standard deviation = 11). 39 subjects had received more than 5 years of musical training, while 8 subjects had experience with bowed string instruments.

An overview of the subjects' responses can be seen in Figures 1 and 2; Figure 1 shows which recording was rated with a higher 'performance quality' per excerpt across all subjects, while Figure 2 shows which recording was rated with a higher 'degree of coordination'.

One can already observe that each excerpt elicits a different response from the subjects. Especially the last two excerpts seem to be the most difficult to compare; given that we selected those two excerpts as examples of rhythmic coordination, it seems plausible that by making the *solo* and *ensemble* recordings identical in terms of note onsets and offsets, we are equalizing them in the aspect of the performance on which the musicians were most focusing on.

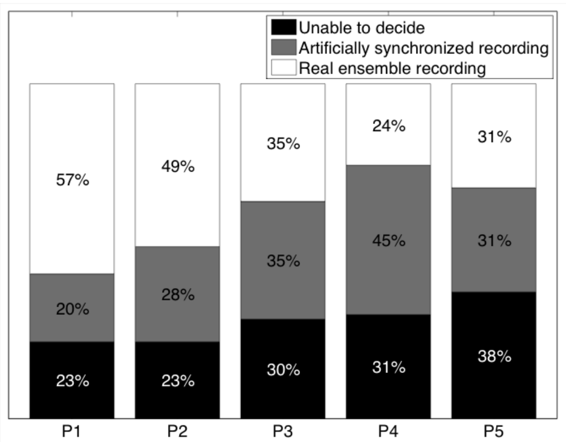

Figure 1. Collected responses for all subjects regarding Performance Quality (Phase 1). See Table 1 for the meaning of the different bars (Px).

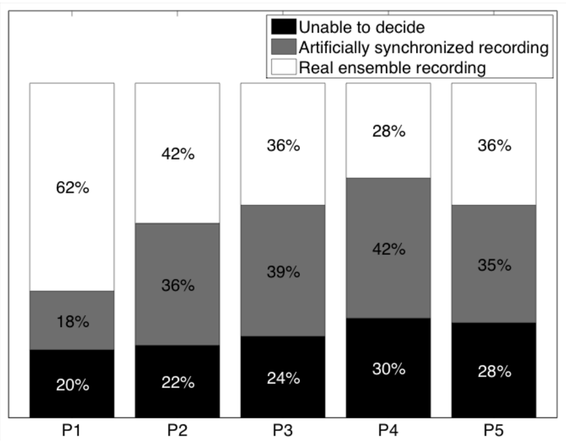

Figure 2. Collected responses for all subjects regarding Degree of Coordination (Phase 1).

Another observation that can be made from the above figures is that the subjects' ratings for 'performance quality' and 'degree of coordination' appear to be in relative agreement; this was confirmed by measuring the Spearman's rank correlation coefficient between these two factors per excerpt; the obtained *rho* values are as follows: P1: 0.84, P2: 0.73, P3: 0.72, P4: 0.66, P5: 0.71 (p-value<0.001 for all cases).

Regarding Phase 2 of the experiment, Figure 3 shows which recording was chosen as the real quartet recording across all subjects, per excerpt.

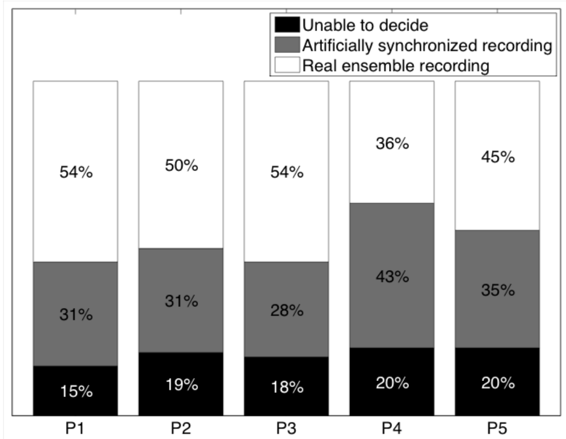

Figure 3. Recording finally chosen as "real" by all the subjects (Phase 2).

Again, it can be seen that listeners encounter difficulties in detecting the real quartet recording, with some piece excerpts showing higher accuracy than others in the same way as in Phase 1.

So far, we have not investigated the effect of musical training on the subjects' responses; moreover, although we have seen that different excerpts provide varying results, the effect of each excerpt remains to be seen. Given that the variable on which the effect of training and excerpt we want to investigate is discrete we performed a logistic regression on the binary outcome of each comparison (=YES for the cases where the real quartet recording was chosen and =NO otherwise). The results can be seen in Tables 2, 3 and 4:

Table 2. Logistic regression results for Performance quality.

Coefficient	Estimate	Std. error	p
Excerpt P1	-0.404	0.320	0.207
Excerpt P2	-0.754	0.324	0.020
Excerpt P3	-1.361	0.341	<0.001
Excerpt P4	-1.932	0.370	<0.001
Excerpt P5	-1.562	0.350	<0.001
Training	0.277	0.108	0.010
String ex.	1.409	0.399	<0.001

Table 3. Logistic regression results for Degree of coordination.

Coefficient	Estimate	Std. error	p
Excerpt P1	-0.285	0.319	0.370
Excerpt P2	-1.161	0.330	<0.001
Excerpt P3	-1.402	0.337	<0.001
Excerpt P4	-1.794	0.354	<0.001
Excerpt P5	-1.402	0.337	<0.001
Training	0.363	0.107	<0.001
String ex.	0.667	0.370	0.071

Table 4. Logistic regression results for Final assessment.

Coefficient	Estimate	Std. error	p
Excerpt P1	-0.568	0.309	0.066
Excerpt P2	-0.738	0.311	0.0177
Excerpt P3	-0.568	0.309	0.067
Excerpt P4	-1.314	0.325	<0.001
Excerpt P5	-0.964	0.315	0.002
Training	0.356	0.101	<0.001
String ex.	0.068	0.357	0.847

From the above results one can observe that the amount of musical training has a significant positive effect on the outcome; that is, subjects with higher amounts of musical training tend to be more accurate. Regarding experience with bowed string instruments, we could detect a significant positive effect only on the assessed performance quality; the small amount of subjects with string experience (8 out of 74) makes conclusive results difficult to achieve, and we believe that a more thorough investigation of the matter is called for.

Regarding the excerpt type, we can observe that excerpts P2, P4 and P5 seem to have the most significant effect on the subjects' ratings, at least for the final decision in Phase 2; for Phase 1 decisions, excerpts P2 to P5 all seem to significantly affect the subjects' ratings. We did not find any significant interaction between the coefficients, although the skewed distribution of some variables (such as experience with string instruments) makes interaction assessments difficult.

Finally, we wanted to compare the subjects' ratings with the estimated amount of interdependence in a music ensemble, as computed in terms of three aspects of the performance: Dynamics, Intonation, and Timbre (Papiotis et al, 2012; Papiotis et al, 2013). Continuous audio and bowing gesture features are extracted as descriptors of the performance; then, computational measures of interdependence are applied between pairs of these features in order to assess the degree to which the musicians influence each other's performance. For the five piece excerpts used in this study, we computed the amount of interdependence on both the ensemble as well as the solo recordings; we then calculate the difference between ensemble and solo interdependence for each of the three aspects of the performance (Dynamics, Intonation, Timbre). In the excerpts where higher interdependence was measured for the solo condition, we simply assign a value of zero.

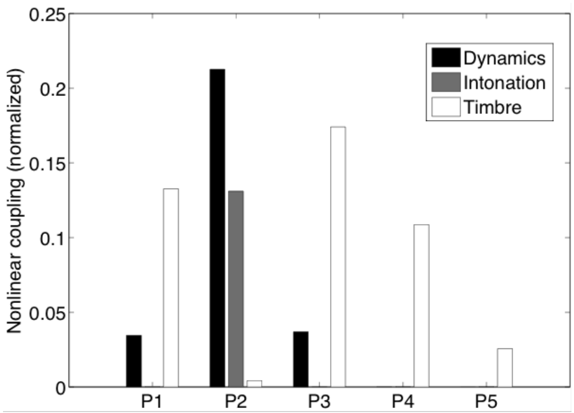

Figure 4. Estimated amount of interdependence for each excerpt, in terms of *Dynamics, Intonation* and *Timbre*.

As it can be seen in Figure 4, the findings are in agreement with the experiment results; the lowest amounts of interdependence are encountered in the P4 and P5 excerpts, while the highest amount of interdependence is encountered in the P2 excerpt (which was found to significantly affect the subjects' response through the logistic regression). On the other hand, overall interdependence values that are averaged across the duration of a recording cannot perfectly relate to human perception, where a short passage or small detail might be enough to make a judgement. This can be reflected in the listeners' ratings of excerpts P1 and P3 which demonstrate higher accuracy than excerpt P2 (whereas interdependence for excerpt P2 is overall higher than for excerpts P1 and P3).

4. Discussion

In this paper, we investigated the listeners' capability (or lack thereof) in discerning between real and artificially synchronized recordings which have the same degree of rhythmic synchronization. In general, our findings suggest that this is a difficult task that is significantly affected by the piece that is being performed and by the aspects of the performance it draws most focus on; however it is seen that synchronization, while of high importance, is not the only aspect of ensemble performance that is reflected through the acoustic result.

It has also been shown that musical training can improve the listeners' capabilities for correct discrimination between real and artificially synchronized performances.

Finally, although methods recently applied to quantifying musical interdependence in string quartets seem to be in agreement with the listeners' judgements, differences were observed for specific excerpts.

This has been an exploratory work, and there are many areas in which investigation can be improved and expanded. A more diverse selection of musical pieces as well as more participants with string performance experience should be included in further refinements of the experiment, while a more thorough analysis on computational methods of interdependence, score-level features, and their relation to the listeners' judgement should be attempted.

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SPECIFIC EMOTIONAL REACTIONS TO TONAL MUSIC – INDICATION OF THE ADAPTIVE CHARACTER OF TONALITY RECOGNITION

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Abstract

People report that specific emotional reactions accompany the perception of tonal relations during listening to tonal music. These reactions are not restricted only to people living in the Western culture. Different types of tonality which are observed in all musical cultures seem to evoke similarly strong emotional reactions. The emotional response to a tonal sound sequence has been predominantly explained by fulfilling or not the pitch-related expectations of listeners. However, although this model indicates the general mechanism of prediction as the main source of an emotional reaction, it does not explain why the musical pitch-related expectation causes a stronger emotional reaction than other sound stimuli such as speech. Thus, an adaptive character of a general mechanism of expectation cannot explain specific emotional reactions in response to tonal stimuli. Because a strong emotional reaction accompanying a specific behaviour is usually an indicator of the adaptive value of this behaviour, it is suggested that the ability of tonality recognition has to possess an adaptive character. This view is supported by the fact that tonal music is still the most popular music in the world, although atonal music has been intensively promoted for almost one hundred years. The origin of the ability to recognize tonal hierarchies could be related to the social character of tonal music performance observed among primitive cultures. A better memory for tonal than atonal sequences suggests additionally that the emergence of tonality could have been gradual and based on genetic assimilation.

Keywords: tonality, adaptation, expectation

1. Introduction

Tonality in a broad sense is an arrangement of pitches in which some pitches are more important than others (Snyder, 2001). This feature of music is one of the most salient elements which influence the impression of musical structure. In the case of tonality the structural function of pitches is realized thanks to difference between the emotional assessments of particular scale degrees. These emotions are usually described as the feelings of tension and relaxation or instability and stability (Meyer, 1956) and they depend solely on musical contexts (Krumhansl, 1990; Huron, 2006). The eliciting of tension and relaxation is explained as a result of common psychological principles of expectations (Krumhansl, 2002). More specifically, listeners' emotional reaction to tonal stimuli results from their successful or unsuccessful predictions based on implicitly learned statistical characteristics of pitch occurrence in music, which is specific to their culture (Huron, 2006).

However, it is difficult to explain these emotional reactions by referring to evolution. Because emotions are evolutionarily old mechanisms of evaluating the external world in terms of the potential adaptive or maladaptive value of stimuli (Panksepp & Biven, 2012), emotional reaction to sounds should reflect the assessment of environmental traits connected to these sounds. But, it seems that there is nothing adaptive in the musical contexts of pitch occurrence which could account for strong emotional reactions observed during listening to tonal music.

Moreover, there is also nothing functionally unchangeable in the extra musical context of tonal music performances which could explain stable emotional assessment of *tonic*. People listen to and perform tonal music in many circumstances and for various purposes, which may or may not be adaptive. Thus, it is extremely difficult to imagine that the Pawlovian conditioning could be responsible for stable emotional reactions to tonal characteristics.

One of the explanations of this problem suggests that specific emotional assessment of tonal features is a result of misattribution (Huron, 2006). According to Huron, the successful or unsuccessful predictions of stimuli generate emotional reactions as a result of the adaptive value of the general ability of prediction. The positive emotional assessment of *tonic* is incorrectly attributed to a particular pitch because our minds learned statistically to expect it and therefore associate a given positive emotion generated by successful prediction with melodic context specific to the appearance of *tonic*. Hence, all tonal predictions are possible thanks to statistically learned characteristics of pitch frequencies observed during our life-long experience of music.

However, because this explanation reduces the emotional assessment of tonal music to principles of general cognition, the same way of reasoning should be applied to predictions of all kinds of stimuli, e.g. pictures, spoken words or elements of other human sound expressions. In other words, according to Huron there is nothing unique about the emotional assessment of tonality. But feelings of tension and relaxation which accompany listening to tonal sound sequences, seem to be qualitatively unique. Insofar as the stronger emotional reaction to sounds in comparison to visual stimuli could be explained by the fact that auditory processing is probably evolutionarily older than visual processing (Panksepp & Biven, 2012, pp. 11-12), it still does not explain why the emotional reactions to well predicted speech or environmental sounds seem to be at best less impressive. Even in the perception of music, accurately predicted timbre does not elicit emotional reaction similar to well predicted pitch.

These observations provoke some important questions. What is the reason for which emotional reaction to pitch statistics differs from the reaction to timber statistics in music and speech perception? Why do children implicitly learn the rules of pitch organization instead of learning some principles of timber or dynamic orders in the same way? Why do people spontaneously organize music using 'pitch syntax' whereas they do not do that by means of 'timbre syntax'? The fact that the former was accidentally invented in the ancient times and has been cultivated from generation to generation through social learning does not seem convincing explanation.

It is suggested in the present paper that these questions can be answered only if it is assumed that the emotional assessment of tonality is an indispensable element of the adaptive human ability which enables perception of tonality. What is here meant as adaptiveness is, for example, that the feeling of relaxation which accompanies the appearance of *tonic* should be understood as a response to the communication of social consolidation rather than mere effect of the prediction of the most probable pitch.

2. The uniqueness of tonality

Tonality seems to be a strange phenomenon. Humans organize pitches in different frequencies and establish their importance depending on some rules. They start to learn them relatively early in childhood (Corrigall & Trainor, 2009) by means of implicit learning (Tillmann et al., 2000). This causes that any conscious knowledge is not needed to predict and comprehend tonal order. In this respect acquisition of tonality resembles the learning of mother tongue (Brandt et al., 2012), but as far as we know there is nothing structurally similar to tonality in any language (Patel, 2008). However, although implicit learning is not restricted only to development of inborn abilities (Reber et al., 1999), in the case of quick learning of a complex pattern of behaviour on the basis of poor input, one usually assumes some innate basis (Dor & Jablonka, 2001, p. 44). In this respect tonality undoubtedly resembles grammar of language.

Furthermore, the function of emotions in the implicit learning of tonality seems special. Emotions play an important role in this process not only because they motivate children to concentrate their perception on pitch order but also because affective response becomes an inherent part of every experience of tonality. An additional probable advantage of the tight connection between emotions and tonality is the extension of working memory for tonal pitch sequences. People remember tonal melodies better than the atonal ones (Schulze et al., 2012). Similarly the sequences of tonally ordered pitches are better remembered than vocabulary, digits and nonrepresentational figures (Steinke et al., 1997). The memory advantage of tonal sequences can probably be ascribed to the fact that emotions attract attention (Compton, 2003), which in consequence improves working memory (Kensinger & Corkin, 2003). This kind of 'implicit mnemonics' is comparable only to facilitating memory for words sequences by means of rhymes (e.g. assonances) in poetry.

Apart from that, tonality seems to be a universal trait of humanity. It is not only observed in all musical cultures but predominates within them (Bannan, 2012). In many cultures tonality is sustained by means of very popular technique of music composition which is known as *bourdon*. Its popularity and presence in many primitive cultures imply that tonality is one of crucial music features.

Surprisingly, although various musical cultures shape the tonal structure of their music in their own unique ways, people are able to make accurate cross-cultural tonal expectations (Castellano et al., 1984; Kessler et al., 1984; Eerola, 2004; Ambrazevičius & Wiśniewska, 2009; Eerola et al., 2009). This suggests that the ability to recognize tonal organization is sensitive not only to culturally specific tonal hierarchies, stored in long-term memory, but also to basic statistical distributions of tones observed in an individual piece of music written in an unknown style (Krumhansl & Cuddy, 2010). This ability probably influences also the way in which music is composed in every culture.

In fact, tonality is the only way of organizing pitches in music except for the Western twentieth-century's post-tonal music (Scruton, 1999). However, tonal music and atonal music differ significantly from the socio-behavioural perspective. Contrary to popularity of tonal music among almost all contemporary social groups, the popularity of atonal music is restricted to the comparatively small groups of academic elites and the avant-gardes fans (Dutton, 2009). This fact is especially notable if we realize that atonal music has almost a hundred-year old history and has been intensively promoted during the last century. Another reason of grater popularity of tonal music is fact that it is familiarized faster. This is because the structural understanding and emotional responses to the atonal music pieces are weaker than to tonal compositions (Daynes, 2011). All these observations imply that the ability to recognize the tonal order of pitches is a part of human nature.

3. The question of function

The suggested natural character of tonality imposes evolutionary explanation of its origin. Every evolutionary explanation demands pointing out an adaptive function of the evolved trait. Because tonality is a structural feature of music, it is necessary to indicate a relationship between tonal structure and its adaptive function. Even though many theoretical assumptions emphasize the structural specificity of tonality (Lerdahl & Jackendoff, 1983; Krumhansl, 1990; Krumhansl & Cuddy, 2010), they at the same time suggest that these structures are products of some mental capabilities used in other domains of human perception and cognition.

However, as far as there is a structural and behavioural similarity of an observable, unique and universal trait, it is reasonable to suppose that this results from some domain-specific inborn predisposition (Gazzaniga, 2008). This predisposition could be understood as a specific motivational mechanism which leads to the development of domain-specific ability or functionally connected abilities. Neither does it mean that this ability needs to work independently of abilities specific to other domains. The structurally complex phenomena (e.g. language) are usually a result of the activity of an interdependent set of different mental tools. What is however crucial for evolutionary explanation of the origin of a behavioural trait is its common functional characteristic which became an object of selection during evolution. While in the case of language grammar its most probable adaptive function is communication of particular constrained subset of linguistic meaning (Dor & Jablonka, 2001), the adaptive function of tonality remains unknown.

One of the clues which could help to resolve this puzzle is affective response to tonality. Information about the emotional state of communicating people is poorly transmitted by means of language vocabulary. It is rather a domain of acoustic features of suprasegmental organization of speech phonology which are not specific solely to language. These features – continuous variables such as modulation of tempo and dynamics, stress etc. – are present also in music (Scherer & Zenter, 2001). Moreover, as a part of so called expressive dynamics they seem to be understandable at least among some species of mammals (Merker, 2003). This interspecies recognition indicates that they are evolutionarily older than discrete communicative ingredients of speech and music such as phonemes and pitches.

But the emotional assessment of tonal sequences is opposite in nature. The feelings of tension and relaxation which accompany tonal recognition results from predictions which concern discrete elements – pitches. Hence, emotional communication in music was extended to include a new tool based on perception of structure. Unlike in language, discrete structural ingredients act in music as an additional tool designed to elicit emotions. However, there are some similarities between tonality and language grammar in respect to their inherent peculiarities. As in the case of linguistic grammar in which particular semantic categories determine some universal aspects of grammar (Dor, 2000), it seems that specific emotions correlate with some aspects of tonal organization. The feeling of relaxation which accompanies the recognition of *tonic* is irreplaceable with the feeling of tension. People are completely unaware both why some grammatical patterns are dependent on semantics (Dor & Jablonka, 2001, p. 38) and why some feelings are dependent on pitch order. In this respect the relationship between the semantic categorization and the grammatical rules is similar to the relationship between the emotional assessment and tonal organization. In the same way grammar in language cooperates with different structural features in order to transmit meanings, tonality in music is only one of many other tools eliciting emotions.

However, tonality does not seem to be a mere emotional meanings transmitter. Although emotional meanings are well communicated through facial expressions (Ekmann, 2007), body language, laughter (Provine, 2001), etc. every of them is designed to perform specific adaptive function. The same is perhaps true when we think about a variety of musical tools such as timbre, dynamics, keys, musical mimesis, musical symbolisation, etc. While many of these musical tools transmit emotional information by means of culture-specific associations (Juslin, 2001), a particular emotion elicited by tonality prediction is not arbitrarily chosen by culture. Thus, the stable connection between feeling of relaxation and *tonic* seems to reflect a specific important communicative function.

The feeling of relaxation usually accompanies situations in which people are safe and comfortable. Because music is mainly a social activity (Cross, 2011) it may be suspected that the function of tonality is to provide information about social acceptance and support. Such information is easily associated with feelings of relaxation. The feeling of uncertainty which accompanies the lack of knowledge about social acceptance once this knowledge is gained results in relaxation. This emotional underpinning of the exchange of mutual acceptance certainly facilitates group integration. Emotional assessment of tonality resembles this scheme. Tonal order is one of the features which enable communal singing. The implicit memory of *tonic* allows singers to intuitively orientate in pitch space. Tonal predictions belong also to important indications of musical closures. Both these elements facilitate integration among performers. Without sustained memory of *tonic*, the consolidating power of music would be definitely less impressive.

Of course, in different cultures both the presence of tonality in music and its elaboration vary drastically. Tonality is present in numerous religious chants without metro-rhythmical order. In the majority of cases tonal order is combined in culturally specific way with other expressive features such as rhythm, stress, dynamics etc. In the history of Western music tonal predictions became a foundation of functional harmony (Dahlhaus, 1968; Thomson, 1999). However, in spite of all these differences the primary emotional meaning of tonal relations remains unchanged.

4. The origin of tonality

The characteristics of tonality suggest that the genesis of the ability to recognize tonal order is connected to interaction between cultural and genetic evolution. As has been recently indicated, the evolution of the human mind is a result of complicated interactions between genetic and epigenetic information as well as the cultural environment (Jablonka & Lamb, 2005). Because the proposed adaptive integrative function of music is related to social life of our ancestors which was based at least on some cultural traditions it is reasonable to suppose that culture became a part of our selective environment.

On the one hand, musical stylistic traditions are transmitted over generations through social learning. Thus, it is easily imaginable that tonal organization of pitches in music could be one of such traditions similar to the invention of some Palaeolithic stone tools. Their appearance and gradual sophistication in our ancestral prehistory is explained solely by means of cultural evolution.

On the other hand, the ability to recognize tonal order is learned implicitly in childhood like language grammar. Additionally, children detect changes in music more easily when the melody contains repeated notes (Schellenberg & Trehub, 1999), which motivates them to develop the implicit knowledge about tonal hierarchies characteristic to their culture. Tonal melodies are better remembered and tonal music predominates in every human culture. The connection between feeling of relaxation and *tonic* as well as spontaneous tonal organization of music are invariant despite the diversity of other musical features. All these observations imply that the origin of tonality has some roots in genetic evolution.

It is however difficult to imagine how accidental mutation which was responsible for proclivity to perceive music in such peculiar way could have proliferated without previous existence of tonality in music. One of the possible solutions of this dilemma is the evolution of tonality recognition by means of genetic assimilation. The process of genetic assimilation, known also as the Baldwin effect (Weber & Depew, 2007), is a process in which natural selection transform learned response of organism into instinctive response (Dor & Jablonka, 2001, p.45). In the case of animals able to socially learn, some adaptive changes, as responses to new challenges, are first socially learned. Then, if the process of learning is strenuous and costly and if the selective pressure is long enough, accidentally emerged instinctive learning is preferred by natural selection (ibid.).

The Baldwinian scenario of tonality evolution starts with the cultural invention of the tonal organization of pitches. It is only a matter of speculation if there was a communal religious ritual or a kind of other group performances in which tonality appeared first. Hominines were able to invent tonal organization because they were endowed with the necessary mental abilities such as pitch categorization, relative pitch, the ability to grouping sound events in linear order. All these skills are observed in non-human listeners too (Trehub & Hannon, 2006), which leads to conclusion that our ancestors definitely used them in cultural contexts.

At this stage however hominines, unlike contemporary humans, had to learn the rules of tonal order by strenuous repetitions similar to the contemporary learning of writing. The emotional component of tonality started to play an important role in this process when tonality became tool of group consolidation. The social context of integrated group during communal singing elicited feeling of relaxation always when singers met together on tonic.

At some point in time, the differences in the speed of learning occurred among people. The accidental mutation predisposed one individual to learn faster than others. It was possible thanks to the instinctive coupling between emotional assessment, implicit knowledge of tonal hierarchy and working memory. Of course, in this scenario the fastest learners were adapted the most successfully, thus they started to dominate among the whole population. What was formerly achieved by means of many repetitions suddenly became an instinctive response to music stimuli.

5. Conclusion

The emotional specificity of music perception is hardly explainable solely by means of social learning. Also the understanding of musical skills and emotional assessment of music as a result of general-purpose mechanisms does not answer to the question why music is so ubiquitous tool applied to eliciting emotions. The proposition of the adaptive character of tonal recognition suggests that the specific emotional reactions to tonal pitch order are music-specific objects of musical communication. Of course, music is complex phenomenon which communicates emotions by means of many mechanisms. Tonality is only one of them. It is probable that also other abilities used in music perception have adaptive character. Another music-specific ability is the synchronisation to musical pulse. Although music is usually composed of both tonality and pulse, these features seem to be separate tools which could act alone.

What is the most important characteristic of tonality recognition is the emotional assessment of the segmental organisation of music. This seems to distinguish music from other forms of human sound communications.

Of course, the presented evolutionary scenario has speculative character. It is only one possible explanation of the potential process which could lead to the emancipation of tonality. Nevertheless, the ubiquity of such peculiar phenomenon as tonality implies that it has to be based on some inborn predisposition.

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MELODIC AND RHYTHMIC CONTRASTS IN EMOTIONAL SPEECH AND MUSIC

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Abstract

Many cues convey emotion similarly in speech and music. Researchers have established that acoustic cues such as pitch height, tempo, and intensity carry important emotional information in both domains. In this investigation, we examined the emotional significance of melodic and rhythmic contrasts between successive syllables or tones in speech and music, referred to as Melodic Interval Variability (MIV) and the normalized Pairwise Variability Index (nPVI). The spoken stimuli were 96 tokens expressing the emotions of irritation, fear, happiness, sadness, tenderness and no emotion. The music stimuli were 96 phrases, played with or without performance expression and composed with the intention of communicating similar emotions (anger, fear, happiness, sadness, tenderness and no emotion). The results showed that speech, but not music, was characterized by changes in MIV as a function of intended emotion. However, both speech and music, showed similar changes in nPVI. Emotional portrayals, both spoken and musical, had higher nPVI values than stimuli conveying "no emotion". The results suggest that MIV may function differently in speech and music, but that there may be similarities between the two domains with respect to nPVI.

Keywords: acoustic cues, prosody

1. Introduction

The communication of emotion in speech and music occurs through similar changes in acoustic cues such as intensity, tempo, timing and pitch (e.g., Juslin & Laukka). Both speakers and musicians change these cues to match the intended emotional signal. However, two broad sets of cues that have been difficult to compare in the domains of speech and music have been pitch and rhythmic patterns.

Pitch and timing form two very important aspects of music but do not appear to serve similar functions in speech. Pitch relationships are organized hierarchally in music. The perception and processing of pitch relations are central aspects of music cognition, including the sense key (e.g., Krumhansl, 1990). In speech, there are no similar analogues to the complex pitch relationships that are observed in music. Recent studies have tried to make comparisons. In music, the interval of a minor third may be associated with sadness and the interval of a major third may be associated with happiness. It has been observed that these same intervals may be mirrored in sad and happy speech prosody as signals of emotion (Bowling, Gill, Choi, Prinz, & Purves, 2010; Curtis & Bharucha, 2010). These studies suggest that there may be commonalities in the emotional expression of speech and music through pitch relationships. However, this work has been constrained by the use of a few intervals and does not extend to other pitch relationships.

A second important aspect of music is rhythm. Like pitch, rhythm is also organized hierarchally through meter. Changes in timing can act as a cue to emotion and are important in conveying musical interpretation and expressivity (Kendall & Carterette, 1990). In speech, rhythm may not serve this same function as there may not be an analogue to expressivity in speech. However, rhythmic differences have been observed between languages and linguists have attempted to quantify and compare these differences (Low, Grabe, & Nolan, 2000).

Two new cues have recently been developed to quantify pitch and rhythmic contrasts in music and speech. Melodic Interval Variability (MIV) and the normalized Pairwise Variability Index (nPVI) assess the degree of contrast between successive pitches or durations. A low MIV or low nPVI indicates that successive changes are relatively uniform as compared to a high MIV or nPVI value.

MIV is calculated as the coefficient of variation (CV) of interval size (CV = SD/M). This requires determining the average interval size between successive tones or syllables and the standard deviation associated with these intervals. NPVI is calculated as the absolute value of the duration of a tone or syllable subtracted from the duration of the subsequent tone or syllable. This value is then divided by the average duration of these two values combined. The sum of these values is then multiplied by 100, divided by the number of elements (syllables or tones) less one.

$$\mathrm{nPVI} = \frac{100}{m-1} \times \sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{\frac{d_k + d_{k+1}}{2}} \right| ,$$

These variables were initially used to assess pitch and rhythmic changes in speech. However, Patel, Iverson and Rosenberg (2006) have extended the use of these variables to compare changes in the music and speech of composers whose native languages differed. Patel et al. found that French speech has lower MIV and nPVI values than English speech and that music written by French composers has lower MIV and nPVI values than music written by English composers. This suggests melodic and rhythmic patterns found in speech are reflected in music.

In this study, we sought to determine whether MIV and nPVI would show a similar pattern of changes in *emotional* music and speech. Previous studies have shown that other cues change similarly in emotional speech and music, such as intensity, tempo, and articulation. The work of Patel et al. (2006) showed that MIV and nPVI change similarly in music and speech of different languages. Therefore, it might be possible that MIV and nPVI can also carry emotional information in both domains. Importantly, this could provide a novel way of comparing complex pitch and rhythmic cues that may communicate emotion.

2. Method

Spoken stimuli - Six male and seven female speakers provided samples of emotional speech. Speakers said seven different semantically neutral phrases, such as "The broom is in the cupboard and the lamp is on the table" with the intention of expressing the emotions of irritation, fear, happiness, sadness, tenderness and no expression.

Thirty-five first year university students judged the emotion that they believed was being conveyed. This allowed us to reduce the large number of stimuli down to the 96 most clearly decoded stimuli, balanced for speaker sex.

Music stimuli – 8 musicians (4 violinists and 4 vocalists) composed music expressing the same emotions as the speakers, with the exception that irritation (mild emotion) was replaced with anger (strong emotion). The compositions were limited to 7-9 notes in length. Musicians were recorded performing these stimuli. The stimuli were also digitally recorded on MIDI with the timbres of violin or voice. This removed performance expression or deviations introduced by the musician in pitch and timing. The MIDI version instead retained the relative pitch and timing changes indicated by the musicians through notation.

Acoustic analysis – Each syllable and every tone in the sentence and musical phrase was indicated with text grids (Praat, 2010). The text grids annotated the start and end time of each tone and allowed us to calculate the average pitch for each tone or syllable. Highly unstable pitches (glides) were ignored. MIV was calculated by first finding the musical interval dis-

Table 1: Shown are the mean MIV and nPVI values for each of the six emotions. Standard errors are shown in parentheses.

	Emotion					
	Irritation	*Fear*	*Happiness*	*Sadness*	*Tenderness*	*No emotion*
MIV speech	*86.25 (6.16)*	*76.22 (5.94)*	*63.63 (6.29)*	*97.07 (5.82)*	*84.52 (6.13)*	*83.82 (5.77)*
Interval Size Speech	*2.42 (0.12)*	*1.64 (0.15)*	*4.46 (0.29)*	*2.37 (0.46)*	*2.98 (0.32)*	*2.06 (0.52)*
MIV music	*74.49 (5.96)*	*71.32 (9.06)*	*74.52 (7.63)*	*67.58 (3.47)*	*63.57 (5.35)*	*66.38 (6.63)*
nPVI speech	*59.05 (2.04)*	*52.55 (1.97)*	*53.45 (2.09)*	*58.65 (1.93)*	*63.04 (2.03)*	*51.98 (1.91)*
nPVI music	*56.22 (6.61)*	*46.39 (6.28)*	*52.01 (3.72)*	*56.59 (3.91)*	*46.44 (4.56)*	*31.19 (4.59)*

tance *in semiton*es between successive syllables or tones. The mean interval distance and standard deviation was calculated for each phrase. The CV or MIV for each phrase was obtained by dividing the standard deviation by the mean interval distance. See Quinto, Thompson, Taylor (in press) and Thompson, Marin, Stewart (2012) for more details of the music and speech stimuli respectively.

3. Results

The data were treated separately for each domain (speech and music) and each dependent variable (MIV and nPVI). The spoken stimuli were subjected to a mixed linear effects model with speaker, sentence and emotion as fixed factors. Speaker and sentence were entered as factors because they were a source of variability. The musical stimuli were also subjected to a mixed linear effects model but with emotion, musician and mode of presentation as fixed factors. All the melodies varied with each musician.

Speech stimuli – The mixed linear effects model with emotion, sentence and speaker as fixed factors and MIV as the dependent variable, revealed a significant effect of emotion, $F(5,74) = 3.594$, $p = .006$. As Table 1 shows, the mean MIV for happiness was lower than for all the other emotions. This suggests that happiness was conveyed with the most consistent changes in pitch whereas the emotion of sadness had the least consistent changes in pitch. The main effect of sentence $F(6,74) = 1.211$, $p = .310$, and of speaker were not significant, $F(10,74) = 0.808$, $p = .621$.

The average interval size for each emotion was compared to MIV. The mixed linear effects model showed a main effect of emotion, $F(5,74) = 8.731$, $p < 0.001$. The emotions of fear and no emotional expression were associated with lower average interval size than the emotions of happiness and tenderness. This demonstrates that MIV and average interval size provide unique pitch based information. For average interval size, there was also a main effect of speaker, $F(10,74) = 2.834$, $p = 0.005$, demonstrating that individuals differed in the extent to which they varied the average interval size. There was no significant effect of sentence.

The mixed linear effects model with emotion, sentence and speaker as fixed factors and nPVI as the dependent variable, revealed a significant main effect of emotion, $F(5,74) = 4.178$, $p = 0.001$. As Table 1 shows, the mean nPVI for "no emotion" expressions was significantly lower as compared to all the other emotions. There was also a main effect of speaker, $F(10,74) = 3.337$, $p = 0.001$, demonstrating that different individuals used varying levels of durational contrasts in their speech. Across speakers, the average range of nPVI values varied from 48.67 to 60.95. There was also a main effect of sentence, $F(6,74) = 31.016$, $p < 0.001$ demonstrating that different sentences strongly influenced the durational contrasts that speakers used. The average nPVI for these sentences was 55.52, SD = 12.14 (range = 44.76 – 69.88). Unfortunately, interactions between these variables could not be tested because these factors were not fully crossed.

Music stimuli - The mixed linear effects model with emotion, musician and mode of presentation as fixed factors and MIV as the dependent variable, revealed no significant effect of emotion, $F(5,74) = 0.634$, $p = .675$. While not significant, there does appear to be a weak trend showing that higher arousal emotions such as anger, fear and happiness had higher MIV values than low arousal emotions such as sadness and tenderness. At this point it is speculation, but it might be possible that in music, but not speech, MIV is associated with arousal. There was a significant main effect of musician, $F(7,74) = 5.454$, $p < .001$. This finding suggests that while musicians did not use MIV as a cue to emotion, there were differences in the consistency of pitch changes in the in musicians' compositions. Some musicians had greater changes in MIV than others. This ranged from average MIV values of 42.68 to 91.93 (M = 69.42, SD = 25.99). There was no significant effect of mode of presentation, $F(1,74) = 0.151$, $p = 0.698$. This is not surprising given that the same pitch information was used in both conditions.

The mixed linear effects model with emotion, musician and mode of presentation as fixed factors and nPVI as the dependent variable, revealed a significant effect of emotion, $F(5,74) = 4.24$, $p = .002$. As table 1 shows, "no emotion" expressions were associated with considerably lower nPVI values than the emotional expressions. This mirrors the finding observed for the speech stimuli. There was also a significant main effect of musician, $F(7,74) = 2.61$, $p = .017$. This finding suggests that there was considerable variability in how musicians used nPVI. The average nPVI values for musicians ranged from 36.82 to 59.20 (M = 48.14, SD = 21.54). The main effect of condition was also significant, $F(1,74) = 9.90$, $p = .002$. The mean nPVI was significantly higher in the live condition (M = 54.03, SD = 22.48) than in the deadpan condition (M = 42.26, SD = 19.03). Musicians introduced increased rhythmic contrasts when they were performing their own pieces relative to the notated durations. This suggests that nPVI might be associated with the expressiveness that is introduced by performers.

4. Discussion

The results of this study suggest that MIV may contribute to emotional communication in speech but not in music. The results also suggest that nPVI may act to differentiate emotional from non-emotional stimuli in both speech and music. Finally, our findings show that there is a high degree of variation in the use of both these cues by musicians and speakers. This last finding highlights the need to test multiple speakers and musicians.

MIV appeared to change with emotional intentions in speech but not in music. In speech, low MIV was associated with happiness and high MIV was associated with sadness. When communicating happiness, speakers alternated between more similar intervals than when expressing other emotions. The consistent and large interval changes may signal a greater amount of physiological control over the pitches that are produced. It is possible that such cues may be used to differentiate emotions that are otherwise similar with respect to pitch cues like interval size.

In music, MIV did not appear to signal emotions. One potential reason for this difference between music and speech is that the expression of emotion in music might be independent of consistency in pitch changes and guided by constraints in pitch relationships. Important pitch based cues may include mode (Hevner, 1935) which may function independently of MIV. It seems that musicians were able to write music expressing various emotions without necessarily showing similarities in the use of MIV in between emotions. Since there were differences in MIV values between musicians, this also suggests that there were other factors that influenced the manner in which they communicated the same emotions which were independent of MIV.

The findings for nPVI suggest that this cue could be important in differentiating emotional from non-emotional stimuli. Changing stimuli may encourage perceivers to attend to information whereas information that does not change might encourage habituation (Jones & Macken, 1993). By its vary nature, emotion acts to signal information to others. In this way, the rhythmic contrasts associated with nPVI in emotional stimuli may attempt to engage the listener.

In studies that have examined expressiveness and emotional communication through performance expression, a common finding is that the duration of sounded notes is lengthened or shortened relative to the notated values (Gabrielsson & Juslin; 1996; Thompson, Sundberg, Friberg & Frydén, 1989). That is, performers may not play tones evenly or exactly with the duration that has been indicated in the score. NPVI may be used as a measure to quantify these durational deviations and contrasts between tones.

Future studies may assess the perception of MIV and nPVI. Listeners can differentiate high and low nPVI (Hannon, 2009) but not much more is known. The extent to which listeners use these cues in differentiating emotional speech and non-emotional stimuli is not clear. For example, does low MIV in speech *signal* happiness to listeners? Does this occur in other languages?

Our work provides some evidence that MIV and nPVI may be involved in emotional decoding. It is possible that MIV can assist in emotional decoding in speech. NPVI appears to be a promising new cue to differentiate emotional versus non-emotional stimuli in both speech and music. NPVI may also be used to quantify the rhythmic changes that are associated with expressive performances.

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MUSIC PERFORMANCE ANXIETY: USE OF COPING STRATEGIES BY TERTIARY FLUTE PLAYERS

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Abstract

This article presents part of a master´s degree research, which focused on investigating causes, symptoms, and strategies used by tertiary flute players to cope with music performance anxiety in the performance of an unaccompanied flute work in recital of evaluative character. However, it will present only the results on strategies of twelve flute students from three music colleges in Brazil to cope with music performance anxiety. Seven of participants were male, and five were female. The procedures of collection and analyses of data occurred as in the study by Siw Nielsen (1999), that is, through the behavioral observation of the participants in the recital, and verbal reports by semi-structured interview. Both procedures were recorded in audio and video. The data were analyzed in four steps, the first and fourth quantitatively, and the others qualitatively. The first step aimed to determine the profile of the participants of this research, and at the ending of crossing of the data the total number of causes, symptoms, and coping strategies. The other steps sought to identify causes, symptoms, and coping strategies through the behavioral observation, and verbal reports analyses. Finally, we performed the crossing of the data for comparison between the two data analyses, and arrived at conclusions about some coping strategies. Thus, the positive self-talk was reported as the main strategy used by tertiary flute players to cope with music performance anxiety in this study.

Keywords: music performance anxiety, coping strategies, self-talk, tertiary flute players

1. Introduction

To be a professional, student, or amateur musician, it is necessary to learn to deal with a gamut of emotions, mainly when the activity is directly related to performance. Among emotions, there are those ones in which the performer has the intention of communicating with his/her audience through the music, and some emotions that can influence the musician in his/her music-making. In the second case, during the process of practicing of the repertoire for a concert, musicians can be confronted not only with the technical-interpretation difficulties that need to be learned and overcome, but also with social cultural contexts and deadlines that they are always submitted to, among other elements. Furthermore, there are expectations and desires generated by the performer and by the audience, what can drive the musician to state anxiety. Thus, Salmon (1990) states that the occupational stress inherent in the music profession provides a sensitizing backdrop against which individuals experience the physiological, behavioral and cognitive symptoms that typically accompany anxiety (Salmon, 1990 in Kenny *et al.*, 2003, p. 579).

In musical performance, anxiety is an emotion that can restrict or impair the performance through its different causes, and symptoms mainly in individuals that do not use to experience this process as in the case of music students. From this evidence, questions arose, such as: How could the tertiary flute players cope with music performance anxiety in the performance of an unaccompanied flute work in a recital of evaluate character? What strategies would the tertiary flute players use to cope with music performance anxiety?

2. Literature Review

The study of the relationship between stimulus (stress) and performance was initially observed by the psychologists Robert M. Yerkes and John Dillingham Dodson. It was represented by the Yerkes-Dodson´s Law (1908), which relates the increase of the performance quality to the physiological and/or psychological stimulus (stress) in different tasks from the simpler to more complex ones. In tasks that are considered simpler, the level of performance can be higher, while in the more complex tasks, the level can be the opposite, if it is compared to a simpler task. The **Figure 1** refers to a more complex task that is represented by blue dotted line, and it is known as inverted-U curve.

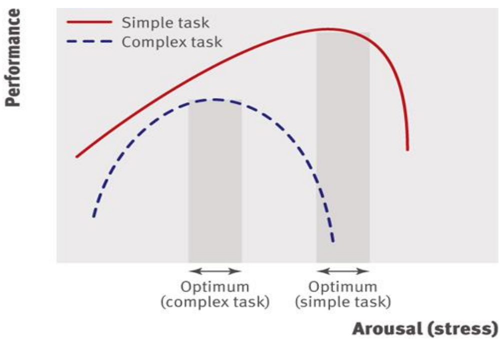

Figure 1. The graphic of Yerkes-Dodson´s Law (1908) presents the inverted-U curve in blue dotted line, the X-axis refers to stimulus (stress), and the Y-axis to performance.

Yerkes and Dodson concluded that the performance reaches its highest level when the stimulus has moderate levels, and when the level of stimulation becomes very high, the level of performance tends to decrease appreciably. Stimuli (stress) in too low or too high levels tend to impair the level of performance. Steptoe (1983 in Valentine, 2004) confirmed this pattern graphic inverted-U curve in music performance while studying singers (students and professionals), and to request evaluation of emotional tension and quality of performance in different situations. The performance has reached its highest peaks in an intermediate level of tension, and after it has decreased. In simpler tasks the level of performance tends to be higher - as demonstrated by the red line in the graphic above - and after reaching this level, the anxiety level goes down significantly.

According to Andrade and Gorenstein (1998), anxiety is an emotional state with psychological and physiological components that are part of the normal spectrum of human experiences, and driving performances. However, anxiety can be both positive and negative, and it can influence the musical performance through its causes and symptoms.

However, Barlow (2000) has also defined anxiety as:

> a unique and coherent cognitive-affective structure within our defensive motivational system. At the heart of this structure is a sense of uncontrollability focused on future threats, danger, or other potentially negative events (Barlow, 2000 in Kenny, 2011, p. 22).

According to Kenny (2011), the anxiety in musical performance may be a defense against experiencing or re-experiencing overwhelmingly painful affect or a fear of the possibility of facing an intolerable future threat, i.e., shame or humiliation following an impaired performance (Kenny, 2011, p. 23). For Cordioli and Manfro (2004), anxiety becomes pathological when it becomes an uncomfortable and unpleasant emotion that arises without external stimulus to explain it, i.e. when the intensity, duration and frequency increase and are associated with social or professional loss (Cordioli & Manfro, 2004 in Jarros, 2011, p. 20).

2.1. Causes of Music Performance Anxiety

According to Valentine (2002, p. 172), three factors contribute to anxiety in musical performance: the person, the task and the situation. The person refers to all aspects of the personality of each individual who may exercise any influence on the behavior, i.e., introversion, extroversion, independence, dependency, trait of perfectionism, sensitivity, anxiety, among others. It is individual and expresses habitual predisposition of the person to react to the environment in which it operates. The level of anxiety on performance is proportional to the task, i.e., the more difficult task, the greater anxiety (Sinico *et al*., 2012, p. 939). The musical interpreter, when confronted with a task considered "difficult", according to your current technical - interpretative level, and it can add psychological and cognitive factors that may make it more difficult to perform the task. Some musical factors that can influence the presentation and realization of the task: the repertoire, the sight-reading, the quality of study and rehearsal, the musical expression and memorization.

Even as the person and the task, the anxiety may be caused by the situation, and it is individual and can vary from person to person. Among the causes that generate anxiety in performance, there are certain situations that are relatively stressful for performers, regardless of their individual susceptibilities (Wilson, 1999, p. 231).

These situations were also noted and compared by Hamann (1982) antagonistically: the solo performance versus ensemble, the recital versus the individual practice, the competition versus the presentation for pleasure, the performance of difficult or ill-prepared works versus those that are easy, family or well-learned (Hamann, 1982 in Wilson 1999, p. 232) and we can infer that the first situation of each group can generate more anxiety than the second situation, letting the performer more exposed. Finally, individual or collective action of the mentioned factors can trigger anxiety musician in the preparation and during the musical presentation.

2.2. Symptoms of Anxiety

According to Valentine (2004) symptoms can be classified into three types: physiological, behavioral and mental (Valentine, 2004, p. 168). For Lehmann *et al.* (2007, p. 149), physiological symptoms, and cognitive behavior are interrelated and occur simultaneously during the preparation and performance of a musical work.

For Marshall (2008), physical/physiological symptoms of anxiety experienced during the performance are similar to those experienced in any stressful situation (Marshall, 2008, p. 9). Among the physiological symptoms in response to the excessive excitation of automatic nervous system are nervousness, headache, increased heart rate, palpitations, shortness of breath, hyperventilation, dry mouth, sweating, nausea, diarrhea and dizziness. Valentine (2004) comments that the behavioral symptoms may take the form of signs of anxiety such as shaking, trembling, stiffness, dead-pan expression, or impairment of the performance itself (Valentine, 2004, p.168-169). Steptoe (2001) adds other signs such as the difficulty in maintaining posture, natural movement and technical failures (Steptoe, 2001, p. 295). These symptoms can exude clear signals to the audience that the performer is nervous or actually impair the performance itself (Williamon, 2004, p. 11). Mental symptoms can be classified into cognitive and emotional. Cognitive symptoms consist of loss of concentration, distraction, memory failure, inadequate cognition, incorrect interpretation of the score, among others (Steptoe, 2001, p. 295). Negative thinking, according to Williamon (2004), is often associated with overidentification of self-esteem and self-worth with performance success (Williamon, 2004, p. 11). Emotional symptoms arise from feelings of anxiety, tension, apprehension, dread or panic, which form the core experience of anxiety for many musicians (Steptoe, 2001, p. 295).

2.3. Coping Strategies for Music Performance Anxiety

According to Weinstein and Mayer (1986), learning strategies are:

> Behaviors and thoughts that a learner engages in during learning and that are intended to influence the learner's encoding process. Thus, the goal of any learning strategy may be to affect the learner's motivational or affective state, or the way in which

the learner selects, acquires, organizes, or integrates new knowledge (Weinstein & Mayer, 1986, p. 315).

Jørgensen comments that strategies are usually consciously applied by the musician but may become automatic with repetition. The author maintains that every practitioner – from the student to the professional musician - must have a thorough knowledge of his or her repertoire of strategies and must be able to control, regulate, and exploit this repertoire (Jørgensen, 2004, p. 87).

For Nielsen (1999), a strategy involves thought and behavior likewise. The author states that it is not just a `pure' cognitive information process, but consists also of different forms of action directed towards learning material (Nielsen, 1999, p. 276). From definition of learning strategies of Weinstein and Mayer, Nielsen defined two 'objects' that learning strategies intend to influence: (a) the learner's motivational or affective state, and (b) the way the learner selects, acquires, organizes, or integrates new knowledge (Nielsen, 1999, p. 276). Similarly, Dansereau (1985) defined strategies intended to operate to the same two 'objects' as: primary and support strategies. Support strategies are used to maintain a suitable state of mind, which consist in maintaining concentration, mastering anxiety, establishing motivation and securing the efficient use of time (Dansereau, 1985 in Nielsen, 1999, p. 277).

According to Papageorgi *et al.* (2007, p. 90), strategies that musicians used to cope with anxiety may be important in how successful they are at controlling physiological arousal and alleviating the potential maladaptive effects of anxiety. Papageorgi (2007 in Papageorgi *et al.*, 2007, p. 90) commented that research has indicated that students experiencing adaptive music performance anxiety use a combination of coping strategies focusing on adequate preparation maintain a positive attitude to the performance concentrating on communication with the audience and enjoyment of the music. Therefore, this article focuses only on support strategies, which can be divided into cognitive, behavioral, cognitive-behavioral, self-help, and other strategies to cope with music performance anxiety.

2.3.1. Cognitive Strategies

Cognitive strategies are supported by cognitive psychotherapy branching itself in other three ones: stress inoculation, positive self-talk, and the use of imagery (Kenny, 2011, p. 186). These strategies will be presented synthetically below.

The principal focus of cognitive therapy is identifying examining, and modifying maladaptive thinking styles through the process of teaching new skills such as rational responding, objective self monitoring, formulating and testing personal hypotheses, behavioral self-management, and problem solving (Newman & Beck, 2010 in Kenny, 2011, p. 183). According to Kenny (2005, p. 185), cognitive therapy is more concerned with changing faulty thinking patterns that give rise to maladaptive behaviors, such as excessive muscle tension, avoidance of the feared situation, or impaired performance . A particular manner of cognitive restructuration may be included in the therapeutic programs what is called by stress inoculation (Meinchenbaum, 1985 in Wilson 1999, p. 241). Stress inoculation aims to replace the negative thoughts that possibly will be part of a given situation by positive ones, which will anticipate the anxiety symptoms. Thoughts are constantly and rarely noticed, but they are powerful enough to create the most intense emotions. The internal dialogue has been called 'self-talk' by rational emotive therapist Albert Ellis, and 'automatic thoughts' by cognitive theorist Aaron Beck (Dunkel & Dunkel, 1989, p. 87). For Kenny (2011), self-talk is a related strategy in which the performer focuses on his/her internal dialogue to identify negative self-statements, and substitution these with more realistic, positive self-statements (Kenny, 2011, p. 186). After self-talk, there is the use of imagery that according to Salmon (1991), in the cognitive domain, the performer may reinterpret autonomic arousal as normal, performances-enhancing excitement rather than as a signal for an impending performance disaster (Salmon, 1991 in Kenny, 2011, p. 186). In the behavioral domain, the performer may be asked to visualize an anxiety-provoking performance situation such as an audition and rehearse in imagination, confronting the situation adaptively (Kenny, 2011, p. 186).

2.3.2. Behavioral Strategies

Behavioral strategies are supported by behavioral psychotherapy, and its strategies that are used in studies as: systematic desensitization, progressive muscle relaxation, and counter conditioning (Kenny, 2011, 181). Behavior therapy refers to the techniques based on classical conditioning, devised by Wolpe (1958) and Eysenck (1960) to treat anxiety. In current practice, the terms 'behavior therapy', 'behavior change programs', and behavior modification' are used interchangeably to denote therapeutic programs based on the principles of learning theory (Kenny, 2011, p. 179-180). Behavioral therapies focus primarily on changing the dysfunctional behaviors that arise when people feel anxious. Wilson (1999, p. 239) explained one of the techniques used to in behavioral therapy is the systematic desensitization, which emphasizes the need for gradual exposure to the object of fear while maintaining a relaxed state. Through relaxation techniques musicians learn to recognize the feelings of deep relaxation, a sense of weight, loss of muscle tension and calm, then trying to recreate those feelings in stressful situations. The relaxation exercises are usually done gradually with the musician to relax through the muscle groups, until the whole body is relaxed, and are simple ways to achieve a state of relaxation. Slow and deep breathing is associated with sleep and the body begins to relax (Meharg, 1988). Breathing is also considered a strategy of self-help, which may be associated with the practice of yoga or even the breathing exercises designed to woodwind and brass players in general that aims to work capacity and control of air emissions.

2.3.3. Cognitive-Behavioral Strategy

The cognitive-behavioral strategy consists of cognitive-behavioral psychotherapy, which comprises the strategies used by both cognitive and behavioral psychotherapies. The most cognitive-behavioral therapies interventions have four major components. There are: (i) exposure to thoughts, objects, situations, and bodily sensations that are not dangerous but are feared, avoided, or endured with great distress; (ii) training in basic stress-management techniques; (iii) application and training in cognitive therapy techniques; (iv) training in specific skills that constitute areas of specific individual concern or weakness (Sadock, Sadock, & Ruiz, 2009 in Kenny, 2011, p. 187).

2.3.4. Self-Help Strategies

According to Kenny (2011, p. 278), the self-help strategies consist of meditation, breathing exercises, physical exercises, yoga, among others. Thus, we need to understand what constitutes synthetically each of these strategies. Meditation is a disciplined practice that cultivates concentration and mindfulness. The purpose of meditation is to learn to experience life fully as it unfolds – moment by moment. Through the practice of meditation, one can develop greater calmness, clarity and insight in facing life's experiences and in turning them into occasions for learning, and thus deepening one's wisdom (Kabat-Zinn & Santorelli, 1999 in Lin *et al.*, 2007, p. 140). According to Stencel *et al.* (2012, p. 40), studies on the influence of staying in good physical condition and with healthy habits and preparation for performance has been little discussed. Greco & Ray (2004 in RAY, 2009, p. 169) conducted a thorough study and found that "the singers and wind instrumentalists musicians are more concerned with the effects of food on their performance on stage", but only on the eve of performance and not in acquiring healthy eating habits.

2.3.5. Other Strategies

Among other strategies to cope with music performance anxiety are Alexander technique, biofeedback, hypnotherapy, besides pharmacotherapy, that is, anxiolytics drugs that operate in the emotional center of the brain in reducing the acquisition and expression of the conditioned emotional responses (Wilson, 1999, 238). Alexander technique is a method that aims to increase body awareness through movement reeducation. The body reeducation and movements are encouraged through exercises that seek to correct body posture and the correct positioning of the head relative to the trunk as well as the observation of muscle work aiming to accomplish daily tasks with the least possible effort. Although the technique has not been developed with the aim of directly reducing anxiety in musical performance, researchers attest to its effectiveness in controlling heart rate, strengthening a positive attitude on performance and level of reported anxiety in musicians (Valentine, 2004 in Lehmann *et al.*, 2007, p. 150-151). The treatment is accomplished via biofeedback through of the using monitoring devices with visual displays, musicians are made aware of the physiological responses their bodies are exhibiting (e.g., accelerated heart rate, higher skin temperature, increased tension in muscles). When they successfully employ relaxation techniques and other coping strategies, they have the benefit of seeing the positive results in physiological measures (Lehmann *et al.*, 2007, p. 150).

Hypnotherapy seeks to suggest emotional states desirable to the patient. It is a kind of psychotherapy that facilitates suggestion, reeducation and analyses personnel seeking details of past situations (memory regression) that could explain their emotional difficulties and / or social at the moment. And, beta blockers are drugs that act on the body's physiological control, reducing the action of adrenaline in the bloodstream. It has been used by professional musicians, often without medical supervision, to control anxiety in musical performance.

It is important to highlight that all strategies has been presented above are available to the musician to cope with music performance anxiety. The using of strategies combined with specific treatments may reduce the negative effects of anxiety. On the other hand, it is important to emphasize that moderate rates of anxiety also have beneficial effects on music performance, making the performance more vivid, true and real.

It is accountability of the aware interpreter your personal process and based in your daily practice to find mechanisms that may assist in your physical, behavioral, cognitive and emotional balance.

3. Method

This study has a qualitative approach, primarily by enhancing the description and interpretation of data, and the subjectivity of the individuals, that is, both the researcher and the participant of the investigation. In order to facilitate the categorization the sample, demographic data of the participants were treated by descriptive statistic, aiming the description of investigated population. A convenience sampling of non-probabilistic nature was used for this study, which participants were selected based on their presumed similarity with the useful population and in its availability (Rea & Parker, 2002, p. 150). Some parameters were outlined for this research as participants, task and situation of music performance, and the procedures of collection and analyses data. These parameters will be described below.

3.1. Participants

All participants were flute players enrolled in Bachelor of Music – Flute Performance from three music colleges in Brazil. In total, 12 flute players participated integrally in the study, 5 from State University of Minas Gerais, 5 from Faculdade Cantareira, and 2 from Federal University of Pelotas. Moreover, three flute players had only participated in the first stage of collection data, and then they abandoned the research. From twelve participants, 7 were males and 5 were females. However, it is important to note that results of this research will not be treated on the basis of gender. Other demographic data that contributed to determine the profile of the participants were average of age, years of flute practice, and the semester they were attending at that moment. The average age of the participants was approximately 23 years old, and the youngest student reported to be 18; and the oldest, 34.

The average years of flute practice was about 8 years among participants. These same flute players were attending different semesters in the music colleges which ranging between the first and seventh semester.

3.2. Task and Situation of Music Performance

In order to investigate only, and exclusively the tertiary flute players in their musical performance, the researcher asked the professors of flute from the music colleges to guide their respective students in the choice of a work from unaccompanied flute repertoire. It should be realized according to the evaluation of professor on the technical-interpretative difficulties of each flute players. After the choice, each participant should prepare the unaccompanied flute work, that is, solve the technical-interpretative difficulties during the semester with your professor of flute. Meanwhile, three participants chose an unaccompanied flute work that had been studied by them before, and its study was retaken in the semester in which the collection data occurred.

The construction of music performance situation for this research was supported on some situations pointed by Hamman that according to the author, can allow the susceptibility of the performer to the action of music performance anxiety. At the same time, we also opted for a situation that is very familiar to music students, thus the recital was chosen as more adequate situation for the research. However, other characteristics were added to it as evaluative, and the presence of an audience that comprised the researcher, professor of flute, and other flute students.

3.3. Procedures of Collection and Analyses Data

The procedures of collection and analyses of data occurred as in the study by Siw Nielsen (1999), that is, through the behavioral observation of the participants, and verbal reports. Thus, the first stage refers to the recital, and the second one to the semi-structured interview. The recital was realized according to the characteristics mentioned above, that is, the performance of an unaccompanied flute work that was chosen and studied by the participant in a recital of evaluative character. In the second stage, the semi-structured interview was used for the collection data of verbal reports of the participants after the recital. An itinerary was developed for the semi-structured interview, and it was thought as a support tool for the researcher. Its aim was to solicit the comment of the participants about some topics found in the literature review. The participants were interviewed individually in a room offered by the professors of flute. But the sequence of the interviews was not the same in the recital. At the end of the semi-structured interview, the researcher solicited the participants to the reading and signing of the Statement of Free and Informed Consent. Both stages were recorded in audio and video. First, because it allowed a posterior observation of the behavior of the participants by the researcher in order to dialogue to the data obtained in the second stage. Secondly, it refers to the existence of a visual and corporal language during the interview beyond the emotions and subjectivities between the researcher and the interviewee. The collection data were realized in three dates and different locations. The dates were defined with the professors of flute according to the calendar of the music colleges.

The analyses data occurred in three stages. First the observational analyses of the behavior of the participants in the recital. Secondly, the analyses of verbal reports from the semi-structured interview. Finally, the crossing of data.

The observational analyses were realized in two different moments. First, when the researcher was present in the recital to watch and record it in audio and video, and secondly when the researcher watched the recordings, allowing at least two observational analyses of behavior of the participants. The first analyses contributed to drive some questions during the semi-structured interview from notes of the behavior of the participants in the recital. Therefore, the researcher was responsible for observing and reporting the behavior of the flute players, and the sounding results through the perception and his evaluation. From that, the researcher was able to make hypotheses through analyses observational for symptoms that each participant had experienced in their musical performance, which would be confirmed by the analyses of verbal reports.

In the analyses of semi-structured interview, the researcher sought to identify causes, and symptoms of anxiety reported by the participants. After that, the researcher sought to identify the strategies used by tertiary flute players to cope with music performance anxiety. The structure of the analyses of verbal reports was composed by the presentation of analyses data followed by excerpts of semi-structured interview of the participants.

The crossing of the data consisted of the comparison of data obtained in the observational analyses of the behavior of the participants in the recital and the analyses of the verbal reports of the semi-structured interview. Thus, the hypotheses made by the researcher in the observational analyses were confirmed or not by the reports of the tertiary flute players.

4. Results

Twelve tertiary flute players reported in total eighteen strategies to cope with music performance anxiety. From larger to minor, the following strategies were reported: the positive self-talk that was used by seven participants, breathing exercises by five tertiary flute players. Relaxation and individual study of the flute were reported by four of them, while the concentration was reported by only three participants as a strategy to cope with music performance anxiety. Furthermore, drink water, and the focus on the musical text were strategies used by two tertiary flute players in this research. Finally, some strategies were reported by each participant: physical exercises, body awareness exercises, choice of repertoire, meditation, use of imagery, low level of concern, submission to the stressful situation, memorization, Bach flower, anxiolytics, and the reading of book.

5. Conclusion

Research focused on investigating causes, symptoms, and strategies used by tertiary flute players to cope with music performance anxiety. Thereunto, professors of flute from three music colleges in Brazil were willing to collaborate to the research through their flute students. The methodology used in this investigation was as in the study by Siw Nielsen (1999), which collect and analyses of data were processed by the observation of the behavior of the participants in the recital, and verbal reports by semi-structured interview.

The main strategy used by tertiary flute players to cope with music performance anxiety was the positive self-talk. This kind of strategy was used by the participants when they were on the stage, and it was related to negative thoughts, fear of failure and judgment, and unresolved technical-interpretative difficulties. The positive self-talk was reported mainly as a strategy for cognitive symptoms. It is important to highlight that one of the participants told to have learned this strategy with your superior during the military training in the army, where he has a career. Secondly, breathing exercises that flute players use to know as a way to help them the production and maintenance of sound. It can be used to reduce the sensation of breathlessness and effects of increased heart rate, and relax. These are some of physiological and behavioral symptoms.

For relaxation were reported the use of the following strategies: physical exercises, breathing techniques, and body movements before and during the performance. The individual study were pointed by tertiary flute players as a strategy to cope with music performance anxiety, that is, practicing of the flute efficiently with the solving of technical-interpretative difficulties, beyond the optimizing of the time through the planning and evaluation of the goals achieved in the end of the study session. This strategy should be closely linked to technical-interpretive problems occurred in the recital.

Drink water is related to dry mouth, which is a physiological symptom of anxiety. However, this strategy was reported by four tertiary flute players, though some of them had drunk water when took the stage, but did not report in the semi-structured interview as a coping strategy for music performance anxiety. The focus on musical text was a strategy to cope with a cognitive symptom that is characterized by the lack of concentration.

Physical exercises, body awareness exercise, meditation, use of imagery, low level of concern, Bach flower, anxiolytics, and the reading of book are strategies that were closely related to cope with physiological and behavioral symptoms of music performance anxiety. The choice of repertoire was reported as a strategy to cope with music performance anxiety that comes from the task. The submission to stressful situation was a strategy reported by a tertiary flute player that has used it to become confident in different musical performance situations as: masterclasse, recital, audition, etc.

Strategies as cognitive, behavioral, and cognitive-behavioral therapies were not mentioned by the flute players or even Alexander technique, biofeedback, yoga, etc. However, we cannot state the reasons for not using these other coping strategies. It is important to highlight the Participant 7 presented the larger coping strategies repertoire for music performance anxiety among them. At the same time, the coping strategies repertoire of each tertiary flute player did not contemplate all causes and symptoms had been reported by them.

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USING TAGS TO SELECT STIMULI IN THE STUDY OF MUSIC AND EMOTION

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Abstract

A wealth of literature on musical emotion exists, including investigation of the use of tags to classify musical emotions. However, the relationship between musical emotions and human annotated information is still unclear. Likewise, the understanding of the differences between induced emotion (also known as felt emotion) and perceived emotion (also known as expressed emotion) is at an early stage. In previous work, lists of songs labelled with one of the four basic emotion tags "happy", "sad", "angry" and "relaxed" were retrieved from Last.FM, and audio excerpts were fetched from 7Digital.com. In this study, we asked listeners to rate musical excerpts with the perceived or induced emotion fitting the excerpt. 80 excerpts (20 for each of the four emotions considered) were rated by 40 participants from various backgrounds and levels of musical expertise. The results show that in majority of the selected songs the tags agreed more closely with the ratings of perceived emotion than induced emotion. In addition, each induced emotion was highly correlated with its corresponding perceived emotion and induced anger can also be very distinct from its perceived ratings. However, the participants' emotional judgements were not related to measured cultural or musical factors.

Keywords: perceived emotion, induced emotion, social tags

1. Introduction

Music provides powerful means of communication and self-expression and has attracted increasingly significant research interest in the past decades (Eerola and Vuoskoski, 2013; Barthet et al., 2013). People report that their primary motivation for listening to music is its emotional effect (Juslin and Laukka, 2004). Additionally, research indicates that people are listening to music more often than any of the other activities (Rentfrow and Gosling, 2003) (i.e. watching television, reading books, and watching movies).

With the emergence of music discovery websites such as Last.FM[1], social tags have received increasing interest for the study of music and emotion in the past ten years (Eck et al., 2007; Levy and Sandler, 2009; Wang et al., 2010). Social tags are words or groups of words supplied by a community of internet users. They are more and more commonly used to aid navigation through large media collections (Wu et al., 2006), allowing users to get a sense of what qualities characterise a song at a glance (Hoffman et al., 2009). Compared with traditional human annotation, semantic tags provide large-scale, cost-efficient, rich and easily accessible source of metadata (Turnbull et al., 2008). In addition, the information they provide is highly relevant to music

1. http://www.last.fm

information retrieval, including genre, mood and instrument, which account for 70% of the tags (Lamere, 2008).

Though the use of social tags is a powerful tool that can assist searching and the exploration of music (Levy and Sandler, 2007), several problems with tags have been identified, such as the "cold start" problem (new or unknown music has no tags), noise, malicious tagging, and bias towards popular artists or genres (Lamere, 2008). There are a number of incentives and motivations for tagging, such as to aid memory, provide context for task organisation, social signalling, social contribution, play and competition, and opinion expression (Ames and Naaman, 2007). However, we know very little about the criteria on which tagging is based.

Music can both induce and express emotion, and it is a fundamental difference that induced emotion (also known as felt emotion) is the emotion experienced by the listener, while perceived emotion (also known as expressed emotion) is the emotion recognised in music (Gabrielsson, 2002). However, separating induced emotion from perceived emotion is not always straightforward. Previous studies have suggested that music seems to induce emotions similar to the emotional quality perceived in music. Felt emotions are often stronger than perceived emotion in connection with pleasure, but weaker in connection with arousal, positive activation, and negative activation (Kallinen and Ravaja, 2006; Evans and Schubert, 2008). To our knowledge, these two facets of emotion communication in music were rarely studied in comparison with semantic tags.

In the study of music and emotion, two popular theoretical frameworks, the categorical model and dimensional model, have both received empirical support (Vieillard et al., 2008; Eerola and Vuoskoski, 2010). The dimensional approach considers all affective terms arising from independent neurophysiological systems: one related to valence (a pleasure-displeasure continuum) and the other to arousal (activation-deactivation) (Russell, 1980). In contrast, the discrete or categorical model describes all emotions as being derived from a limited number of universal and innate basic emotions such as anger, happiness, sadness and fear. The experimental work in this paper is based on the discrete model, since the data was collected through human-annotated social tags, which are categorical in nature (Ekman, 1992; Panksepp, 1998). We used four basic emotion classes: *happy*, *angry*, *sad* and *relaxed*, considering these four emotions were widely accepted across different cultures and covered the four quadrants of the two dimensional model of emotion (Laurier and Grivolla, 2008).

Gabrielsson (Gabrielsson, 2002) stated that people generally agree on the basic emotion that a particular piece of music is expressing. In this paper, we studied whether the same agreement exists between human-annotated tags and emotional judgements. We examine a number of questions: (1) Do semantic tags agree show a greater agreement with perceived emotion or with induced emotion? (2) How can we quantify the reliability of tags, for example, for selecting stimuli in the study of music and emotion? (3) What are the influences of musical education, music engagement and culture on the attribution of emotion to music?

2. Method

2.1. Participants

Forty English-speaking students (20 male and 20 female) from undergraduate to postgraduate participated in this study. They were recruited through university email lists, and had ages ranging from 18 to 44 years (age 18-24: 55%; age 25- 34: 35%; age 35-44: 10%) with various educational and musical training backgrounds. Among these participants, 32.5% of them were Chinese and 50% of the participants attentively listened to music more than one hour per day. Also 87.5% of the participants can play at least one instrument. Moreover, 67.5% of the participants prefer pop/rock music, 10% of them prefer jazz, and the rest prefer classical music.

To assess the participants' musical expertise and engagement the Goldsmiths Musical Sophistication Index questionnaire (GOLD-

MSI) was given (see subsection 2.3). The three factors measured were *importance* (importance of the music in everyday life), *musical training* (life history of formal musical training) and *emotion* (importance of music for psychological functions) (Müllensiefen et al., 2012). The values were calculated in a provided template[2] (importance (min: 15 - max: 105), musical training (min: 9 - max: 63), emotion (min: 8 - max: 56)). A summary of the responses can be found in **Table 1**.

Skills	Min	Max	Mean	SD
Importance	26	99	72.5	18.1
Musical Training	9	59	37.4	15
Emotion	30	56	45.5	6.7

Note: 32 questions adapted from GOLD-MSI

Table 1. Summary of Musical Attributes

In order to minimise the effect of song sequence and conditions, the study was conducted in four equal groups (n=10 for each group). The order of presentation of the two rating conditions (perceived and induced emotion) and two song blocks (m=40, 10 for each emotion category) was counterbalanced across subjects. The songs in each block were randomly distributed across participants (see **Table 2**).

Group	Block 1	Block 2
Group 1	Induced Emotion	Perceived Emotion
Group 2	Perceived Emotion	Induced Emotion
	Block 2	**Block 1**
Group 3	Induced Emotion	Perceived Emotion
Group 4	Perceived Emotion	Induced Emotion

Table 2. Group allocation

2.2. Stimuli

The stimuli were selected from a collection of 2904 excerpts retrieved from Last.FM[3] and 7Digital[4], which were previously used in music and emotion studies (Song et al., 2012). Each excerpt had been tagged on Last.FM with one of the four words "*happy*", "*sad*", "*angry*" and "*relaxed*". We randomly chose a total of 80 excerpts from these four categories (n=20 from each category). The excerpts ranged from recent releases back to 1960s, and covered a range of Western popular music styles such as pop, rock, country, metal and instrumental. Each excerpt was either 30 seconds or 60 seconds long which was randomly selected by 7Digital, and it was played from a standard mp3 format file (bitrate: 128 kbps or 64 kbps, sample rate: 22,050 kHz or 44,100 kHz).

2.3. Procedure

The study was approved by Queen Mary Research Ethics Committee (REF: QMREC1019). Participants were asked to sit in a laboratory environment. They were given studio quality headphones, and they could adjust volume to a comfortable level. First of all, participants were asked to familiarise themselves with the interface and read an instruction page, for example:

1. Listen to the songs one after one (30 or 60 seconds).
2. From page 1-4, you will be asked to answer "What emotion do you feel in response to the music" (induced ratings) and from page 5-8, you will be asked to answer "How would you describe the emotional content of the music itself" (perceived ratings).
3. For each single track, once you are sure about the question, click the "stop" button on the audio player.
4. Choose from one of the options: happy, sad, relaxed, angry, or cannot tell/none of above.
5. Note: you can only listen to each song once.

The participants filled in a demographic form including name, age, gender, "type of music they are most familiar with", nationality, and "music culture they grew up with". Then they responded to each excerpt (n=10 per

2. http://www.gold.ac.uk/music-mind-brain/gold-msi/
3. http://www.last.fm/home
4. http://www.7digital.com/

page) and chose one of corresponding emotions: *happy*, *sad*, *relaxed*, *angry* and *none/cannot tell*. They also indicated whether they knew the song by selecting *yes* or *no*.

At the end of the experiment, their opinions and feedback were collected. A selected Goldsmiths Musical Sophistication Index (GOLD-MSI) questionnaire was given to measure participants' musical expertise and engagement (see section 2.1. The whole experiment lasted about an hour without any breaks. However, the participants were able to stop whenever they wanted.

3. Results

Depending on the group (refer to **Table 2**), each participant rated the perceived emotion and induced emotion for different blocks. Therefore, we analysed perceived ratings and induced ratings separately. The data analysis was conducted using the Matlab 2012 Statistics Toolbox. We considered the results with and without the none/cannot tell option. However, as similar conclusions were reached in the analyses, we only present the output with none/cannot tell option included in this section.

3.1. Comparison of agreement of perceived and induced emotion ratings with social tags

In order to compare the agreement of perceived emotion and induced emotion results with social tags, a Wilcoxon Signed Rank test was used for the entire 80 excerpts (see **Table 3**). The analyses revealed that though both are well above chance, the agreement of the perceived emotion ratings with tags was ranked significantly higher than that of the induced data (p values <0.0001).

	Perceived	Induced
Median	0.5	0.35
Mean	0.4694	0.3962
Standard Deviation	0.2919	0.2385
P-value	6.78E-04	
Zvalue	-3.3983	

Table 3. Wilcoxon Signed Rank Test

3.2. Differences across emotion categories

Though section 3.1 showed perceived emotion is closer to human tags, for each emotion a Wilcoxon Signed Rank test was carried out to analyse the individual differences (see **Table 4**). In the case of happiness (induced mean = 0.47 and perceived mean = 0.45) and relaxedness (induced mean = 0.39 and perceived mean = 0.37), interestingly, the agreement for induced emotion and perceived emotion showed no significant difference (p = 0.51 and p = 0.52 respectively). However, the agreement of tags for anger and sadness in perceived emotion were significantly higher that the agreement for induced emotion (p = 1.6e-04 and p = 6.78e-04).

	Happy	Sad	Relaxed	Angry
Induced	**0.47**	0.36	**0.39**	0.37
Perceived	0.45	**0.56**	0.37	**0.51**
P-value	0.51	*1.6E-04*	0.52	*6.78E-04*
Zvalue	0.66	-3.77	0.64	-3.4

Table 4. Agreement with tags for each emotion

In order to study the relationships between perceived and induced emotions, correlation analyses were performed, with the results shown in **Table 5**. Positive correlations between perceived and induced emotions for each corresponding emotion were found (p < 0.001), and several other significant correlations were revealed such as negative correlations between induced happiness and perceived sad- ness (r = -0.59 and p < 0.05), and induced anger with perceived happiness (r = -0.57 and p <0.01), sadness (r = -0.77 and p < 0.001) and relaxedness (r = -0.69 and p < 0.001).

	I Happy	I Sad	I Relax	I Angry
PHappy	***0.76	*-0.56	*-0.52	**-0.57
PSad	*-0.59	***0.89	0.13	***-0.77
PRelaxed	-0.27	*-0.48	***0.73	***-0.69
PAngry	-0.23	-0.44	-0.26	***0.96

*p <0.05, **p <0.01, ***p <0.001

Table 5. Correlations between perceived (P) and induced (I) emotions, for each emotion

3.3. Cultural and musical factors analysis

To discover whether there was any association between gender, cultural background, or musical training and engagement with the musical emotion judgements, a Wilcoxon Signed-Rank test, Mann Whitney U test and correlation analysis were carried out respectively. No significant difference was found between male and female in their agreement with tags (p = 0.9038). In addition, there was no significant impact on musical judgement for Asian (n=15) and Western (m=25) participants (p = 0.7474)[5]. As shown in **Table 6**, no correlation was found between perceived and induced agreement with the three musical attributes: importance, musical training and emotion. However, there is a weak negative correlation with musical training in induced emotion for group 2 and group 3 (r = -0.5137 and $p < 0.05$).

	Group 1 and Group 4	
	Induced	**Perceived**
Importance	-0.0877	-0.3107
Musical Training	0.0134	0.1062
Emotion	-0.1784	-0.2594
	Group 2 and Group 3	
	Perceived	**Induced**
Importance	0.2399	-0.3154
Musical Training	-0.0772	*-0.5137
Emotion	0.1115	-0.1897

*p <0.05, **p <0.01, ***p <0.001

Table 6. Correlation between levels of tag-rating agreement and the GOLD-MSI scale, where tag-rating agreement can be divided into induced and perceived emotion

4. Discussion

The experiment reported in this paper aimed at finding associations between social emotion tags (happy, sad, angry and relaxed) and participants' emotional judgements (perceived and induced emotion). First, we found that participants' ratings of perceived emotion showed a significantly higher level of agreement with tags than that shown by their induced emotion ratings. Furthermore, we tested the difference for each individual emotion. The results revealed that there is no significant difference for the happy and relaxed tags, but for the excerpts labelled with angry and sad, these labels are more likely to correspond to perceived emotion ($p < 0.001$).

Second, we studied the correlations between perceived and induced emotions. As expected, there is a highly significant positive correlation between induced emotion and its corresponding perceived emotion. Previous studies mentioned that happy and sad excerpts were identified easily (Terwogt and Grinsven, 1991; Vieillard et al., 2008). However, a highly negative correlation between induced anger and the perceived emotions of happiness, sadness and relaxedness showed that induced anger can also be very distinct from its perceived emotion. Despite the fact that individual differences such as personality traits and listeners' current mood are relevant to music preference and emotional judgement (Vuoskoski and Eerola, 2011b,a; Shiota et al., 2006), we focused on the influence of gender, culture, musical expertise and engagement on emotional judgements. There was an only weak negative association between induced emotion agreement and musical expertise. However, the results remain tentative, since the use of the discrete model, particularly with only four emotions, is inadequate to describe the richness of emotional effects of music.

Feedback from participants reinforces the issue of the inadequacy of our discrete model, with comments such as: "*four emotional classes are not enough*", "*more options should be added*", "*many times I was feeling limited because of the small amount of feelings options I had to choose from*", and "*I could feel more than one emotion, or another emotion which was not included in options (like energetic, romantic, etc.)*". To investigate this difference further, it is suggested that the dimensional model and a music-specific model, the Geneva Emotion Music Scale (GEMS (Zentner et al., 2008)), should be considered in future studies.

Comments from participants raised other issues which are worthy of further investiga-

5. Asian: Chinese, Indian, and Pakistani excluding those who were born in the UK

tion, for example: "*If I feel sad I will usually listen to songs in my mother tongue, it is always sad.*"; "*Sometimes I felt angry because I didn't like the song and didn't want to listen*."; "*I feel multiple emotions.*"; "*I really like heavy metal, so I think many of the metal songs, normally people would've felt angry, but I just felt happy + energised.*". Further research is required to understand cross-cultural differences and the influence of participants' musical taste on their ratings.

One interesting outcome of this work is the comparison with our previous studies on automatic emotion recognition, in which we obtained classification results of up to 54% based on analysis of musical features extracted from the audio excerpts (Song et al., 2012). Surprisingly, this is higher than the level of agreement between human listeners, for either perceived or induced emotion. In future work, we will compare further the predictions of classifiers based on high-dimension musical features with the results of human listening tests for ratings of perceived and induced emotion.

5. Acknowledgements

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EMPATHY IN MUSICAL INTERACTION

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Abstract

Entrainment has been linked to positive affect and pro-sociality, e.g. empathy. Empathy and entrainment are facets of the "shared manifold", mirroring and mental simulation system allowing us to automatically share emotions and intentions, and to understand others. They are foregrounded in music, which is very efficacious in communicating emotions and intentions. We perceive the intentional, expressive motor acts behind the sounds of music. Music therapists take advantage of this and use musical interaction to work with their clients. The cognitive foundations of synchronisation have been studied extensively, but its emotional aspects only rarely and the methods of entrainment research have only rarely been used in music therapy research, which has mainly focussed on qualitative case studies. Our aims are to study the associations between empathy, entrainment and musical communication. In dyadic tapping tasks, participants started in different tempi and later on started to hear each other's tapping. We also carried out an exploratory case study analysing the timing characteristics of a client and therapist in videos of music therapy improvisation sessions. In both cases we analysed whether and how the players entrained and the contributing factors. The link between entrainment and empathy is not linear; we discuss e.g. the effects of pair constitution and task difficulty and the characteristics of bouts of entrained and non-entrained behaviours in the music therapy session.

Keywords: interaction, music therapy, empathy

1. Introduction

People automatically and unintentionally mimic each others' body movements and gestures in conversation (Kendon, 1970; Chartrand & Bargh, 1999; Shockley, Santana & Fowler, 2003). Unintentional entrainment of body rhythms has been observed in many contexts, for example as gait entrainment between people walking side-by-side (Nessler & Gilliland, 2009), as increased body sway synchrony in conversations (Shockley et al., 2003), and in swinging pendulums and rocking in chairs (Schmidt, Carello & Turvey, 1990; Richardson et al. 2007).

Entrainment is important in all communication, but intentional entrainment is especially fore-grounded in music and dance. Interestingly for the current study, entrainment has been linked to positive affect and pro-sociality, e.g. empathy. Successful synchronisation in a finger-tapping task resulted in higher ratings of affiliation (Hove & Risen, 2009). In another series of studies, a person whose actions were mimicked was consequently more generous and helpful than controls, and this pro-social tendency was not specific to the person who mimicked them, but a more general effect (van Baaren et al. 2004).

Empathy can be seen as a multi-dimensional trait with cognitive and emotional components (Davis, 1980). Seeing the world from another person's perspective or identifying with characters in films or books are examples of the cognitive aspect of empathy (closely linked with the theory of mind), while feeling the pain or anxiety of another person is an example of the emotional dimension (some would prefer to call this *sympathy*).

Empathy and entrainment are facets of the "shared manifold" (Gallese, 2001, 2003), the mirroring and mental simulation system that allows us to automatically and rapidly share emotions and intentions, and to understand others' actions. While present in all interpersonal interactions, they are a core feature of music and dance, two very efficacious activities in communicating emotions and intentions. Through mirroring, we perceive the intentional, expressive motor acts behind the sounds of music, and gain understanding of the underlying emotions (Overy & Molnar-Szakacs 2009). Music therapists take advantage of this and use musical interaction to work with their clients.

The cognitive foundations of rhythmic synchronisation have been studied extensively (see e.g. the classic review by Bruno Repp, 2005), but its emotional and social aspects only rarely. Also, the methods of entrainment research have only rarely been used in music therapy research, which has mainly focussed on qualitative case studies. Our general aims are to study the associations between empathy, entrainment and musical communication, using dyadic tapping studies and video data from music therapy improvisations.

2. Study 1 – Aims and methods

The aim for our dyadic entrainment study was to investigate how task characteristics such as initial tempo difference and personality and empathy factors contribute to entrainment.

A dyadic tapping experiment was conducted in two stages. In the first stage, 36 participants, 20 of whom had extensive musical training, took part. In the second stage, 38 non-musicians took part. In the first stage, participants were paired together based on their musical expertise, forming 10 musician pairs and 8 non-musician pairs. In the second stage, participants were paired together based on their perspective taking -subscale scores of the Interpersonal Reactivity Index (IRI) (Davis, 1980). This is a cognitive empathy measure. Pairs of matching high, matching low, and mixed empathy were formed.

In both stages, the tapping trials were almost identical. Participants heard a metronome click produced by a digital audio workstation through their headphones. They could also hear a woodblock sound as auditory feedback of their own tapping, as well as a different woodblock sound from the other participant's taps. The participants were producing isochronous tapping with one finger, using Roland Hand-sonic 10 MIDI drums.

Participants performed a series of 45 second tapping trials. Each trial had the same structure: the trial was started by a metronome that faded out after about 5 seconds. Participants were asked to start tapping as soon as they felt the beat, and to synchronise their taps with the metronome as accurately as possible. They were instructed to keep their original tempo as accurately as possible after the metronome faded out, and to keep tapping until they heard the end jingle (continuation tapping). See figure 1 for a schematic of the structure of the tapping trials.

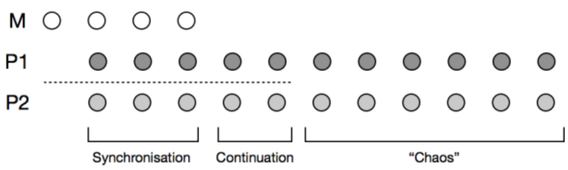

Figure 1. Structure of the tapping trials.

There were three kinds of trials. In solo trials, the participants only heard feedback from their own tapping all through the trial. In duet tasks, they started hearing their partner after 4 seconds of continuation. In same tempo trials, both participants had the same metronome in the synchronisation stage, meaning that after the synchronisation stage and a brief continuation, they entered the duet stage in very similar tempo. In different-tempo duet tasks, participants had different metronomes in the synchronisation stage, thus leading them into the duet stage in very different tempi. (We jokingly refer to this as the "chaos" stage, as two people tapping in very different tempi sounds somewhat chaotic.) In the duet tasks the instruction for the continuation and duet stages was the same as in the solo tasks: keep the original tempo as accurately as possible, thus indicating that whenever the other participant is tapping in a different tempo, they were not supposed to synchronise with them.

Circular statistics were used to analyse entrainment between participants (Fisher, 1993; Jammalamadaka & SenGupta, 2001). Looking at tapping data as circular data means that instead of analysing the linear progression of onset times, the onset times are converted to phase angles. In this process they are related to the underlying period of the rhythm. Looking at entrainment, instead of calculating the onset time asynchronies between the participants, we calculate their relative phase at each tap, and then summarise their performance with the mean direction of these angles (e.g. whether they are entrained in-phase or anti-phase), and the concentration of this distribution, which tells us how stable this phase relationship is. Conveniently, the concentration of the distribution can get values between 0 and 1, where 0 means no consistent phase relationship, thus no entrainment) and 1 refers to perfectly stable phase relationship, perfect entrainment. Thus this concentration measure *R* is a good index for entrainment in the dyadic tapping study (Himberg, forthcoming).

3. Study 1 – Results

In *stage 1* of the experiment, we had musicians and non-musicians, and they also had filled in a personality questionnaire (Big Five Inventory, John & Srivastava, 1999). From this first stage, we learned that entrainment seems to be an on-off issue, as could be predicted from the dynamic systems studies in synchronisation (Haken, Kelso & Buntz, 1985). This is also in line with cognitivist studies of synchronisation, as once you get entrained, the automatic mechanisms of phase attraction will keep you locked in (see e.g. Repp, 2004). As figure 2 shows, musicians tend to entrain even over larger tempo differences, whereas non-musicians tend not. This could be due to the musicians having a lower tolerance for unentrained performances, as they are highly trained in playing together with others and adjust to their timing. The musicians were the better tappers, as their stability was higher than the non-musicians in all tasks (ANOVA: $F_{(1,70)} = 9.200$, $p= 0.003$, $\eta^2 = 0.116$).

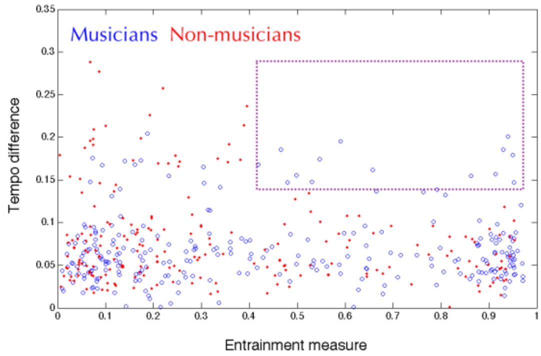

Figure 2. Entrainment measure vs. tempo difference in musicians and non-musicians, in the first stage of experiment 1. Each circle represents one trial. The purple dashed square indicates an area of high entrainment and large initial tempo difference, with only trials by musicians in it.

Logistic regression confirmed our predictions that musicianship and initial tempo difference were the most important factors in predicting entrainment. Unsurprisingly, the personality factors had no effect.

In *stage two* we modified the experiment only slightly. Mainly, we only invited non-musicians, and asked them to fill in an empathy questionnaire beforehand, so that we could form matching high and low empathy pairs as well as mixed empathy pairs. We also added more tempo combinations, so that the effect of tempo difference on entrainment could be properly statistically analysed. Also, we looked at how stabile the entrainment is in each trial by calculating a windowed entrainment analysis and looking at the standard deviation of the segment scores. Finally, we looked at how much the participants speeded up or slowed down during the chaos section and how that interacts with these other factors.

These four variables are summarised in figure 3. Looking at the stability of entrainment with-in trials (colour of the circles), this confirms our findings that it is an on-off matter, as trials that are entrained and the ones that are not (trials scoring close to 1 or 0) remain so all through, while the ones in between are the ones with more fluctuations – although there are some un-stable non-entrained trials, especially ones where the tempo drift is large. In itself, the tempo drift during the trial does not seem to have an effect on entrainment, as the range of this variable remains the same regardless of the entrainment score. This is in line with previous findings in dyadic tapping - participants can drift a lot in tempo while remaining very tightly entrained (Himberg, 2006).

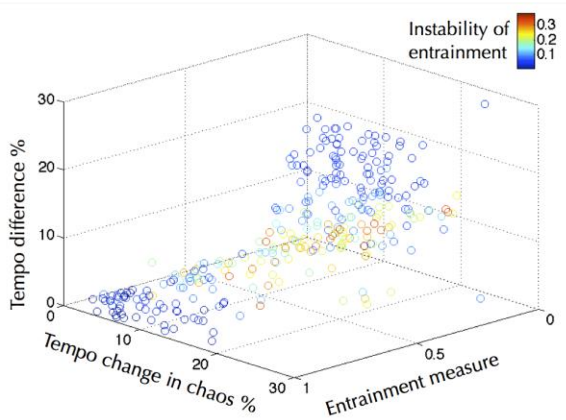

Figure 3. Entrainment measure, tempo difference at the start of the chaos section, tempo change, and instability of entrainment during the chaos section in stage 2 of the experiment.

In logistic regression, we investigated the factors contributing to entrainment. Trials were classified as "entrained" or "not entrained" using a median split of the entrainment measure. A range of variables characterising the tasks and the participants were used as predictors of class membership. Significant models were found ($X^2 = 175.2$, $p<0.0005$), with the best model classifying 81.9% of the trials correctly as entrained or not. Tempo difference was the main factor, with sum of empathy in the pair adding only a very small contribution to the model (beta<0.1).

We did not know beforehand whether it would be the individual trait or the sum across the pair, or the matchedness in the pair that would matter. Although none of these turned out to be a strong predictor of performance, it seems that it is the combined amount of whatever personality trait (Big Five or the total or individual dimensions of the IRI) that work a little better in these models than e.g. the difference in the pair or individual scores.

4. Study 1 – Conclusions

Although even simple finger tapping tasks can have a measurable effect on ratings of affiliation, and even brief encounters where gestures are mimicked can influence participants' prosocial tendencies, it seems that dispositional empathy does not have a measurable effect on entrainment in finger tapping tasks, even when the effect of it is maximised by constructing the pairs based on these scores. The task dynamics are much more important in determining synchronisation outcomes, as is musical training.

Musicians often report that they have clear preferences as to which other musicians they like to work with, and that there are clear differences in how easy it is to interact and play together with them. In the folk psychological terms, this is attributed to similarities or differences in personality. Similar differences can occur in the therapist-client relationships in music therapy. In the light of our results, we would suggest that rather than being based on personality traits or dispositional empathy as such, these differences are due to more complex combination of factors, including musical preferences and prior experiences, musical skills, communication styles, rehearsing skills etc.

5. Study 2 – Introduction

Music therapists often talk of entrainment, shared pulse and the fore-fronting of such fundamental musical characteristics in working with some client groups, those with autism among them. The reasons have been often rehearsed – before one can share much else, one needs to be able to 'share time' and attend to the same things at the same time. We now have sufficiently established methods of identification and analysis of entrainment to be able to begin to transfer these methods to the world of music therapy. In this paper we explore the precursor of such analysis through a case study exploring what questions can be asked of videos of music therapy sessions. In particular, we explore the timing characteristics of two players in a music therapy session: a client and a therapist – how much time do they share? How much time do they not share? And what happens during these moments of shared pulse?

6. Study 2 – Aims and methods

This case study had two broad aims. The first was the exploration of the pulse characteristics of a client-music therapist pair in music therapy sessions. The second was the exploration of the context of pulse – the elements that may contribute to, and result from, different types of pulse characteristics and relationships. More specifically, we explored:

1. The distribution and length of bouts of players' regular pulse and irregular sounds throughout two music therapy sessions.
2. The distribution of bouts of shared and not-shared regular pulse (entrained and not entrained pulse)
3. The relationship between these bouts and their contexts on one hand, and behaviours that could be indicative of attention and therefore perhaps social interaction on the other.

We analysed videos of the first and third music therapy sessions from the beginning of a series of music therapy sessions with the same client (a child with ASD, in a 1-to-1 music therapy session with a Nordoff Robbins music therapist). ELAN was used for all video analysis.

We identified bouts of regular and irregular pulse (the shortest bout was 1.8 seconds long and time between beats was between 100ms and 2 seconds). We then looked at the bouts of regular pulse and identified what proportion of these contained 'shared pulse'. This was followed by an identification of where these shared pulse bouts fell in the context of the following features:

1. The bout is preceded by a clear instruction concerning what music is about to occur.
2. The bout coincides with a song with words
3. Talking 'over' the music about something other than the music
4. The client looks in musically or socially expectable directions (the instruments being played, the instruments played next, or the music therapist).

7. Study 2 – Results

There are three categories of results: (a) the characteristics of the regular and irregular moments, (b) the contexts in which we find shared and not shared pulse and (c) behaviours associated with shared pulse compared with behaviours that occur when there is no shared pulse.

The 1-to-1 music therapy sessions at Nordoff Robbins with this client group usually last about 30 minutes each. In this case total time in the room for the first session was about 16 minutes and for the second session was about 30 minutes. The total amount of time spent playing music was about 9 minutes (i.e. about 56% of the session). The total amount of time making music in the second session is about 18 minutes (i.e. about 60% of the session).

(a) Distribution and length of bouts of players' regular pulse and irregular sounds

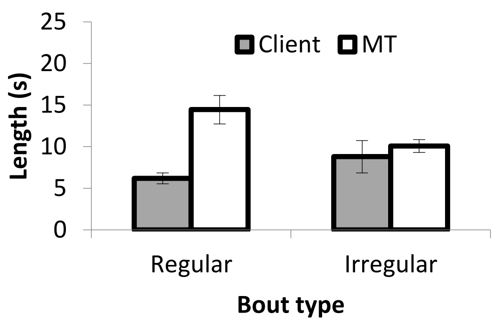

Figure 4. Bout length for Client and Music Therapist

All of the client's bouts are less than a minute (and usually less than half a minute). One of the music therapist's bouts is longer than 1 minute (Figure 4). The average length of the client's irregular bouts is longer than that of the regular bouts (and the longest two bouts are irregular). However, the total number of the client's regular bouts (50) and total time that he spends playing regular bouts (309 s) are greater and longer than the irregular ones (24 and 211 s respectively).

The music therapist has more (70) and longer (14 s average) bouts of regular pulse than the client. The music therapist has fewer bouts of irregular pulse than the client (7). However, the average length of irregular bouts is similar for both music therapist and client (Figure 4).

The average length of bout is under 15 seconds for all categories. There are 10 longer bouts for the client (4/24 (16%) irregular bouts – two of these are the longest client bouts, and 6/50 (12%) regular bouts), 29 longer bouts for the music therapist (1/7 (14%) irregular bouts and 28/70 (40%) regular bouts).

The shared pulse bouts make up a large (80%) proportion of the client's playing time (i.e. he does not play a regular pulse on his own very much).

The shared pulse bouts last longer (7 s) and there are more of them (29) than the no-shared pulse bouts. But simultaneous no-shared pulse bouts do occur (12 times and lasting on average 4 s). There are 4 shared pulse bouts lasting longer than 15 seconds and no longer non-shared pulse bouts.

(b) Contexts in which we find shared and not shared pulse

1. We compare moments of "prearranged" music making with moments that are "not prearranged". In prearranged moments either client or therapist has given a verbal instruction relating to the type of song to play next (e.g. 'Let's play our goodbye song now'), or has given the other a musical instruction prior to the shared pulse incidence that is fulfilled (e.g. 'Come and join me at the piano…'). In moments that are "not prearranged" there was no verbal introduction to the music making.

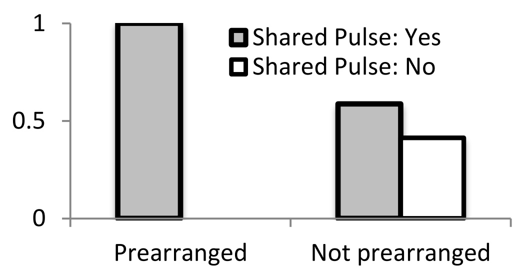

Figure 5. Proportions of shared pulse in prearranged and not prearranged situations.

We see that when the music making is prearranged there are no moments in which pulse is not shared; prearranged music making is always followed by shared pulse. However, when music making is not prearranged the music that follows may or may not include shared pulse.

2. We also compare moments of music making which includes words (i.e. either client or therapist is singing) with those that do not (music without words, i.e. no singing with words).

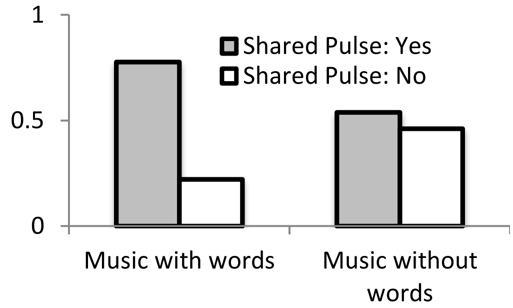

Figure 6. Proportions of shared pulse in music with and without words.

We see in figure 6 that the songs are dominated by shared pulse while those without words may or may not include shared pulse.

(c) Behaviours associated with shared pulse compared with behaviours that occur when there is no shared pulse.

Gaze direction is often taken as indicative of attention and so in this case we look at whether or not the client looks that the therapist or the musical instrument either partner is playing or the instrument the client plays next. In other words we look at musically or socially relevant looking direction.

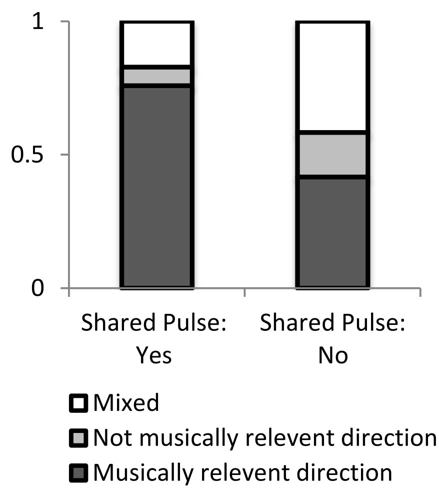

Figure 7. Proportions of gazes in musically relevant, non-relevant and mixed directions under shared and not shared pulse.

Figure 7 illustrates that musically or socially relevant looking occurs more often during the shared-pulse sections.

One of the behaviours that accompanies music making is talking 'over' the music, i.e. the client or therapist is talking about something completely different or may be related in topic but is not song like. This is compared with moments during which neither the music therapist nor client are talking at the same time as music is played. Talking 'over' the music may be seen as a contributor to the music making (and the relative pulse characteristics) or, alternatively, as a result of shared or lack of shared pulse. In the case of the former, talking over the music may be a distraction or indicator of attention. In the case of the latter, talking over the music may arise because either one of the partners or both are not focussed on the music and so begin to talk.

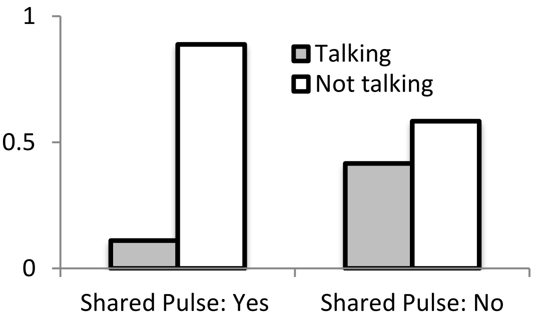

Figure 8. Proportions of talking and not talking in music with shared pulse or not.

As shown in figure 8, when there is no talking over the music, most of the music making includes shared pulse. However, when there is talking the music that follows may or may not include shared pulse.

8. Study 2 – Discussion

This case study focussed on just two music therapy sessions of the same client-music therapist pair. The total amount of time spent music making was about 56% and 60 % of the first and second session respectively.

From the beginning of the videoed sessions, it is clear that whether the client can play a regular rhythm and that whether or not he plays in time with the therapist does not seem to be physically constrained. Nonetheless, the results indicate that the average length of the client's irregular bouts is longer than that of the regular bouts but the total number of regular bouts and total time playing regular bouts are greater and longer than the irregular.

In comparison with the music therapist, the client has fewer and shorter bouts of regular pulse and more bouts of regular pulse. However, the lengths of irregular pulse bouts are similar for music therapist and client.

Putting these observations in the context of the analysis of shared pulse is telling: The shared pulse bouts make up a large proportion of the client's regular playing time; he doesn't play a regular pulse on his own very much, and playing with the therapist is associated with a greater likelihood of playing a regular pulse.

Adding in the analyses of context, we learn that there are contexts associated with shared pulse (preparing the music, and singing words with the music), while others are associated with less shared pulse (e.g. talking over the music). Finally, looking in a musically or socially relevant direction occurs more often during moments of shared pulse.

9. Conclusions

Our first study agrees with previous findings that entrainment is an automatic process and it is hard to resist. Moving from entrained to not entrained state turned out to be more like a sudden switch than a gradual transition. The first stage of the study suggested that while musicians were better in maintaining a stable pulse in general, they sometimes entrained even over large tempo differences, while non-musicians did not. This could be due to their musical training that emphasises adapting to the playing of others, and where synchronised ensemble playing is also an important aesthetic goal. The second stage further demonstrated the bimodal distribution of entrainment across tasks, and while trials with small tempo difference tend to end up entrained and those with a large difference tend to not be entrained, there is no clear threshold, but other factors seem to be at play.

In relation to task-related factors such as the initial tempo difference, personality traits had very little effect. The overall amount of dispositional empathy in the pair was seen to contribute a little to a model that classified the trials as entrained or not. While entrainment has been observed having a measurable effect on affiliation, pro-sociality and empathetic behaviour (e.g. Hove & Risen, 2009; van Baaren et al., 2004), it seems that the effect to the other direction is weaker.

These links between empathy and entrainment are relevant for music therapy. In our first study, we tested so-called *normal* participants, while clients in music therapy often have impairments in social cognition and severe problems in connecting with others. Often clients in music therapy show great improvement in synchronisation and coordination over the course of their sessions, but a lot of the mechanisms are still unclear. To this end, we first wanted to see how often the client and the therapist play in synchrony, and under which conditions.

The second study suggested that the number of bouts and length of regular and irregular pulse differ between the music therapist and the client. The client's regular pulse occurred predominantly when it was shared with the music therapist. Certain contexts seemed to promote regular while shared pulse and others co-occurred with bouts of no-shared pulse.

Nordoff Robbins music therapists often hone in on the fleeting moments of togetherness in order to promote and develop musical interactions with their clients. As we know from the first study in this paper, players do not tend to gradually move towards or away from entrainment – there's usually a switch. A development of the current study will be to explore the non-shared moments in more detail; to identify fleeting moments of togetherness, the contexts in which they occur, and their relationships with the bouts of shared pulse. A second development will be to bring the methods of these two studies closer to capitalise on automated methods of pulse analysis. By studying a wider range of entrained behaviours (resisting it in addition to aiming for it) and by investigating its occurrence in music therapy, we hope to learn more about how music therapy works, how to measure its effects or how to predict which clients would benefit from it the most.

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EMBODIMENT OF LOVE IN HANDEL´S OPERA GIULIO CESARE

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Abstract

By studying metaphors of love in Handel´s opera Giulio Cesare in Egitto, I will introduce how it is depicted by the protagonists´ arias; via Cleopatra´s and Caesar´s musical relations, as a prevailing message. The atmospheric tone paintings set to the musical highlights of the protagonist arias answer the questions: how is love defined in Giulio Cesare? What kind of musical signs of love are there to be found and what will they tell us? Love is an essential theme in the work because the arias` foci are interlocked by the affectual tensions. These have encouraged various performance views of the work, for instance: ENO´s "epoch" depiction in 1984; Sellar´s "satirical" version in 1990; and Glyndebourne`s "colonialist" perspective in 2005. I apply the theory of affects in music appearing in the writings by Handel´s colleague Johann Mattheson (Das Neu=Eröffnete Orchestre, 1713) grounded on Classic Aristotelian and Cartesian ideals (Aristotle´s Rhetoric, Descartes´ Les passions de l'âme) (Suominen, July & September 2010). It also relates to so called Hippocratic-Galenic four elements, temperaments or humours theory by which I will show the different representations of the opera´s characters as a cathartic (ethic, Lutheran based) implication by Handel.

Keywords: 18th century opera, musical rhetoric, theory of affects

1. Introduction: the topic

In my doctoral dissertation as well as in this paper I am studying affects, rhetorical (French, Italian and German) applications of emotive musical systems appearing in Georg Frideric Handel´s opera Giulio Cesare in Egitto (Julius Caesar in Egypt), which was first performed in 1724 in London at the King´s Theatre. Giulio Cesare was Handel´s fifth work for the Royal Academy of Music (which was established in 1719 in London for promoting and advancing Italian opera there). Handel by then was only 39 years old yet had reached his peak of fame as an opera composer in London. His operas gained more performances than any other Royal Academy composers´, he had an annual payment from the king, was royal princesses´ music teacher, and appointed as composer for the Chapel Royal. Handel´s Giulio Cesare was the most often performed of all of his operas during his lifetime and it was the most successful opera by him also after his death.

Love and revenge are the main themes in Giulio Cesare, that will be revealed, defined and established musically as well as in the drama narratively, and love wins over revenge, this is also why I have chosen love into my dissertation title.

Handel was influenced by Italian, German and French (rhetoric) philosophies (especially Descartes´ ideas on human passions as well as Greek physician Hippocrates´ and Galen of Pergamon´s theory on humours / temperaments). These features are shown in my dissertation analysis on Giulio Cesare´s performances.

2. Previous research

There has been a vast range of musicological research done by many scholars on Handel and his works in general, for instance by such great names as: Donald Burrows, Terence Best, Suzanne Apsden, Graydon Beeks, Hans Dieter Clausen, Winton Dean, Ellen Harris, Anette Landgraf, Anthony Hicks, Lowell Lindgren, Hans Joachim Marx, Martha Ronish, Ruth Smith, Dorothea Schröder, Steffen Voss et alii. These have been mostly manuscript based studies.

Dr. Johanna Ethnersson from the University of Stockholm has published a research article on Giulio Cesare in Svenska Samfundet för Musikforskning. She studied the changing roles of manhood and womanhood of the protagonists via musical analysis by utilizing gender theory as a framework. Dr. Bettina Varwig from the King´s College London has studied rhetorical principles of musical forms and historical modes of analysis and listening in the 17th Century. Professor Dietrich Bartel from Canadian Mennonite University Winnipeg Manitoba pursues research in the area of German Baroque music theory, doctrine of musical-rhetorical figures. His book Musica Poetica (1997) has become as a standard work, a textbook in the field of musical rhetoric.

A proceedings article based on my international conferences´ speeches has been published online in internet on December 12th 2011 titled as "Signs and Messages of Love in Performing Handel´s Giulio Cesare". The article is found from the Sibelius Academy´s proceedings database. During 2013 a peer-reviewed conference proceedings book will be appearing containing also an article by me on this same theme.

3. My research aims

Main themes of Giulio Cesare, love and revenge, are interlocked by the affectual tensions in arias. These have encouraged various performance views of the work.

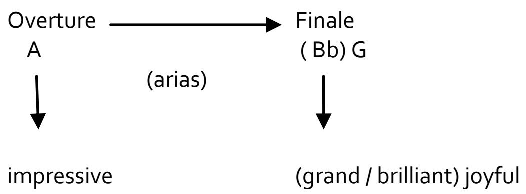
I will utilize them as basic instances of the opera: 1) English National Opera´s "epoch" / pastoral depiction from 1984 (which is an example of a brilliant, sublime manner having with an emphasis on a definition of a *beauty* by Italian rhetoric ways); 2) American stage director Peter Sellar´s modern, politically aware "satirical" / hunting version from 1990 (which is an instance of the Ciceronian *irony*, making ridiculous out of tyranny and stressing effectiveness by French rhetoric means); and 3) Glyndebourne´s festival performance production from 2005, which I have named here as a "colonialist" / military perspective of the work (which is an example of morally universal ideas and ideals giving an emphasis on *rationality* by German rhetoric views). These three performances are seen as thinking models for later recent interpretations of the opera.

3.1. On the study

As already mentioned previously here, I have chosen to study how love is defined in the work. Also, this can be applied to the overall musical structure of the opera, which again, is seen via French, Italian, and German musically defined rhetoric ideals.

The Ouverture, which is in A major, is seen as reflecting the affect of impressiveness, and because of this it represents the French typed of musical rhetoric thinking, while the finale starting in Bb major, and basicly in G major, stands for that of grand and brilliant, i.e. joyful affects, within those representing both the Italian and German rhetoric musical ideals (please, see table no. 1: the overall structure of the opera).

Table 1. The Overall structure (Handel: Giulio Cesare, 1724):



By examining the theatricality (poetic / scenic and musical levels), as seen by the characterization of the personages of the work, I am studying the protagonist and the other characters of the opera via the Hippocratic / Galenic theory of the four (basic) humours / temperaments (sanguine, choleric, melancholic, phlegmatic) and as temperamental / humoural types of heroic and sensual, which is related to rhetoric by its connections with the affect (ie. emotional) tensions (Goltz, 1992). In Handel´s Giulio Cesare, this agential duality is modified as a counter-forcible embodiment of the main theme (of love and vengeance) of the opera, appearing as a positive vengeance (manifested by Caesar) and as negative vengeance (by Ptolemy), as a positive love (by Cleopatra), and as a negative love (by Ptolemy and Achilla). I study the appearance of Cleopatra´s figure in her different roles as a feminine character exchanging with that of Caesar´s masculinity which is questioned as well as seeing Cleopatra turning into a hero instead of merely being a heroine. I study how this has been handled in the three performance instances mentioned already above. (Please, see table no. 2: the roles of the opera).

Table 2. Roles of Giulio Cesare

Role	Voice type	Premiere Cast, 20 February 1724
Giulio Cesare (Julius Caesar)	alto castrato	Senesino
Cleopatra, *Queen of Egypt*	soprano	Francesca Cuzzoni
Tolomeo, *her brother and husband, King of Egypt*	alto castrato	Gaetano Berenstadt
Cornelia, *widow of Pompey*	contralto	Anastasia Robinson
Sesto, *Cornelia´s stepson*	soprano (en travesti)	Margherita Durastanti
Achilla, *Tolomeo's General*	bass	Giuseppe Maria Boschi
Curio, *a praetor, Caesar's General*	bass	John Lagarde
Nireno, *Cleopatra's and Tolomeo's servant*	alto castrato	Giuseppe Bigonzi

Giulio Cesare is scored for trumpet, 4 horns, 2 oboes, bassoon, flute, first, second and third violins, violas, cello, viola da gamba, harp, theorbo and basso continuo.

3.2. On the object of my analysis

Handel was a creator of skillfully set musical moods. He merged traditional German firm contrasting harmonic ideas with Italianate-French musical rhetoric usage of affects, which he formulated into his inventive expression. I examine Handel´s rhetoric based affectual musical methods occurring in his Giulio Cesare which function as opera´s alternatives giving hidden narrative clues for different performance views.

According to Aristotelian cathartic (soul purifying) ideal, in his Giulio Cesare, Handel puts forward, the quest for a virtuous rulership (Aristotle, 1997 [2012], 17). The opera´s characters have been defined by Platonian, Aristotelian, and Empedoclean atomistic proportions (Parry, 2005) of opposite pairs (Parsons, 2006). The personages can be grouped along classic (geometrical) elements, which were furthered into a medical-psychological theory of humours by Hippocrates-Galen-Avicenna (Goltz, 1992); and Aristotle´s syllogistic square of opposition (Parsons, 2006). This relates to the Aristotelian thesis of substantiating, and finding a way of narrating a story by allowing its listeners to participate in a "true" argument (Aristotle, 1997 [2012]).

4. On the performance analysis of the opera

Handel applies the square of opposition in Giulio Cesare, and though being an opera seria, it contains ironical elements. Handel contradicts tragedy and irony, developing his own type of a Machiavellian "choise" for drama. Other opposed elements in Giulio Cesare are the characters, the main themes: love and revenge.

Through love, Caesar and Cleopatra will succeed in getting the power, to rule over Egypt, and Rome together equitably and defeating the obvious tyrant, the rival Ptolemy, deemed unsuited to reign. Handel followed Cicero by his allegorical and metaphorical creations, by having formed out highpoints of resemblances to natural phenomena in his metaphoric simile (or Devisen) arias.

Handel utilizes in his Giulio Cesare some basic and best known rhetorical concepts of his time such as for instance a) *metaphors* (which are implied comparisons without "like" or "as"; for example this is shown in practice in Cleopatra´s aria "Tu la mia stella sei", in act I, scene 2; in which Cleopatra compares Caesar to a star who shows and stands for her the right path both to joys of love and righteous rulership, emphasizing the affect of love); b) *similes* (which are comparisons using "like" or "as"; for example in Caesar´s aria "Va tacito e nascosto" in act I, scene 3; here a clever and righteous ruler is being compared to a skilled huntsman in representing the affect of a positive revenge by Caesar towards Ptolemy´s tyrannical acts (Aristotle, 1997 [2012], Rhetoric III ch.4, 123-4); (verbal) c) *irony* (which is saying one thing and meaning the opposite; for example Cleopatra in her aria "Non disperar", in act I, scene 2; her scornful ideas towards her brother Ptolemy who is having a joint tenancy with her are being disguised here as benevolent wishes, here she has the affects of joy and contempt; see René Descartes about Mockery in his Passions of the Soul, 1649:

> Derision or Mockery is a species of Joy mingled with Hatred which arises from perceiving some small misfortune in a person we think to be deserving of it. We have Hatred for this misfortune, and Joy in seeing it in someone who deserves it. And when it springs up unexpectedly, the surprise of Wonder causes us to break into laughter -- (Descartes, 1649 [1989] art. 178, 117).

Also Thomas Hobbes describes mockery calling it as a sudden glory in his Leviathan (1651), for Plato laughter represented scorn (= mockery; Hobbes, 1651 [2012]) and Aristotle agreed with him having added to that the description of youth, which is applicable Handel´s portrayal of the young impatient and fiery-natured Cleopatra in his Giulio Cesare (Aristotle, 1997 [2012], Rhetoric II ch.12, 85-6).

Yet another rhetorical concept is that of: d) *juxtaposition* (i.e. an antithesis, which is a rhetorical scheme meaning "placing side by side" of two elements for contrast and emphasis; in Cleopatra´s aria "Piangerò la sorte mia" in act III, scene 1; the affects of grief and revenge have been placed side by side for to emphasize her right for revenge (= a positive revenge). (Aristotle 1997 [2012], Rhetoric III ch. 9, 20; 132).

4.1. On recent performance instances

I have chosen for my analysis here three performance versions, which to my mind will give some variable (opposing) views and choices on the musical affectual depictions found from the opera.

The English National Opera´s traditional "epoch" / pastoral perspective from 1984, gives a particular overview on the changes of the work. The other versions sung in their original language in Italian have various emphasis based on their overall productions according to which I have titled them as "satirical / hunting, the Peter Sellar´s version from 1990, and "colonialist" / military, the Glyndebourne performance from 2005.

Caesar´s state of mind starts from his victorious mood which will be introduced in his opening aria, towards more justified revenge (a positive act), via his longing for love to consolidation of alliance between the two states, Rome and Egypt and constancy of his love towards Cleopatra (loyalty), set by him as the ruler of Egypt. Cleopatra begins by a joyful expectation wishing for good prospects (an act of innocence). By awaking love, she hopes to cast herself into power and as the sole holder of the throne. She will achieve her goal by dubious seduction (an act of a negative love), but her emotions and motives will be cleared and revealed by her true affects of despair, lamenting and victorious revengefulness (acts of catharsis) over Caesar´s enemies, and finally by her fairness through her love (an act of positive love) towards Caesar and justice. Beauty is being celebrated here as a morally virtuous act (a realization of justice, righteousness).

4.2. Protagonist roles

Both the musical key relations and time signatures of Caesar´s and Cleopatra´s arias suggest that there is an antithesis of characters set by Handel. Cleopatra starts with the key of fate and love (in E major) and pilots the way for Caesar´s emotional side which is hidden at first by his acts of bravery (in C major) which in the end prove to be also acts of true and righteous love.

On the other hand, Cleopatra hides her real thirst-for-power motives under her disguise of love, and pastoral charm attempts, so nothing is foretold in the beginning of the opera although the ideals have already been introduced by Handel at the beginning of the work. In his aria "Presti omai" he is already being proudly self-assertive, inviting the people to receive and accept him as a victor. His musical affect is heroic, in an Allegro-duple meter, in D major key. Onwards moving harmony is connected with accentuated melodic line, which alternates between larger leaps, intervals and a stepwise progression containing with coloratura fragments.

Already in the third scene of the first act, Caesar performs his second aria, which depicts his second important character type: the warrior. Since the beginning, he is introduced as a high-ranking person within the hierarchy of the characters. He is triumphant, victorious and militant character type, which status continues to be confirmed both by textual and musical means the course of the opera. His flawlessness and masculinity are being emphasized directly and indirectly. In a monologue "Alma del gran Pompeo" he reflects a brave hero´s fragile lifespan. Here the accompanied recitative instead of an aria stresses that this is a reflection, contemplation. The music functions as a support, clarifying the text as declamatory forth bringing force by heavily and dark accented strokes of strings.

The hero´s noble position will be strengthened by the opening´s majestic Largo, in which the French overture´s tone is prevailing with the dotted Sarabande figures. Modulating harmony attests his pondering and searching state of a mind. One can sense how the moods of the protagonists proceed from aspiring to certainty by Cleopatra and assuring reliability of Caesar´s faculties to reign and to effect on Cleopatra. (Ethnersson, 2005).

5. Comparing the performances

By Sellar´s (1990) Cleopatra´s pastoral innocence is questioned right from the start, as she is depicted as a girl, who is used to luxury, and both she and her brother Ptolemy show a shallow side of themselves by being fond of commodities offered by the superpower, which in turn is represented by Caesar, also parodied here, by his exaggerated need for protection and surveillance. ENO´s production gives wittier character to Cleopatra, to whom her brother does not give much of a competition, so it is obvious that she possesses those special abilities required from a ruler. Caesar´s role is also stabilized by ENO´s production as he seems to be mostly equal to his position.

Glyndebourne´s version is shadowed by warlike efforts, the sets are decorated by fleets and zeppelins in the background, yet the overall mood is positive and mellow, almost musical-styled with athletic gestured dance scenes. Cleopatra is shown as a real queen with "Egyptionized" choreographies including symbols of ancient Egyptian deities of the royal powers, which refer to her historical Greek (Ptolemaic) origins, and to her aims for having tried to please her subjects by maintaining the traditions despite of the new winds blowing from Caesar´s direction, Rome.

Sellar´s view on baroque dance forms occurs as a satirical tool for his palette of sharp typed of ballet gestures in a French manner by which the overture of the opera is also written. Handel´s performance direction of "majestic" will be questioned, as are all actions into gaining exclusive power, opposing to that of an autocrat. ENO´s reply to that is choosing the legitimate alliance of two rulers.

While Glyndebourne´s route is gaining sovereignty by agreeing on peace and by the importance of emphasizing signing the peace treaty. Which one of these might be Handel´s choice in the end, one could play with this thought for a fleeting moment, but then again he has left choices open for the performers to close, solve or unfold.

The main theme of the opera which is love is being celebrated and highlighted in the end of the work, in the finale. Love is peace in Giulio Cesare by Handel, which proves to make out of him one among pacifists of his time. So probably the ultimate message of the work is as follows: "let there be peace on earth for all people".

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Julius Caesar (1984 [1979]). D: John Copley (live performance in 1979) / John Michael Phillips (video in 1984). M: G. F. Händel. Mr: English National Opera Orchestra by musical direction of Sir Charles Mackerras. C: Michael Stennett. S: John Pascoe. A/S: James Bowman – Ptolemy, Valerie Masterson – Cleopatra, Sarah Walker – Cor nelia, Della Jones – Sextus, John Tomlinson – Achillas. P: HBO / Pioneer. L: c. 180 min. An abbreviated version of the opera, which is sung in English, and translated into English by: Brian Trowell.

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(Abbreviations: D = Scenic direction, M: music, Mr: musical realization/performers, S =Staging/sets, C = costume design, A/S = actors/ soloists, P =publication, L= length).

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EFFECTS OF MUSIC ON EMOTION REGULATION: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Music and its use for emotion regulation processes, to this day remains an unresolved question. Multiple experimental layouts encompassing its daily life use and clinical applications across different cultures and continents have preserved music as a self-regulative tool. Therefore it is seen as a very individual but by some researchers cross-culturally, accepted therapeutic tool. Large amounts of recent studies demonstrate the effects of music on emotion and emotionally evoked processes. A thorough literature search was conducted across the data bases for the timeframe from January 2001 to July 2012; CINAHL, EMBASE, PubMED, PsychINFO, The Cochrane Library, Eric, Psychology and behavioral science collection, SpringerLink, google scholar, picarta, Web of Science, Science Direct, DARE,Worldcat, and handsearch. Inclusion criteria encompassed youth/adolescents from 10 to 29, including healthy as well- as clinical populations. Music intervention and emotion regulation measures were viewed and included only when at least forms of music participation (singing, playing, listening, engagement) were noted in the study and effects on emotion regulation were directly measured. The interrelations between the effects of music on emotion regulation and the use of it as a purposeful instrument, e.g. music interventions for specific educational or therapeutic functions, yielded limited results. Music has a 'self regulative capacity', but is restricted as valuable instrument for specific emotion regulation interventions. This review presents the effects of music on emotion regulation for youth population, detecting 1) insufficient adequate (clinical) studies about the purposeful use of music for emotion regulation, and 2) insufficient actively used music interventions, like listening, singing, playing in academically studies.

Keywords: emotion processing, emotion regulation, music and emotion

1. Introduction

Humans spent an average of 18 hours a week (Rentfrow 2012), and an increased amount of money (1000% increase since 2004; Rentfrow 2012) on various forms of music activities. Music is wildly used, described in different ways and its complexity and effects are multi interpretable. Music can involve cognitive processes influencing attention, memory, categorization, motor action planning, prediction, communication and emotion (Levitin 2009), while large amounts of recent studies demonstrate the effects of music on emotion and emotionally evoked processes (Koelsch 2012, 2009; Koelsch et al. 2011; Juslin and Sloboda 2011; Peretz 2009; Schlaug 2009; Levitin 2009; Patel 2008; Thaut 2005). In this review, music will be described as an instrument for processing and regulating emotions in humans. This description has been found in different cultures where humans preserve music as a self regulative tool; a very individual however cross-culturally accepted therapeutic instrument, as research of Boer and Fischer (2010) and Chamorro-Premuzic et al. (2009) show. The researchers in this review have widely agreed on music as an effective regulative tool for emotions. Its capacities range from arousing and intensifying specific feelings, evaluating and accepting – especially – negative emotions and mood management as well as coping and facilitating thoughts and feelings (Thoma et al. 2012; Miranda 2012; Rentfrow 2012; Boer and Fischer 2010; Goethem and Sloboda 2011; Miranda and Gaudreau 2010; Sarikallio 2007, 2008, 2011; Chamorro-Premuzic et al. 2007, 2009; Greenwood and Long 2009; Sarikallo and Erkkilae 2007 and Mennin et al. 2005). Moreover, the use of music as an active intervention to measure how individuals actually regulate their emotions is limited. This review will present the gap between existing studies as reviewed by Miranda (2012), Rentfrow (2012) and Saarikallio (2007, 2008, 2011), and inspecting the effects of music on emotion regulation purposes. Measurements of applied use of music as active intervention tool are scarcely presented, in addition to the limited interest on emotion dys-regulation, an important perspective for psychopathology and health not only in clinical studies.

2. Results

The 13 included studies about music and emotion regulation for youth populations (10-29) were categorized in age groups: adolescents (age M=15.11), youth (age M=21.88) and young adults (age M=28.7). The age categories reflect divergent developmental stages and abilities of adolescents, youth and young adults. From the 13 included studies, 12 studies are non-clinical studies, only one study revealed clinical case descriptions. A general overview of all included studies is presented in table (1).

3. Discussion

The robust empirical studies of everyday listening effects of music here presented are one sided: most samples are taken from (non-psychopathologic, not diagnosed or healthy) university students of common social and economical background, reporting about their experiences after music listening, filling in dairies, questionnaires, online surveys and interviews. Representative samples of schoolchildren are exclusive, only one large study of schools (Finland) (Saarikallio 2008) was found. 12 of the 13 included studies are non-clinical studies, and only one of these studies integrated psychopathological tests in a university setting (Mennin et al. 2005). Further, only one study offered active music making in the only clinical setting (Plener et al. 2011), and two studies applied music listening interventions (Thoma et al. 2012, Mennin et al. 2005). Reflecting, talking and writing about the use of music seem to be most applied interventions, but we believe that they do not echo real effects of music on emotion regulation of the individual. Music is very complex, containing musical elements as rhythm, melody, timbre, harmony and dynamics and is therefore in-separately to any measurement of music making and listening. Purposefully, goal-oriented application like music interventions of active listening, singing or playing for specific emotion regulation purposes in education or therapy, in schools or clinical settings are rare. These studies are very poorly researched and documented. Nevertheless, applied music for this emotion regulative purpose can be directly measured while influencing and affecting participants, like the study of Mennin et al. (2005) demonstrated. More detailed research studies of multidimensional aspects are in demand, including regular participants with and without psychopathology, using control groups and measuring directly the effects of music (on health). Also Miranda (2012), Rentfrow (2012), Rottenberg and Gross (2007) as well as Aaldo (2013) urge for more detailed and combined studies, building bridges between researchers, educators and therapists, focussing on emotion regulation for real world participants. Furthermore, the direct influence of music on health and psychopathology, like thoughts about emotional (dys)regulation are supported by Mennin et al. (2005), Thoma et al. (2012) and Ellis and Thayler's (2010) relating to the effects of music on the autonomic nervous system and its therapeutic relevance. Emotional dys-regulation in case of depression, BPS, ODD/CD, anorexia and anxiety (GAD) reported difficulty evaluating, managing and accepting negative emotions and makes it complicated to achieve emotional and physiological health, whereby

Table 1. General overview of included studies

Table A: population settings
Table B: treatment/measurement/gender participants

Table A: population setting

Populations/ research setting	**Adolescents/clinical**	**Adolescents/school**	**Youth/young adults universities**
Studies	**1 pilot**	**3**	**9**
inpatient/outpatient	**Outpatient**	**Non-clinical**	**Non-clinical**

Table B: intervention/measurement clinical/non-clinical study

Intervention	**1 study live music MT band project & DBT-A**	**Total: 12 studies experiences about music listening; 10 studies without + 2 studies with applied music listening intervention (column right)**	2 studies applied music listening intervention
Measurements	**Diary card, tests, parent sessions, psycho education**	**self-rating lists/online survey, interview**	tests/questionnaires
Participants adolescents/youth	**N=5 outpatient clients psychiatric youth unit**	**N=4588 schools + universities**	N=89, N=122 university students
Gender	**females**	**females 2761; males 1790 18 participants no gender recorded; 1study no gender recorded**	study 1: 41 females, 48 males study 2: 69% female, 41% male
Adolescent ages	**14-16**	**3 studies M=15.11**	
Young adults ages		**9 studies M=21.88 1study M=28.7**	study 1: M=24.29 study 2: M=19.52

misinterpretations of emotional valences and musical emotions can appear. Music might be able to prevent psychopathology, by using music making and listening as natural intervention of health promotion to increase or restore wellbeing (Plener et al. 2011, Miranda 2012, Miranda and Gaudreau 2010, Saarikallio and Erkkilae 2007). Therefore, the purposeful application of music for 'self-regulation' (Blair and Diamond, 2008) is required whereby the cognitive and behavioural processes through levels of emotional, motivational, and cognitive arousal are combined for positive adjustment and adaptation. And these multidimensional processes of life command specified music interventions, integrating difficulties of emotional dys-regulation for reliable results which are valid for school environments, universities as well as clinical settings.

4. Conclusion

The clinical as well as the non-clinical studies, all demonstrate the effective use of music as self-regulative tool for emotions. Despite the diversity between the study designs, using active music making and listening versus reflective and non-experimental use of music, all studies revealed the individual applications of music for personal employ, promoting self regulative skills for positive adjustment, which are culturally comparable between all tested societies. These studies support the general agreement of this review that music listening is most frequently used with a large range of goals and strategies for emotional regulation purposes.

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EMOTIONS IN CONCERT: PERFORMERS' EXPERIENCED EMOTIONS ON STAGE

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Abstract

Music is often said to be expressive of emotions. Surprisingly, not much is known about the role of performers' emotions while performing. Do musicians feel the musical emotions when expressing them? Or has expressive playing nothing to do with the emotional experiences of the performer? To investigate performers' perspectives on the role of emotions in performance, we conducted qualitative in-depth interviews with nineteen musicians teaching or studying at a European conservatoire. In the interviews, musicians were first asked to describe a recent performance experience in as much detail as possible, then to make a visual representation of their experiences on stage, and finally, to answer some general questions about the role of emotions in performance. Qualitative Thematic Analysis of the interview transcripts revealed a difference between performance related emotions and emotions related to the music. In addition, a difference was found between emotional and expressive playing. To allow the music to be expressive of emotions, performers seem to feel the musical emotions to some extent, while they make sure to have the technical ability to express them on their instrument, and stay in control of their playing.

Keywords: performing musicians, felt emotions, expressive performance

1. Introduction

Do musicians feel the musical emotions when expressing them? Or has expressive playing nothing to do with the emotional experiences of the performer? Little is known about the relationship between felt and expressed emotions in performing musicians (Gabrielsson, 2001-2002). Some musicians and researchers adhere to the vision that 'A musician cannot move others unless he too is moved' (C.Ph.E. Bach, quoted in Persson, 2001). Others argue that performing is more a matter of deliberate conscious awareness and planned expressiveness: 'I also have to play pieces which are not so emotionally connected to me, because I am a professional' (pianist interviewed by Sloboda & Lehmann, 2001).

Expressivity is a multi-dimensional and largely investigated subject (e.g., Juslin, 2001; 2003), as is the study of whether music is expressive of emotions (e.g., Juslin & Laukka, 2003; Vuoskoski, 2012). Surprisingly, there is little systematic knowledge about whether performers' experienced emotions play a role in the creation of an expressive performance (Juslin, 2009).

In several studies (e.g., Woody, 2000; Karlsson & Juslin, 2008), playing expressively and playing with emotions are considered as being one and the same. Studies by Lindström et al. (2003) and Van Zijl and Sloboda (2011), however, suggest that there might be a difference between emotional and expressive playing.

Lindström et al. (2003) conducted a questionnaire study to investigate how conservatoire students approach the subject of expressivity. They found that 44 percent of the students defined 'playing expressively' largely in terms of 'communicating emotions', while 16 percent defined 'playing expressively' in terms of 'playing with feeling'. According to Lindström et al., the first way of defining focuses more on actually conveying something to the audience, whereas the second one focuses more on the performer's own feelings.

In a diary and interview study investigating performers' emotions during the process of constructing an expressive performance in private practice or rehearsal, Van Zijl and Sloboda (2011) found that music students described 'emotional playing' as 'just feeling and enjoying the music'. In the case of an expressive performance, the communication of a previously constructed musical interpretation to an audience seemed to take centre stage, rather than the performers' own feelings.

In the present study we aimed to investigate what role performers' experienced emotions play on stage, by asking performers to reflect on a recent performance experience. In addition, we aimed to explicate the meaning of emotional and expressive playing in music performance.

2. Method

2.1. Participants

Participants in the present study were nineteen musicians (11 females), teaching (N = 6) or studying (N = 13) at the Guildhall School of Music and Drama, a conservatoire in London, United Kingdom. Participants played the violin, viola, cello, double bass, flute, clarinet, French horn, percussion, harp, or piano. Classical music was the stylistic aim in education for all participants. Participants were recruited via an invitation email.

2.2 Procedure

The in-depth, semi-structured interviews consisted of four parts. In the first part, the structure of the interview was explained, participants were asked to sign a consent form, and given the opportunity to ask any questions. In the second part, participants were asked to think of a recent performance experience. They were encouraged to describe this experience in as much detail as possible, and describe what they experienced before the performance, when going onstage, when starting to play, while playing, when ending the performance, and after the performance. In the third part, participants were asked to make a visual representation (with pencil on paper) of their experiences on stage. In the fourth part, participants were asked to answer some general, reflective questions: how they would describe their ideal performance, how they would describe emotional and expressive playing, whether emotions help them and whether they hinder them, to what extent they think emotions are necessary for a successful performance, if they could think of any aspect related to emotions not discussed yet, and whether they had anything to add or ask. The interviews typically lasted about 60 minutes (range: 50 – 90 minutes).

2.3. Analysis

The interviews were transcribed and subsequently analysed by means of Qualitative Thematic Analysis. This involves an interpretative analysis of textual meaning based on a coding scheme derived both deductively from pre-existing concerns, questions and hypotheses, and inductively from examination of the actual data (Seale, 2004).

3. Results

Analysis of the interviews allowed a detailed characterisation of the role of performers' emotions on stage. A distinction was revealed between performance-related emotions and emotions related to the music. In addition, it was found that emotional and expressive playing were perceived in different ways.

3.1. Performance-related emotions

Performance related emotions as described by the musicians were emotions such as excitement or anxiety, and they were typically featured by an urge to move or play faster, and bodily sensations such as sweaty hands, muscle tension, or trembling. In the words of two of the participants:

> I noticed that I was shaking slightly, like round my embouchure area. Erm…and I had, like, sweaty palms. But that's like a standard thing, really, when…well, when anyone performs, I guess. (Clarinettist, student)

> …I was worried that I would mess up my playing and then it would be really embarrassing. But I think it just takes practise. Performance needs to be practised. (Harpist, student)

3.2. Music-related emotions

In addition to emotions related to the act of performing in front of an audience, performers tend to experience emotions in relation to the music they perform. The present study revealed that music-related emotions reflect a complex relationship between the music and the performer. This is illustrated by the following quote:

> …Schubert G Major Quartet is such a work of immense scope and magnitude, and it really deals with the essence of light and dark and optimism and despair. Erm…and I guess in the music he has reflected that, very simply, in major and minor, and so there's a huge, sort of, dialogue between major and minor, even from the very first…or even from the opening of the piece. Erm…and I think also…I mean, obviously, he knew that he was dying when he wrote it, and…erm… Every person's interpretation of what he's written, I guess, would be different, but for me, I just do find a huge…erm…sense of loss and…and anger: I think there is anger in this music, or maybe anger at the loss that he's going through, in saying goodbye to his life. Erm…and also, huge tenderness as well, so…that's…that's, I guess, what I mean by extreme music. Because it encompasses such a huge scale of…of human emotion. Erm…and so, in this particular performance…erm…I just…I felt very connected to…to that. And… I…I felt able…to really…I felt very sad. I felt…I felt really sorry for him. And I felt…I could also identify, as I was playing, I could identify with the anger in the music, and the despair, and the loss, and…erm…and I guess…I feel that I was able to, at least for myself, connect with that physically, and sort of manifest it on my instrument. And it…and it gave me like a spur of energy. To actually…to creating the line of music the way that I feel it. (Viola player, staff)

The score played a central role in the accounts of the musicians interviewed. This may reflect the fact that in classical music, the score, the composer's intentions, and conventions regarding styles of playing occupy centre stage. A score, however, needs to be interpreted. The process of interpreting the score mainly takes place in the practise room, where musicians translate the notes into a musical narrative and try to find and master the technical means to manifest the narrative on their instruments (see also Van Zijl & Sloboda, 2011).

In order to bring the musical narrative to life, on stage, the musicians in the present study tend to connect emotionally with the musical narrative by relying on life experiences, and connecting to the reason why they are musicians: their love for music, the desire to share their music with others, and the belief that music has some deeper meaning which needs to be understood and communicated.

When connecting emotionally with the musical narrative, all participants emphasised the importance of maintaining a balance between being emotionally involved (in a way a listener might be) and being in control of their playing. In addition, all musicians emphasised the need to have the technical ability to express the musical narrative on their instrument. The balance between being emotionally involved and being in control of their playing is reflected in the performers' perspectives on emotional and expressive playing.

3.3. Emotional playing

In the interviews, all musicians described the difference between emotional and expressive playing in a similar way. Emotional playing was associated with genuine playing, with experiencing raw emotions, and with directly feeling the emotional impact of the music. In the words of several participants:

> 'Emotional'... it's more of an adrenaline driven thing. I mean, in the moment, if you can...if you just feel the sudden sensation or emotion, it can really carry you. (Violinist, student)

> 'Emotional' is being involved in... in a very personal way...and feeling very directly the emotional impact on me while I'm playing... I'm going through the feeling, while I'm playing. (Flautist, staff)

> ...it's feeling the emotion you're dealing with when you play. And feeling a sense of catharsis or...or...it's almost a variant on...on having an orgasm while making love. Really. It can get to...to that. It's, of course, not the same, and...but some...some of the sensation is similar. (Pianist, staff)

In addition to emotional playing as a positive and personal experience of the music, emotional playing was associated with the risk of getting carried away, and losing control of performance. In the words of two participants:

> ...sometimes it's very easy to get so carried away that you're not in the room anymore. And then suddenly you come back to the room and it really sort of makes you jump, and...I think...erm...yeah: if you get too carried away, you go too far into your thoughts, and then when you come back into reality, it's quite a...a shock. And that's what makes you make mistakes, I think. (Pianist, student)

> When I get emotional, I'm carried away, and I...I lose the sense of... my feeling is it's a risk of losing the sense of control, which is so important for...erm...you know: successful performance. (Flautist, staff)

Several musicians gave examples of concert situations in which they got carried away too much. In the words of one of them:

> ...today, I played the Shostakovich Prelude and Fugue No. 15, and the fugue is just insane. Like, the hardest thing I've ever attempted to play in my entire life. And...erm...because it was so difficult, and I was so excited by the...just the whole...the whole fugue is just basically...the emotion behind it, I'd probably describe it as something like... erm... bizarre madness... erm... and excitement with anxiety at the same time. It was weird. But it's like really, really, really excited, and...you know: no rest in it at all, you know. So, as a performer, I have to try and generate that, you know, while I play it. And I just got so carried away in the middle that the technical aspect of it - which is very important...erm... probably because I was focusing on the meaning behind it more than the technique - then...erm...the technique got lost, and in losing the technique, you lose some of the communicative power, you know? Which is...er...a shame. (Pianist, student)

All musicians agreed that experiencing emotions while playing is important for their motivation to practise and perform. However, most musicians indicated that it is not that helpful to experience strong emotions on stage. In the words of two participants:

> ...the strong emotional experience possibly is not helpful at the time of performance. (...) I think my job is to play as beautifully as possible, and...and... in a way that doesn't distract anybody that's listening. So if I knock over a few notes, that's going to be distracting, and is going to stop the music having its effect on somebody else. So it's my responsibility to actually...you know: someone else receives; I give. (French horn player, staff)

> Well, I think you have to control your emotions, basically, because you're not only...you have to...there's a physical element to playing an instrument, and as much as we'd like it all to be completely free or whatever, you have to assert some control, and control, kind of in some sense, goes against emotion. Like, raw emotion.
> (Cellist, student)

3.4. Expressive playing

Expressive playing, on the other hand, was associated with playing what the score prescribes, with bringing out the structure of the music, and having the technical ability to express the composer's intentions. In the words of three participants:

> 'Expressive' playing can be something which is...erm... done more in a distance from the emotion itself, from the pure emotion. It's more a musical phenomenon. It's about... maybe

> more thinking about the differences in, you know: timing and timbre and whatever. Er... changing the music, you know, moment to moment, and fluctuations of all the musical parameters. 'Expressive' means being in and out at the same time. I'm observing while I'm doing, while experiencing. (Flautist, staff)

> 'Expressive' playing may suggest more that it comes from the music. So somebody who really thought about the music and really chooses which notes to...to lean on, for example. Erm... and it... has a real awareness of the structure of the whole piece, so you feel like they know where they're going in the piece, and they take you on that journey. Expressive playing makes me think of somebody who's actually really studied the score and worked out what they want to do with each part of the music.
> (Pianist, staff)

> ...expressive playing, I would say, contains the emotional aspect, and contains everything you feel about it, but you're also able to express it to somebody else... as opposed to keeping it in your head and just hoping it comes out. Erm...but having...having...yeah: having something to say and the tools to say it.
> (Violinist, student)

Although several musicians believed that one could give a successful performance without being emotionally involved, it was suggested that being emotionally connected with the musical narrative might turn a technically perfect performance into a remarkable one. In the words of two participants:

> I think emotions might not be very essential if you have flawless technique. If you play everything correct... if you play the music beautifully, it is a successful performance. But maybe it's not the best performance. I think emotion, it's... it makes it the top. (Harpist, student)

> I think if the emotions are channelled in the right way then they can really make a special performance, but I think that you could have a really brilliant performance without necessarily somebody having to be emotionally involved. (Pianist, staff)

On stage, the interviewed musicians all aimed for expressive playing rather than emotional playing. They seemed to identify with and feel the musical emotions to some extent, while making sure to have the technical ability to express the musical emotions on their instrument, and while being in control of what they are doing.

4. Discussion

In the present study we aimed to investigate what role performers' experienced emotions play on stage, by asking performers to reflect on a recent performance experience. We found a difference between performance-related emotions and emotions related to the music. As regards the music-related emotions, a complex relationship was found between the music and the performer.

In addition, we aimed to explicate the meaning of emotional and expressive playing in music performance. In line with the findings by Lindström et al. (2003) and Van Zijl and Sloboda (2011), we found a difference between emotional and expressive playing. Emotional playing was associated with genuine playing, with experiencing raw emotions, and with directly feeling the emotional impact of the music. It was also associated with the risk of getting carried away, and losing control of performance. Expressive playing, on the other hand, was associated with playing what the score prescribes, with bringing out the structure of the music, and having the technical ability to express the composer's intentions.

The finding by Lindström et al. (2003) that music students defined 'playing expressively' either in terms of 'communicating emotions' (focus on conveying something to the audience) or in terms of 'playing with feeling' (focus on the performer's own feelings), might suggest that the role of performers' experienced emotions in expressive performance is something musicians discover at some point during their education, and that musicians have to make the transition from approaching musical emotions as a listener to approaching musical emotions as a performer.

Although it is possible to experience strong emotions while playing, performers cannot neglect the fact that there is a physical aspect to playing an instrument, and that they are likely to make mistakes and lose control of their playing when getting carried away too much. In addition, just feeling something does not necessarily mean that that feeling is transmitted to an audience. Several of the musicians interviewed indicated how different a recording could sound to how they thought it would sound based on their experiences while playing. All musicians interviewed emphasised the need to translate the notes into expressive music by finding and mastering the appropriate technical means before entering the stage.

Do musicians feel the musical emotions when expressing them? Or has expressive playing nothing to do with the emotional experiences of the performer? The results of the present study suggest that performers feel the musical emotions to some extent, while they make sure to have the technical ability to express them on their instrument, and stay in control of their playing. The findings support the validity of distinguishing between emotional and expressive playing, and seem to be valuable for both research and artistic practice and pedagogy.

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THE SOUND OF SADNESS: THE EFFECT OF PERFORMERS' EMOTIONS ON AUDIENCE RATINGS

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Abstract

Very few studies have investigated the effect of performers' felt emotions on the audience perception of their performances. Does it matter what a performer feels or thinks about when performing? To investigate this, we asked four violinists to play the same musical phrase in response to three different instructions. The first instruction was to focus on the technical aspects of their playing. The second instruction was to give an expressive performance. Following a sadness-inducing mood induction task, the third instruction was to play while focusing on their felt emotions. High quality audio and motion-capture recordings were made of all performances. Subsequently, motion-capture animations, audio recordings, and motion-capture animations combined with audio recordings of the performances were presented to an audience. Thirty audience members rated how much they liked each performance, how skilled they thought each performer was, and to what extent each performance was expressive of sadness. Statistical analysis revealed that, overall, audience members preferred the Expressive performances to the Technical and Emotional ones. In addition, the Expressive performances were rated as played by the most skilled performers. The Emotional performances, however, were rated as being most expressive of sadness. Our results suggest that what performers feel or think about when performing does affect the perception of their performances by an audience.

Keywords: performing musicians, felt emotions, audience perception

1. Introduction

Many studies have examined listeners' ability to recognize emotions expressed in music (e.g., Gabrielsson & Juslin, 2003; Juslin & Laukka, 2003; Eerola & Vuoskoski, 2013). In addition, the characteristics of the music – in terms of composed features (e.g., mode, harmonic, and rhythmic structure), performance features (e.g., tempo fluctuation, articulation, vibrato), and performer features (e.g., body movement, facial expression) – leading to the identification of certain emotions have been investigated (e.g., Clarke, 1988; Gabrielsson & Juslin, 1996; Gabrielsson & Lindström, 2010; Dahl & Friberg, 2007; Livingstone, Thompson & Russo, 2009). However, little is known about how performing musicians actually try to achieve a performance expressive of emotions, and whether performers' felt emotions play a role in this process (Gabrielsson, 2001-2002). Should musicians feel the musical emotions when expressing them? Or should they rather focus on technique or expressivity when trying to bring a musical message across?

To investigate this, we asked performers to play the same musical phrase in response to three different instructions. This resulted in high quality audio and motion-capture recordings of so-called Technical, Expressive, and Emotional performances. Computational analysis of the audio recordings revealed differences in playing tempo, dynamics, articulatory features, timbral features, and the extent and rate of vibrato between the three performance conditions. The Expressive performances, for instance, were characterized by the fastest playing tempo, the loudest sound, the brightest and roughest timbre, direct note attacks, and a wide and fast vibrato, as compared to the Technical and Emotional performances (Van Zijl, Toiviainen, & Luck, 2012). Computational analysis of the motion-capture recordings revealed differences in body posture, amount, speed, acceleration, and smoothness of movement of the performers in the three performance conditions. In the Expressive performances, for instance, performers were standing most upright, and moved most, fastest, with the highest acceleration, and lowest smoothness, as compared to the Technical and Emotional performances (Van Zijl & Luck, 2013). Although computational analyses of the recordings revealed differences between performances played with a different focus of attention, the question remains whether these differences would influence audience perception of the performances.

To investigate the effect of performers' thoughts and feelings on audience perception, we asked audience members to rate each performance with regard to three statements. The first statement – 'I like this performance' – was related to preference. Do audience members have a preference for Technical, Expressive, or Emotional performances? The second statement – 'This performer is skilled' – was related to expertise. Do audience members perceive performers who focus on Technique, Expressivity, or felt Emotions as more skilled? The third statement – 'This performance is expressive of sadness' – was related to emotions. Do audience members perceive Technical, Expressive, or Emotional performances as most expressive of, in this case, sadness?

2. Method

2.1. Participants

Participants were thirty Master's Degree students (mean age = 28.07 years, SD = 5.64, females = 18) from a University in Finland. All participants had played a musical instrument (including voice) for at least one year, while the majority (63.3%) had played a musical instrument (including voice) for more than ten years.

2.2. Stimuli

The stimuli were performances of four violinists (two amateurs and two professionals, all females) who were asked to play the same musical phrase in response to three different performance instructions. The first instruction was to focus on the technical aspects of their playing (i.e., the Technical performances). The second instruction was to give an expressive performance (i.e., the Expressive performances). Following a sadness-inducing mood induction task, the third instruction was to play while focusing on their felt emotions (i.e., the Emotional performances). High quality audio and motion-capture recordings were made of all performances.

Subsequently, motion-capture animations were created using the MATLAB Motion Capture Toolbox (Toiviainen & Burger, 2010). Using the QuickTime 7 software, the motion-capture animations were paired with the audio recordings. A presentation film depicting the motion-capture animations, audio recordings, and motion-capture animations with audio recordings, was created using the iMovie software. The order of the performances was randomised within each presentation mode (see below).

2.3. Procedure

The performances were presented on a big screen in an auditorium. Participants were comfortably seated in the auditorium and the lights were dimmed, so as to resemble a real concert setting. Participants were asked to rate their agreement with the statements 1) I like this performance, 2) The performer is skilled, and 3) This performance is expressive of sadness, on a seven-point bipolar scale (completely disagree – completely agree). Participants were told that they would see or hear 36 performances played by different performers and with different performance intentions. They were neither told how many performers had provided the performances, nor what the performance instructions had been.

The performances were presented in three blocks, each block containing the same performances but presented in different orders. In the first block, the motion-capture animations were shown without sound (i.e., Vision-only). In the second block, only the audio recordings were played (i.e., Audio-only). In the third block, the motion-capture animations were shown with sound (i.e., Vision & Audio). After each performance, participants had 20 seconds to rate the performance, until a sound signal indicated the start of the next performance.

To make sure all participants understood the rating procedure, data collection was preceded by an example of the same musical phrase performed by a bassoon player. After rating all performances, participants were asked to write down any comments they had about the study and their experiences. Data collection lasted about 45 minutes.

2.4. Analysis

Participants' ratings were entered into SPSS and analysed by means of three (one for each statement) three-way repeated-measures ANOVAs with presentation mode (Vision-only, Audio-only, Vision & Audio), expertise of the performer (Amateur, Professional), and performance condition (Technical, Expressive, Emotional) as independent variables. Correlations between ratings of the three statements were analysed by means of Pearson's Correlation Coefficient.

3. Results

We present the findings in accordance with the three statements investigating preference, perceived expertise, and perceived emotional expression. Figure 1 depicts the main effects of presentation mode (1A), expertise (1B), and performance condition (1C), as well as the two-way interactions between presentation mode and expertise (1D, 1G, 1J), presentation mode and performance condition (1E, 1H, 1K), and expertise and performance condition (1F, 1I, 1L).

3.1. Preference

The Vision-only performances received the highest preference ratings overall (Figure 1A), although the main effect of presentation mode on preference ratings was non-significant, $F(2, 58) = 1.92$, $p > .05$. There was a significant main effect of expertise on preference ratings, $F(1, 29) = 8.81$, $p < .01$, with the performances of the Professionals receiving the highest ratings overall (Figure 1B). The Expressive performances received the highest preference ratings overall (Figure 1C), and the main effect of performance condition on preference ratings was significant, $F(2, 58) = 13.43$, $p < .001$, with Bonferroni-corrected posthoc pairwise comparisons revealing a significant difference between the Technical and Expressive performances ($p < .001$), and between the Expressive and Emotional ones ($p < .001$), only.

As illustrated in Figures 1D and 1E, significant interactions were found between mode and expertise, $F(2, 58) = 19.51$, $p < .001$, and between mode and performance condition, $F(4, 116) = 2.84$, $p < .05$. The interaction between expertise and performance condition (Figure 1F) was non-significant, $F(2, 58) = 0.40$, $p > .05$. In addition, a significant three-way interaction was found between mode, expertise, and performance condition, $F(4, 116) = 4.06$, $p < .01$ (not shown).

3.2. Perceived expertise

The Vision & Audio performances received slightly lower ratings of perceived expertise (Figure 1A), although the main effect of presentation mode on expertise rating was non-significant, $F(1.36, 39.39) = 0.42$, $p > .05$. There was a significant main effect of the performers' expertise on perceived expertise ratings, $F(1, 29) = 39.13$, $p < .001$, with the performances of the Professionals receiving higher ratings than the Amateur performances (Figure 1B). The Expressive performances received the highest ratings of perceived expertise (Figure 1C). The main effect of performance condition on expertise ratings was significant, $F(2, 58) = 25.75$, $p < .001$, with Bonferroni-corrected posthoc pairwise comparisons revealing a

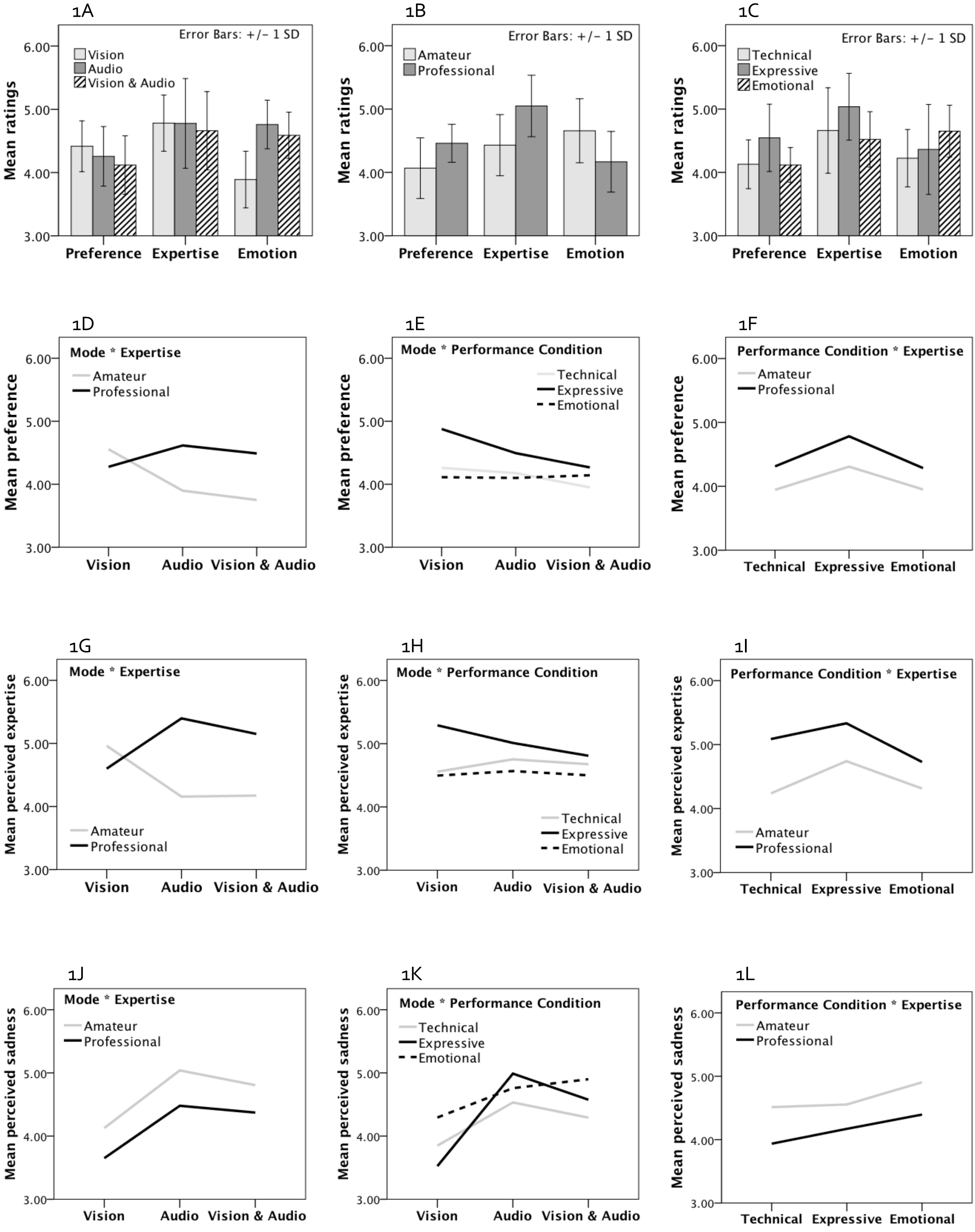

Figure 1. Main effects and two-way interactions of the repeated-measures ANOVAs.

significant difference between the Technical and Expressive performances ($p < .001$), and between the Expressive and Emotional ones ($p < .001$), only.

As depicted in Figures 1G, 1H and 1I, significant interactions were found between mode and expertise, $F(2, 58) = 60.54$, $p < .001$, between mode and performance condition, $F(4, 116) = 3.81$, $p < .01$, and between expertise and performance condition, $F(2, 58) = 3.27$, $p < .05$. In addition, a significant three-way interaction was found between mode, expertise, and performance condition, $F(3.17, 92.03) = 3.71$, $p < .05$ (not shown).

3.3. Perceived emotional expression

The performances in the Vision-only mode received lower ratings of perceived expression of sadness than the performances in the Audio-only and Vision & Audio modes (Figure 1A). The main effect of presentation mode on perceived emotional expression ratings was significant, $F(2, 58) = 15.38$, $p < .001$, with Bonferroni-corrected posthoc pairwise comparisons showing significant differences between the Vision-only and Audio-only presentation modes ($p < .001$), and between the Vision-only and Vision & Audio ones ($p < .01$), only. The performances of the Amateurs received higher ratings of perceived expression of sadness than the performances of the Professionals (Figure 1B). The main effect of expertise on perceived emotional expression ratings was significant, $F(1, 29) = 25.00$, $p < .001$. The Emotional performances received the highest ratings of perceived expression of sadness (Figure 1C). The main effect was significant, $F(2, 58) = 10.09$, $p < .001$, with Bonferroni-corrected posthoc pairwise comparisons showing a significant difference between the Technical and Emotional performances ($p < .001$), and between the Expressive and Emotional ones ($p < .05$), only.

As illustrated in Figure 1K, a significant interaction was found between mode and performance condition, $F(4, 116) = 7.41$, $p < .001$. As depicted in Figures 1J and 1L, the interactions between mode and expertise, $F(1.45, 41.93) = .24$, $p > .05$, between expertise and performance condition, $F(2, 58) = .67$, $p > .05$, and between mode, expertise, and performance condition, $F(4, 116) = 1.21$, $p > .05$ (not shown), were non-significant.

3.4. Correlations

A significant correlation was found between ratings of preference and perceived expertise, $r = .90$, $p < .001$. No correlation was found between ratings of preference and perceived emotional expression, $r = -.01$, $p > .05$, or between ratings of perceived expertise and perceived emotional expression, $r = -.14$, $p > .05$.

4. Discussion

Does it matter what a performer feels or thinks about when performing? The results of the present study suggest that a performer's focus of attention influences audience perception of a performance.

As illustrated in Figure 1C, statistical analysis of audience ratings revealed that, overall, audience members preferred the Expressive performances to the Technical and Emotional ones. In addition, the Expressive performances were rated as played by the most skilled performers. The Emotional performances, however, were rated as being most expressive of sadness.

When looking at differences between the Amateur and Professional performers, overall, the performances of the Professional violinists were rated higher in terms of preference and perceived skill. The Amateur performances, however, were perceived as being more expressive of sadness, as can be seen in Figure 1B.

The presentation mode, overall, did not really influence the ratings for preference and perceived expertise, as shown in Figure 1A. The presentation mode, however, did affect the ratings for perceived emotional expression. The ratings for perceived expression of sadness were much lower in the Vision-only condition.

The interactions between variables provided a more detailed view of the audience ratings. As depicted in Figures 1D and 1G, the presentation mode affected how the performances of the Amateurs and Professionals were perceived. In the Vision-only condition, the performances of the Amateurs received higher ratings in terms of preference and perceived expertise. In the Audio-only and Vision & Audio conditions, the performances of the Professionals were rated higher. Analyses of the performers' movements revealed that the Amateurs moved more, more slowly, more smoothly, and with less acceleration than the professionals (Van Zijl & Luck, 2013). It seems that more extensive and more fluent movements were perceived as more pleasing, and were associated with a higher level of musical expertise – in the absence of sound. If we compare the ratings in the Vision & Audio condition to the Vision-only and Audio-only conditions, it becomes clear that the audience members were guided more by sound than by vision in their ratings.

As illustrated in Figure 1J, the performances in the Vision-only condition received the lowest ratings for perceived expression of sadness. This might be explained by the presentation order of the stimuli: When rating the performances in the Vision-only condition, the audience members did not know the piece that was played – although they heard it in the example performance. In addition, it might be difficult to infer the emotional expression of a performance by looking at motion-capture animations without the accompanying sound.

In all presentation modes shown in Figure 1J, the performances of the Amateurs were rated higher than the performances of the Professionals in terms of perceived expression of sadness. In addition to the differences in performers' movements, the differences in audio features of the Amateur and Professional performances might have been of influence here. Analysis of the audio features revealed that the Amateurs played slower, softer, with less direct note attacks, a different timbre, and a wider and slower vibrato, as compared to the Professionals (Van Zijl, Toiviainen, Luck, 2012). It seems that both the movement and auditory characteristics of the Amateur performances were more in line with the characteristics generally associated with the expression of sadness (e.g., Crane & Gross, 2007; Juslin & Laukka, 2003).

As illustrated in Figures 1E and 1H, the Expressive performances received higher ratings than the Technical and Emotional performances in terms of preference and perceived expertise of the performer in all modes of presentation. The presentation mode interacted in different ways with the Technical, Expressive, and Emotional performances. Again, this might be explained by the audio and movement characteristics of the performances. The Expressive performances were characterised by the fastest tempo, the loudest sound, the most bright and rough timbre, direct note attacks, and a wide and fast vibrato, as compared to the Technical and Emotional performances (Van Zijl, Luck, Toiviainen, 2012). In addition, in the Expressive performances, the performers moved most, fastest, with most acceleration, and lowest levels of smoothness, as compared to the Technical and Emotional ones (Van Zijl & Luck, 2013). The Expressive performances seemed to be of a more extraverted character, which was appreciated by the audience.

As depicted in Figure 1K, the ratings of perceived sadness were different for each presentation mode. In the Vision-only condition the Technical performances were perceived as being most expressive of sadness, followed by the Emotional and Expressive ones. In the Audio-only condition, The Expressive performances were rated highest, followed by the Technical and Emotional ones. And in the Vision & Audio condition, the Technical performances scored highest, followed by the Expressive and Emotional ones. Whereas the pattern in the Vision-only condition might be related to the movement characteristics of the performers (e.g., performers moved least in the Technical condition and most in the Expressive condition), the patterns in the other modes are difficult to explain.

As can be seen in Figure 1F and 1I, the performances of the Professionals received higher ratings in terms of preference and perceived expertise than the performances of the Amateurs. The Expressive performances of both the Amateur and Professional performers received higher ratings than the respective Technical and Emotional ones. As depicted in Figure 1L, in case of perceived expression of sadness the performances of the Amateurs received higher ratings than the Professional performances. In case of perceived expression of sadness, the Emotional performances of both the Amateur and Professional performers received higher ratings than the respective Technical and Expressive ones. The finding that audience members preferred the Expressive performances and believed they were played by the most skilled performers but perceived the Emotional performances as being most expressive of sadness might suggest that a more external focus of the performer (i.e., 'give an expressive performance') results in a 'better' performance, whereas a more internal focus (i.e., 'focus on felt emotions') results in a performance more expressive of emotion.

Should musicians feel the musical emotions when expressing them? Or should they rather focus on technique or expressivity when trying to bring a musical message across? The findings of the present study suggest that a performer's focus of attention affects the perception of the performance by an audience. It was found that audience members perceived the Emotional performances as more expressive of sadness than the Technical and Expressive ones. It seems that sad feelings of the performer can make a sad piece of music sound sadder. Although we cannot simply equate the lab setting of the present research with a real concert situation, the findings are valuable for music research, education and performance: It does matter what a performer feels or thinks about while performing.

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THE EFFECTS OF NICOTINE ON MUSIC-INDUCED EMOTION

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Abstract

Nicotine is an available drug widely self-administered in the context of music (e.g. pubs, clubs). Furthermore, nicotine effects one's physiology, which allowed us to test the effects of these physiological changes on the emotional experiences of music. We hypothesized that because nicotine changes one's physiology it may also change one's affective arousal in response to music. To test this, non-smokers were administered nicotine gum at either 2mg, 4mg, or placebo level. Participants then listened to 4 musical excerpts: happy, sad, neutral, and self-selected chill-inducing. After each listening, participants rated their emotional responses on 6 intensity scales: arousal, pleasure, happy, sad, familiar, and liking. Although nonsignificant, results showed a trend, as nicotine levels increased pleasure and happy intensity ratings correspondingly decreased. Future research may be interested in testing these effects in dependent and nondependent smokers.

Keywords: music, emotion, nicotine

1. Music and nicotine as sources of pleasure

Despite that music lacks the canonical features of pleasure induction, such as biological necessity, secondary reward, or addictiveness, we know that listening to music is indeed pleasurable. In a series of studies by Dube and Le Bel (2003) music was consistently rated as one of the top ten activities found to be pleasurable. Among the four categories of pleasure found (physical, social, intellectual, and emotional) music was categorized as a form of emotional pleasure.

Damasio (1999) suggests that pleasures arising from social and physical antecedents may stem from evolutionary goals. For example, the social pleasure of a strong family bond helps protect the family, while the physical pleasure of sex perpetuates the species (Berridge & Kringelbach, 2008; Levitin, 2008). However, pleasures arising from intellectual and emotional antecedents may be more convoluted, and seen as 'pleasures of the mind' (Dube & La Bel, 2003). For example, emotional pleasures require complex appraisal and consist of both positive and negative emotions. Furthermore, an experience of emotional pleasure is likely to begin with joyful anticipation before the antecedent is encountered (Dube & La Bel, 2003), a claim corroborated with musical stimuli (Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011). Categorizing music as an emotional pleasure may help explain why it does not demonstrate a biological necessity, but is still considered pleasurable.

Although music may be classified as a non-biological form of pleasure it is shares the same cerebral pathway as other, more biological antecedents of pleasure (Gebauer, Kringelbach, & Vuust, 2012). That is, music activates the dopaminergic system of the brain and it is this system which is associated with the wanting of rewards, such as food, sex (Berridge &

Robinson, 1998; Wise, 2006), and gambling (Shizgal & Arvanitogiannis, 2003).

Music also activates the brain structures most associated with pleasure. Blood & Zatorre (2001) and Menon & Levitin (2005) found that listening to highly pleasurable music activated the limbic and paralimibic regions of the brain, areas particularly implicated in reward (Rodriquez de Fonseca & Navarro, 1998). These studies also found activation in the mesolimbic pathway including the ventral striatum, nucleus accumbens, ventral tegmental area, and amygdala (Blood & Zatorre, 2001; Menon & Levitin, 2005; Mitterschiffthaler, Fu, Dalton, Andrew, and Williams, 2007). The mesolimbic system is particularly responsible for assessing the value of a potential reinforcer of reward (Adinoff, 2004). Another system, the mesocrotical pathway, which is connected to the mesolimbic pathway and is also involved in reward assessment, was found to be activated via the orbitofrontal cortex and anterior cingulate cortex (Blood & Zatorre, 2001: Menon & Levitin, 2005; Mitterschiffthaler et al., 2007). These brain areas are well established for their involvement in the release of dopamine (Berridge & Robinson, 1998) and in the experience of pleasure (Berridge & Kringelbach, 2008). For example, they are activated in response to highly pleasurable activities such as euphoria and drugs of abuse (Blood & Zatorre, 2001; Menon & Levitin, 2005).

Nicotine is also a source of pleasure as evidenced by its addictive qualities (Dani, Ji, & Zhou, 2001; Balfour, Wright, Benwell, & Birrell, 2000). For example, smoking has a cessation rate of only 20% (Balfour et al., 2000). In laboratory conditions nicotine elicits reinforcing behavior, such as intravenous self-administration of the substance and place preference (Corrigall, 1999; Di Chiara, 2000).

As with other addictive substances nicotine enhances reward from brain stimulation (Dani, Ji, & Zhou, 2001). Nicotine increases reward by activating nicotinic acetylcholine receptors (nAChRs) located in the ventral tegmental area (VTA) of the midbrain. These receptors produce neuronal excitation via the release of glutamate neurotransmitters. Glutamate neurotransmitters then activate the dopamine neurons of the VTA, which in turn cause dopamine to be released in the nucleus accumbens (Koob & Markou, 2013). This cascading process is known as the mesolimbic dopamine pathway. It is responsible for the reinforcing properties of rewarding behavior (Koob & Markau, 2013), and is crucial for drug reward (Volkow, Wang, Folwer, Tomasi, & Telang, 2010; Wise, 2009). As such, stimulation of this 'reward' pathway modulates the experience of pleasure and creates a rush or 'high' (Adinoff, 2004). Nicotine and music share the mesolimbic pathway as both are rewarding stimuli, demonstrating their commonalities in eliciting reward for those who engage in their activities.

2. Interactions between emotion and physiology

The relationship between emotion and physiology is complex. Research has demonstrated the ability of each domain to influence the other (Dibben, 2004; Khalfa et al., 2002). Emotions are coupled with physiological responses via the autonomic nervous system (ANS). A function of the ANS is to activate bodily systems to support action (Ron & Amir, n.d.). Therefore, the ANS plays a critical role in emotion, producing visceral sensations that shape subjective emotional experience. The most common emotions to be investigated are anger, fear, sadness, disgust, and happiness, and are typically induce in volunteers via film clips or personalized recall (Kreibig, 2010). Although contradictions exist, induction of these emotions have shown to increase heart rate, skin conductance, and respiration rate (Aue, Flykt, & Scherer, 2007; Ax, 1953; Boiten, 1996; Collet, Vernet-Maury, Delhomme, Dittmar, 1997; Gross, Fredrickson, Levenson, 1994). Other emotions are more associated with deactivation of the ANS. For example, a decrease in heart rate is found in studies of affection and certain types of sadness (e.g. non-crying, imagery-induced) (Eisenberg, Fabes, Bustamane, Mathy, Miller, & Lindholm, 1988). Furthermore, respiration rate decreases when relief or anticipatory pleasure is elicited (Kreibig, 2010, Vlemincx et al., 2009).

The influence of emotion on physiology has been demonstrated with musical stimuli as well. Khalfa and colleagues (2002) musically inducing participants with four emotions, fear, happiness, sadness, and peacefulness, and measured their corresponding skin conductance response (SCR). Fear and happiness were associated with higher SCR magnitudes compared to sadness and peacefulness. This was explained by the high arousal rate of fear and happiness, which is further explained by SCR's sensitive to changes in arousal (Bradley & Lang, 2000; Winton, Putnam, & Krauss, 1984). This arousal effect has also been demonstrated using slides of affective pictures and environmental sounds (Bradley & Lang, 2000; Lang, Bradley, & Cuthbert, 1998).

Contrastingly, physiology can be used to inform emotions. Scherer and Zenter (2001) suggest that peripheral feedback can influence the intensity and valence of felt emotion. That is, each emotion tends to have its own distinguishable set of bodily changes (Philippot, Chapelle, & Blairy, 2002). For example, anger increases heart rate, breathing rate, and blood pressure (Kreibig, 2010). Therefore, activation of a particular set of body changes (e.g. an increase in heart, breathing rate, and blood pressure) may have the ability to give rise to the emotion with which it is coupled (e.g. anger) (Damasio, 1994). In this way, individuals can use their body state to inform them of their emotions (Dibben, 2004). This process is known as peripheral feedback (Philippot, Chapelle, & Blairy, 2002; Damasio, 1994) and is suggested to help enhance the emotional characteristics of stimuli (Ron & Amir, n.d.).

In a seminal study Schachter and Singer (1962) injected either epinephrine (adrenaline) or a placebo into 184 university students. The epinephrine caused a rise in heart rate, blood pressure, blood flow, and respiration rate. Only one third of the participants were informed about the effects of epinephrine, the others were either deceived, being told the injection was used to test their eyesight, or were left ignorant of its side effects. The students were then placed into either a euphoric or angry social situation. Results show that those students who had been deceived (misinformed or left ignorant) about the injection and had been exposed to the euphoric social condition reported the most intense experiences of euphoria. This suggests that the deceived subjects, who had no explanation for their arousal state, labeled their physiological state of arousal based on their appraisal of their social situation. Although Schachter and Singer (1962) has been criticized for methodological limitations (Mezzacappa, Katkin, & Palmer, 1999) it demonstrates that arousal has the potential to influence the intensity of an emotional experience.

In a more recently study, Dibben (2004) demonstrated the ability of peripheral feedback to influence music-induced emotion. This was accomplished by inducing physiological arousal via a short uphill walk. Immediately proceeding the exercise participants listened to four music excerpts, one from each quadrant of the circumplex model of emotion (Russell, 1989), and rated the intensity of the emotions they perceived and felt. When comparing the exercising group with a relaxation group it was found that the exercising group, those with higher arousal, gave higher intensity rating for felt emotion, suggesting arousal to influence the emotions experienced in response to music.

3. Interactions between nicotine and music

Nicotine in known to influences physiology by increasing heart rate, blood pressure and skin conductance (Tro, 2009). Since nicotine can influence physiology and in turn, physiology can inform emotions via peripheral feedback (Schachter & Singer, 1962) it may be that nicotine can effect responses to emotional stimuli.

Furthermore, nicotine has been suspected of increasing the reinforcing properties or reward value of other stimuli (Balfour et al., 2004; Donny et al., 2003), which suggests that nicotine may enhance music-induced emotion. That is, nicotine has two effects on reinforcement. Firstly, it is a primary reinforcer as the intake of nicotine results in pharmacological actions which strengthen or 'reinforce' an individual to continue the use of the drug. Research has demonstrated that in animals and humans nicotine increases the frequency of behaviors which are necessary for nicotine administration (Palmatier et al., 2006). For example, humans and animals will learn to perform an action (e.g. lever press) in order to receive intravenous nicotine infusions (Corrigall & Coen, 1994). Secondly, because nicotine releases extracellular dopamine in the nucleus accumbens, which is part of the pleasure pathway, it also increases the reinforcing properties of other stimuli (Balfour et al., 2004; Donny et al., 2003). As a consequence of this increase in dopamine there may be an increase in the pleasure experienced from other behaviors performed concurrently or immediately after nicotine intake (Attwood, Penton-Voak, & Munafo, 2009). Indeed, animals increase their response rate to food, alcohol, and cocaine subsequent to nicotine administration (Bechtholt & Mark, 2002; Clark, Lindgren, Brooks, Watson, & Little, 2001).

This may suggest then that upon the intake of nicotine and subsequent action of music listening, two emotional results may occur: (1) an individual may experience an increase in the intensity of music-induced emotion and (2) and an individual may experience an increase in pleasure.

4. Research aims and current study

The first aim of the current study is to understand the basis for music-induced emotion. Music is known to influence physiology (Menon & Levitin, 2005; Rickard, 2004). However, it is unknown whether these physiological changes are important in determining an individual's emotional response to music. Because nicotine can cause similar physiological changes as music (Benowitz, Porchet, Sheiner, & Jacob, 1988) it is possible to use nicotine as a tool to induce a heightened physiological state of arousal in the listener, then examine the effect of this induction on emotional responses to music.

A second aim of this study is to understand if, and how, nicotine effects music-induced emotion by bridging two lines of established research: (1) the effect of nicotine on physiology and (2) the effect of physiology on emotion. This will help us to understand why smoking cigarettes and listening to music often co-exist. For example, smoking and music listening are frequently observed together at pubs, clubs, and music festivals. Do drugs and music have similar effects on the brain and behavior? Does simultaneous consumption of nicotine and music listening result in extreme pleasure or reward?

Although there may be social reasons for why cigarette smoking and music listening are coupled, we anticipate that physiological reasons also play a role. We expect nicotine administration to contribute to and enhance affective arousal in response to music listening by temporarily increasing physiological arousal and increasing alertness to sounds (Baldeweg, Wong, & Stephan, 2006; Benowitz et al., 1988; Gilbert, 1979). This is based on previous research demonstrating nicotine to increase arousal (Benowitz et al., 1988), and arousal to intensify music-induced emotion (Dibben, 2004).

5. Method

Participants were 44 non-smokers, 17 male and 28 female, with an mean age of 22 years, ranging from 17 to 51 years (*SD* = 6.51). Participants were staff and students of varying levels of study from the University of Sheffield, England. Although no participants were professional musicians, 65% had musical performance experience to at least a high school level. Non-smokers were defined as individuals who smoked less than 7 cigarettes in a life time and who scored a maximum of two on the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, Fagerstom, 1991). Participants were paid £5 for their time. Informed consent was obtained prior to experimentation. The research protocol met the ethical requirements of the University of Sheffield Department of Psychology.

6. Materials

Materials for this study included 10 excerpts (4 happy, 4 sad, 2 neutral) based on 2 preliminary surveys. The surveys verify (1) that each excerpt induced its intended emotion and (2) identify excerpts which were the most emotionally intense example of their emotion category. Surveys were administered online to approximately 100 volunteers. The first survey requested participants to listen to 18, 1 min excerpts of popular music and to rate their emotional response on three 7-point scales: (1) pleasantness (unpleasant-very pleasant), (2) arousal (sleepy-energetic), and (3) liking (not at all-very much). A follow-up survey was needed for the selection of sad and neutral music. This survey followed similar procedures to the previous one, but used six intensity scales instead of three: arousal, pleasure, happy, sad, familiar, and liking.

Participants were asked to self-select a 2 min excerpt of music known to consistently and reliably bring them to chills and to either email this music prior to experimentation or to bring this music with them at the time of their experiment.

The nicotine gum (2 mg and 4 mg) was Boots NicAssist ice mint flavored gum. The chewing gum was Wrigley's Extra peppermint flavored gum, used because it was of similar size, shape, and color to the nicotine gum.

7. Procedure

First, baseline levels of mood were taken where participants rated their current mood on four intensity scales: (1) arousal, (2) pleasure, (3) happy, and (4) sad. Next, they were administered either one of two dosages of nicotine (2mg, 4mg) or a placebo and asked to chew the gum for 25 minutes. After 5 min of chewing they were given a piece of chewing gum to mask the flavor of the nicotine. During the 25 min chewing task participants were engaged in two distraction tasks, a 15 min reading task and a 10 min writing task. After 25 min participants discarded all gum and were checked for side effects using the Subjective Treatment Emergent Symptom Scale (Guy, 1976). They then rate their current mood using the same scales as before. Next, volunteers listened to 4 music excerpts (happy, sad, neutral, chill-inducing). After each listening subjective ratings of intensity were taken on six emotion scales: arousal, pleasure, happiness, sadness, familiarity, and liking. Song order was played at random to account for ordering effects.

8. Result

A GLM multivariate analysis was used to assess the mood ratings taken directly before and immediately after the intake of nicotine gum. Overall, we found a significant difference in mood ratings (arousal, pleasure, happy, sad) for those ratings taken before and after the administration of nicotine gum/placebo, $F = 3.07$, $p = < 0.036$. However, there were no significant differences found between these ratings and gum conditions, $F = 0.51$, $p = 0.84$.

Of the four mood ratings that were measured before and after the intake of gum (arousal, pleasure, happy, sad) three were shown to significantly increase after the intake of gum/placebo. Arousal was marginally significantly higher after the intake of nicotine gum/placebo, $F = 4.014(1,26)$, $p = 0.056$. Also, pleasure was rated significantly higher after the intake of nicotine gum/placebo, $F = 7.654(1,26)$, $p = 0.01$. Lastly, happy was rated significantly higher after the intake of nicotine gum/placebo, $F = 5.529(1,26)$, $p = 0.027$. Sadness ratings were not shown to be significantly different before or after the intake of nicotine gum/placebo, $F = 1.234(1,26)$, $p = 0.277$.

Next, a GLM multivariate analysis was used to compare the three gum conditions (2 mg, 4 mg, placebo) to test whether participants experienced any adverse effects due to the intake of nicotine. Examining the pair-wise comparisons we found no significant differences between any of the gum conditions and any of the four adverse effects. Difficulty in pay attention ($M = 3.648$, $SE = 0.351$) was not significantly different between the dosage conditions, $F(2, 27) = 0.608$, $p = .552$. Stomach aching ($M = 1.435$, $SE = 0.160$) was not significantly different between the dosage conditions, $F(2, 27) = 0.590$, $p = .561$. Feeling dizzy ($M = 2.815$, $SE = 0.350$) was not significantly different between the dosage conditions, $F(2, 27) = 0.527$, $p = 0.596$. Lastly, feeling shaky ($M = 2.278$, $SE = 0.282$) was not significantly different between the dosage conditions, $F(2, 27) = 0.090$, $p = 0.914$.

Lastly, a GLM repeated measures analysis was used to examine if music and nicotine interacted to effect participants' intensity ratings. From the initial analysis we realized that the self-selected chill-inducing music created a ceiling effect as all intensity ratings were extremely high for this category of music. Furthermore, chill-inducing music substantially differed from the happy, sad, and neutral music because it was self-selected and so highly familiar. Therefore, we performed the analysis again, omitting the ratings for chill-inducing music.

Although results of the reanalysis are nonsignificant, the linear contrast estimates showed a trend for pleasure and happy ratings. When looking at the pleasure ratings we saw a nonsignificant probability level, $p = 0.079$. We then examined the mean pleasure ratings for each dosage condition, which are available in Table 1. We found a trend showing that as nicotine intake increased pleasure ratings decreased.

We also looked at the happy ratings, also finding a nonsignificant probability level, $p = 0.076$. We then examined the mean happy ratings for each dosage condition, which is available in Table 1. We found a trend showing that as nicotine intake increased pleasure ratings decreased.

Table 1. Means of Pleasure and Happy Ratings

Rating	Condition	*M*	*SE*
Pleasure	Placebo	4.73	0.20
	2 mg	4.67	0.20
	4 mg	4.2	0.20
Happy	Placebo	4.41	0.20
	2 mg	4.08	0.20
	4 mg	3.84	0.23

9. Discussion

This study aimed to understand why music and nicotine often co-exist. We hypothesized that because nicotine can change one's physiology it may be able to change one's affective arousal to music-induced emotion. However, our results do not support this hypothesis. Although we saw a significant increase in participants' arousal, pleasure, and happy ratings from before to after the intake of nicotine gum, there was no significant difference found between each of the dosage conditions. It could be that nicotine, regardless of dosage, increased arousal, pleasure, and happy ratings, but that a placebo effect was strong enough to cause no significant differences between the dosage conditions. Previous research has shown placebo to result in an increased positive mood (Perkins, Sayette, Conkin, Caggiula, 2003).

We also checked whether participants experienced any adverse effects due to the intake of nicotine. We found no significant differences between any of the dosage conditions and any of the adverse effects. This confirms that for the 2 mg and 4 mg dosage conditions participants did not experience any negative side effects significantly different from those of the placebo condition. Because it is common for non-smokers to feel some adverse effects from nicotine (Guy, 1976), these results may imply that participants were unaffected by the amount of nicotine administered.

Our other results, although nonsignificant, showed a trend suggesting that as nicotine increased pleasure and happy ratings for music decreased. These results suggest that as nicotine levels for non-smokers increased the intensity they felt for music-induced pleasure and happiness correspondingly decreased. Unfortunately, this finding is in complete opposition to our hypothesis. However, previous literature has noted this phenomenon. Gilbert (1979) noted the paradox of nicotine increasing physiological arousal yet simultaneously reducing self-reports of emotion experiences. The decreases in pleasure and happiness are not thought be a consequence of nicotine's side effects as these were checked and found to not correspond to nicotine dosage. However, it is possible that this result is due to nicotine's ability to increase tranquility (Firth, 1971) and to decrease measures of aggression and anxiety (Nowlis, 1965).

A limitation of this study is the low participation, as there were only 44 participants. The trend between an increase in nicotine and a decrease in pleasure and happy ratings suggests the need for more participants, especially non-students. This may help results increase to significant levels and encourage more generalizable findings. A major limitation of this study was the use of only non-smokers. A follow-up study may be interested in examining dependent and nondependent smokers who are familiar with nicotine and as such respond to its emotional, physiological, and cognitive effects differently than non-smokers.

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AMBIVALENT EMOTIONS IN MUSIC: WE LIKE SAD MUSIC WHEN IT MAKES US HAPPY

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Abstract

We often react ambivalently to a piece of music, simultaneously experiencing both sadness and happiness, and attributing both emotions to the musical content. Two experiments were conducted (1) to empirically test for ambivalent emotions and (2) to investigate the amount of musical information necessary to elicit such emotions. In experiment 1, synthesized musical excerpts were manipulated in tempo (fast/slow) and mode (major/minor). By using unipolar scales, listeners could independently rate how (1) happy and (2) sad the music made them feel, as well as the (3) happiness and (4) sadness perceived in the music. Regarding perceived emotion, happiness was higher in major-fast excerpts, sadness was higher in minor-slow excerpts, and mixed emotions were reported (raised happiness and sadness ratings) for ambivalent music (major-slow and minor-fast). Ratings of felt emotions were similar, except that sad music (minor-slow) was experienced as ambivalent, happiness often nearly equalling the amount of sadness. Furthermore, the liking of sad excerpts positively correlated ($r=.59$) with the experienced happiness in the same excerpts. The results help to understand the enjoyment of sad music by suggesting that feelings of happiness are a desired emotional outcome. In experiment 2, the main results of experiment 1 were replicated with shorter musical excerpts (0.5-1.5s), suggesting that ambivalence is an immediate and effortless emotional response.

Keywords: ambivalent emotions, sad music, emotion perception/induction

1. Introduction

Studying the relationship between specific musical characteristics and the emotions they convey and elicit has a long tradition in music psychology. To date, these associations have been well established in more than 100 studies on the topic (Gabrielsson & Lindström, 2010). Among these characteristics, most researchers would agree that tempo and mode play a crucial role. Especially when it comes to happiness and sadness, different modes and tempi have clear emotional associations in Western music: Major mode and fast tempo are usually cues for happiness, whereas minor mode and slow tempo imply sadness (Juslin & Laukka, 2004**).** Although these associations have been repeatedly substantiated, one has to consider that in "real" musical compositions, the use of musical cues is often more dynamic than in scientific musical stimuli, i.e. it is common to change the mode within a piece, or to incorporate conflicting cues (e.g. major mode with slow tempo) at the same time, consequently carrying more complex or ambivalent emotional material. Hardly any studies have explicitly dealt with the listener's emotional reaction to music with such conflicting cues. This lack is partly due to the underlying emotion theories: One of the predominant approaches organizes emotions in bipolar *dimensions* (Russell, 1980). In this context, happiness and sadness are considered as mutually exclusive, since their positive and negative quality represent the two ends of the *valence* dimension. Thus, studies based on dimensional models and their respective response formats do not allow listeners to rate happiness and sadness independently, and thereby neglect the existence of ambivalent emotions. The other predominant approach, the *categorial* one (Ekman, 1992), allows listeners to respond ambivalently in principal. Yet, studies based on this theoretical framework often did not record ambivalent emotions, simply because response formats were not designed to do so. However, new findings by Hunter, Schellenberg, & Schimmack (2010) have showed how listeners react to music with such conflicting cues (in this case multiple MIDI-versions of excerpts of J. S. Bach), if given the opportunity to independently evaluate happiness and sadness: In contrast to music with clear emotional cues for happiness or sadness, in most cases music with conflicting cues was both perceived and experienced ambivalently, i.e. the listeners perceived/experienced happiness and sadness simultaneously.

The question arises how common such ambivalent emotions are, and whether they are a more elaborate and time-consuming reaction than unambiguous emotions. In order to answer this question, one would have to compare the immediacy with which both types of reactions occur. For pure emotions, Vieillard et al. (2008) showed that listeners accurately identify happy or sad music after merely 3 musical events, which corresponds to 0.5-2 seconds, according to the original tempo of the piece. As mentioned above, "real" music often provides conflicting or more subtle emotional cues than scientific musical stimuli. Thus, listeners should have experience in decoding complex and ambivalent emotional material as they are exposed to music in daily life. Consequently, if the experience (or perception) of simultaneous happiness and sadness is a common and effortless reaction to music, as is proposed here, listeners should accordingly be able to identify ambivalent musical material correctly after 3 musical events.

Special interest was furthermore aimed at sad music, and a possible role of ambivalent emotions. To date, several studies have shown that sad music elicits sad emotions in listeners. Such findings resulted from different measurement techniques, such as self-reports (e.g. (Bigand, Vieillard, Madurell, Marozeau, & Dacquet, 2005) indirect measures (Thompson, Schellenberg, & Husain, 2001), or neuroimaging techniques (Mitterschiffthaler, Fu, Dalton, Andrew & Williams, 2007). Yet, the situation seems to be more complex. Newer research suggests that in many cases, listeners do not react to sad music with exclusively negative, but rather ambivalent emotions of positive and negative valence, and also other positive emotions such as wonder or peacefulness (Vuoskoski, Thompson, McIlwain & Eerola, 2012). Hunter et al. (2010) similarly found evidence for ambivalent emotions of happiness and sadness in reaction to sad music. It seems that mixed emotions might be a thoroughly important response to examine the motivational outcome of why people listen to sad music, especially as such mixed reactions usually do not occur with happy music. The liking of sad musical pieces might also be affected as a function of the listener's perceived and experienced emotions. Vuoskoski et al. (2012) found that the liking of sad music correlates with the overall intensity of felt emotion, regardless of its quality. In the present study, a more distinguished proposal is tested, namely how liking of sad music is affected by the magnitude of perceived and felt happiness.

2. Aims

The aim of the present study was to (1) represent and elicit ambivalent emotions of happiness and sadness through music by mixing musical cues for happiness and sadness in musical excerpts, and (2) examine the relationship of such ambivalent emotions with the liking of sad music. In a second experiment, it was (3) tested if a minimal exposure to the musical stimuli is sufficient to decode ambivalent emotions. Here, it was hypothesized that 3 musical events comprise enough musical information for the listener to decode such ambivalent emotions.

3. Methods

In Experiment 1, 50 students of the University of Salzburg (25 male, 25 female) between 18-26 years of age (M = 22.68, SD = 2.14) rated their felt and perceived emotions related to 16 synthesized musical excerpts of approx. 40 seconds length. In order to avoid preferences for popular genres (which could bias ratings), the musical stimuli were composed to be best described as film music, which many listeners do not consume actively, yet it's main objective is to transport emotions. The 16 excerpts resulted from 4 versions of 4 original compositions, each of which was manipulated in the dimensions mode (major/minor) and tempo (fast/slow). The 4 resulting versions of each excerpt represented individual conditions in a 2 x 2 field, which were expected to represent happiness (major-fast), sadness (minor-slow) and ambivalent emotions of happiness and sadness (major-slow and minor-fast). In order to allow for ambivalent responses, subjects independently rated (1) perceived and (2) experienced happiness, as well as (3) perceived and (4) experienced sadness on unipolar VAS-scales of 100mm length (coded from 1-100). Liking and disliking ratings were also measured independently on identical scales. Subjects were tested separately in a laboratory setting. The questionnaire was presented on a laptop, while the musical stimuli were heard with studio-quality headphones. A session lasted 30-40 minutes.

In Experiment 2, 47 students of the University of Vienna (20 female, 27 male) between 18-28 years (M = 23.13, SD = 2.58) ran through an identical version of Experiment 1, except that the musical stimuli were severely shortened. The stimuli were not trimmed to a certain amount of time (e.g. 1 second), as this would result in stimuli of unequal musical (and thus emotional) information. In other words, a piece of music with 60 bpm trimmed to 1s will contain far less musical information than a piece with 120 bpm. Instead, the unit of choice was musical events. Vieillard et al. (2008) proposed that fewer than 3 musical events suffice to accurately label happy and sad music. Acting on that assumption, each of the 16 musical stimuli was shortened to 3 musical events. As a function of the respective stimuli's tempo, the shortened versions were 0.5 - 3.0 seconds.

4. Results

In order to evaluate the occurrence of ambivalent emotions, the main dependant variable of interest was the absolute difference between each participant's rating of happiness and sadness on scales from 0-100 (perceived or felt, respectively) for every musical piece. A higher difference between happiness and sadness represents a clearer preference for either happiness or sadness, whereas a small difference is a marker for a more ambivalent response. For example, if a subject rates a musical piece's amount of happiness as 75, and its sadness as 5, the difference of 70 points to a clear preference for one emotion, in this case happiness. Ratings of 60 (happiness) and 55 (sadness) would result in a difference of 5, proposing an ambivalent response. Hence, in the consistent conditions (major-fast / minor-slow), a higher overall difference was expected than in the ambivalent conditions (major-slow / minor-fast).

To test these hypotheses in experiment 1, two separate two-way repeated-measures ANOVAs were conducted to evaluate perceived and felt emotion, with tempo (fast/slow) and mode (major/minor) as independent variables, and the above mentioned difference value as target variable. Regarding perceived emotions, significant main effects were found for both mode and tempo, $F(1, 49) = 6.79$; $p < .05$, $\eta_p^2 = .12$, and $F(1, 49) = 8.72$; $p < .01$, $\eta_p^2 = .15$. In detail, pieces in minor were perceived more ambivalently than the pieces in major. The same applies to slow tempo, which listeners perceived as more ambivalent than fast tempo. Most importantly, a highly significant interaction was found between mode and tempo, $F(1, 49) = 166.47$; $p < .001$, $\eta_p^2 = .77$. As expected, the mean differences in the consistent conditions major-fast (54.82, SD = 16.29) and minor-slow (41.51, SD = 22.7) were significantly higher than in the ambivalent conditions major-slow (19.56, SD = 14.23) and minor-fast (18.5, SD = 15.03). All post-hoc simple effects comparisons were significant at the .001 level. These results reveal that the inconsistent musical pieces were perceived as more ambivalent than the consistent ones. However, they do not give evidence about the composition of happiness and sadness in the respective conditions, i.e. the high difference value in the happy excerpts (major-fast) could theoretically result from a high amount of sadness and a low amount of happiness. In order to check for this, the absolute means of the perceived happiness and sadness ratings for each condition have to be examined. As evident in Figure 1 (upper figure), all conditions were rated as expected, i.e. high happiness ratings in major-fast excerpts, high sadness ratings in minor-slow excerpts, and ambivalent ratings in the major-slow and minor-fast excerpts.

Figure 1. Absolute mean ratings of perceived (upper figure) and felt (lower figure) happiness and sadness in the individual conditions. Error bars are Standard errors.

Regarding felt emotions, both factors showed significant main effects: Again, pieces in minor mode were experienced more ambivalently compared to major mode pieces, $F(1, 49) = 86.13$; $p < .001$, $\eta_p^2 = .53$. Similarly, slow tempo was experienced as more ambivalent than fast tempo, $F(1, 49) = 56.2$; $p < .001$, $\eta_p^2 = .64$. Furthermore, a significant interaction was found between mode and tempo, $F(1, 49) = 24.22$; $p < .001$, $\eta_p^2 = .33$. As expected, participants rated the major-fast excerpts highest (47.71, SD = 17.65), i.e. as the most unambiguous. The two inconsistent conditions major-slow (24.23, SD = 14.68) and minor-fast (21.39, SD = 15.05) were experienced as significantly more ambivalent, represented by the smaller difference, as revealed by the simple effects analysis ($p < .001$). Interestingly, the sad pieces in minor-slow elicited the most ambivalent reactions of all conditions (17.3, SD = 14.68). The corresponding difference value was lower than in the so-called inconsistent conditions, even reaching significance compared to major-slow ($p < .05$). Again, a look at the absolute means of the participants' initial ratings (see Figure 1, lower figure) is necessary to confirm the expected distribution of happy and sad ratings in the individual conditions.

In order to better understand the ambivalent responses regarding felt emotions in the sad condition, the relationship between liking/disliking and perceived/felt emotions was analysed with Pearson correlations (see Table 1). The results showed that the listeners liked the sad excerpts, the more happiness they perceived and above all, felt, in reaction to the sad excerpts. Disliking ratings showed complementary results: Listeners disliked sad music, the more sadness they felt and perceived.

Table 1. Sad music: Pearson correlations between liking/disliking ratings and perceived/felt happiness and sadness.

	Liking	Disliking
Felt happiness	**.59****	-.21
Perceived happiness	**.34***	.14
Felt sadness	.13	**.31***
Perceived sadness	.17	**.30***

*p<.05; **p<.01

Experiment 2 aimed to evaluate if a minimal stimulus exposure time influenced the emotional ratings. For that purpose, the datasets of Exp. 1 were compared with Exp. 2, since both were identical except for the stimulus length. Thus, mixed three-way ANOVAs were conducted, both for perceived and felt emotions. The within-subject factors were mode (major/minor) and tempo (fast/slow), whereas the group factor was stimulus length (long/short, corresponding to Exp. 1/Exp.2). The previously used absolute difference between the happiness and sadness rating functioned as the target measure.

The results of the ANOVA regarding perceived emotions are presented in Table 1. To test the hypothesis if listeners similarly perceive ambivalent emotions in short musical excerpts, a non-significant three-way interaction was desired. Indeed, this was the case, showing that the two-way interaction was independent of the stimulus length, i.e. the ratings ambivalence in the individual conditions are the same between the long and short musical pieces. Further results are depicted in Table 1 , but will not be discussed as they are not fundamental for the hypothesis.

Table 2. Results of the mixed three-way ANOVA for perceived emotions.

	F	p	η_p^2
Within-subjects			
Mode	3.18	ns	.03
Tempo	9.17	< .01	.09
Mode x Tempo	227.46	< .001	.71
Between-groups			
Stim. Length	12.05	< .001	.11
Mode x Stim. Length	5.35	< .05	.05
Tempo x Stim. Length	1.89	ns	.02
Mode x Tempo x Stim. Length	2.91	ns	.03

ns = not significant; N = 97; df (1,95)

In terms of felt emotions, the findings were similar (see Table 2). Again, the three-way interaction of all within-subjects and between-groups factors was not significant. The results propose that the listeners' experience of ambivalent emotions was comparable in response to the short and long musical excerpts. Table 2 provides the complete results of the ANOVA.

Table 3. Results of the mixed three-way ANOVA for felt emotions.

	F	p	η_p^2
Within-subjects			
Mode	90.65	< .001	.49
Tempo	52.89	< .001	.36
Mode x Tempo	38.65	< .001	.29
Between-groups			
Stim. Length	14.8	< .001	.14
Mode x Stim. Length	16.75	< .001	.15
Tempo x Stim. Length	14.05	> .001	.13
Mode x Tempo x Stim. Length	1.69	ns	.02

ns = not significant; N = 97; df (1,95)

4. Discussion

The present study aimed to elicit ambivalent emotions of happiness and sadness by mixing emotional cues (mode and tempo) for happiness and sadness in short musical excerpts. 8 of 16 excerpts had unambiguous cues for happiness (major mode/fast tempo) or sadness (minor mode/slow tempo), whereas the other 8 excerpts featured conflicting cues for both emotions (major mode/slow tempo, and minor mode/fast tempo). As expected, listeners perceived nearly equal levels of happiness *and* sadness for excerpts with conflicting cues, as compared to excerpts with consistent cues, which were perceived as predominantly happy or sad. These findings substantiate the concept of ambivalent emotions, which were previously demonstrated with both pre-selected "real" music of different genres (Hunter, Schellenberg, & Schimmack, 2008), and highly controlled MIDI-versions of Bach pieces (Hunter et al., 2010). The present study adds comparable results with a new set of musical stimuli, namely controlled MIDI-based film music.

The listeners also evaluated the same excerpts in terms of actual felt emotions: Here, happy excerpts clearly induced happiness. In the ambivalent excerpts, listeners again reacted with higher levels of happiness *and* sadness. Yet, compared to the perception of the same excerpts (which were equally happy and sad), the amount of felt happiness exceeded the perception of happiness. Finally, the sad excerpts were experienced as the most ambivalent of all, i.e. happiness nearly equalled the amount of sadness. This finding is particularly interesting when considering the discrepancy between perception and experience: Listeners perceived sad excerpts as predominantly sad, yet they experienced a far lesser amount of sadness, which was accompanied by a nearly equal amount of happiness. Thus, sad music elicited an amount of happiness, which exceeded the amount of perceived happiness. In this context, liking ratings were analysed and showed a strong relationship with felt happiness. In other words, the more happiness participants felt when listening to sad music, the more they liked it. Although a causal relationship cannot be concluded from these results, it could be hypothesized that the tendency of liking music that elicits happiness (Ladinig & Schellenberg, 2012) is also applicable to sad music. Experiencing positive emotions such as happiness in response to music might resemble an implicit goal, which becomes particularly relevant when listening to sad music, since obvious cues for positive emotions are absent. Regardless of influencing factors such as mood (Hunter, Schellenberg & Griffith, 2011) or personality (Vuoskoski et al., 2012), in all cases the goal might remain the same: experiencing positive emotions. Huron's (2011) thoughts on the enjoyment of sad music and the role of the hormone Prolactin take up a similar stance. He proposes that some people choose to listen to sad music because of the positive emotional outcome, resulting from the release of the hormone Prolactin, which provides the organism with a feeling of comfort.

In Experiment 2, it was tested if participants are able to perceive and experience ambivalent emotions in musical excerpts consisting of merely 3 musical events. For that purpose, the ratings were compared to those of the long excerpts (Experiment 1). The data revealed that listeners perceived and experienced the short excerpts in a comparable way to the long ones, regarding the relationship between happiness and sadness. In other words, the participants' ratings of ambivalence remained the same, no matter if long or short excerpts were presented. It has to be noted that this measure does not allow conclusions about the absolute extent of perceived/experienced emotion. In terms of absolute magnitude of emotion, throughout all conditions, a lower amount of happiness/sadness was observed. This finding seems obvious, as the long excerpts carry more emotional information than the short ones, which in turn allows a stronger emotional reaction to enfold. On the one hand, the results of Experiment 2 are consistent with Vieillard et al. (2008) in terms of listeners identifying happy and sad musical excerpts after 3 events, on the other hand they are extended by the listeners' ability to react similarly to ambivalent pieces. Turning to applied fields, these findings might be particularly interesting for the use of music in advertisement or sound branding, in which music or jingles are often presented for a very short duration of time.

The fact that listeners could perceive and experience the interplay of happiness and sadness after the short period of 3 musical events raises the assumption that such ambivalent emotions are an effortless response. It likely is the case that such ambivalent reactions are actually a popular response to music. Firstly, this claim is supported by the fact that even musical pieces with seemingly explicit cues for happiness were rated as somewhat sad, even though to a marginal extent. Comparably, the perception of sad music was accompanied by a small extent of happiness, and the experience of sad music being even highly ambivalent. Furthermore, examples from the GEMS (Geneva Emotional Music Scale) by Zentner, Grandjean, & Scherer (2008) which consists of the 9 most common emotional responses to music, likewise offers some emotions with seemingly ambivalent characters. For example, the emotion *nostalgia* could be described as a state in which an individual reminisces about past events, both feeling positive about having experienced them, and negative about them having past. Similarly, the emotions *tension*, *wonder* or *power* could be regarded as ambivalent, or at least unclear regarding their valence.

The results as a whole support previous findings regarding ambivalent emotions and further extend them. Future studies should further differentiate the concept of ambivalence, and especially highlight the role of ambivalent emotions in sad music.

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TOWARDS AFFECTIVE ALGORITHMIC COMPOSITION

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Abstract

Automated systems for the selective adjustment of emotional responses by means of musical features are driving an emerging field: affective algorithmic composition. Strategies for algorithmic composition, and the large variety of systems for computer-automation of such strategies, are well documented in literature. Reviews of computer systems for expressive performance (CSEMPs) also provide a thorough overview of the extensive work carried out in the area of expressive computer music performance, with some crossover between composition and performance systems. Although there has been a significant amount of work (largely carried out within the last decade) implementing systems for algorithmic composition with the intention of targeting specific emotional responses in the listener, a full review of this work is not currently available, creating a shared obstacle to those entering the field which, if left unchecked, can only continue to grow. This paper gives an overview of the progress in this emerging field, including systems that combine composition and expressive performance metrics. Re-composition, and transformative algorithmic composition systems are included and differentiated where appropriate, highlighting the challenges these systems now face and suggesting a direction for further work. A framework for the categorisation and evaluation of these systems is proposed including methods for the parameterisation of musical features from semiotic research targeting specific emotional correlates. The framework provides an overarching epistemological platform and practical vernacular for the development of future work using algorithmic composition and expressive performance systems to monitor and induce affective states in the listener.

Keywords: algorithmic composition, affect

1. Introduction

Algorithmic composition, and the large variety of techniques for computer automation of algorithmic composition processes, are well documented in literature (Collins, 2009; Miranda, 2001; Nierhaus, 2009; Papadopoulos and Wiggins, 1999). Surveys of expressive computer performance systems such as that carried out by (Kirke and Miranda, 2009) also provide a thorough overview of the extensive work carried out in the area of emotionally targeted computer aided music performance, giving rise to the popular Computer Systems for Expressive Performance (CSEMP) paradigm, which has been used to carry out perceptual evaluations of computer aided performative systems (Katayose et al., 2012). Although there has been a significant amount of work carried out by researchers implementing musical features in algorithmic composition with the intention of targeting such specific emotional responses, an overview of this work (largely carried out within the last decade) is not currently available. This paper therefore presents an overview of existing compositional systems that use some emotional correlation to shape the use of musical features in their output.

A dimensional model of the functionality of existing systems is then presented, with each system assessed against the model. Systems covering the largest number of dimensions are then outlined in greater detail in terms of their affective model, emotional correlates, and musical feature-sets.

2. Background: terminology

This section introduces the terminology that forms the basis for assessment of the various affective algorithmic systems outlined in section 3. A hierarchical approach to musical features is proposed, whereby a combined musical or acoustic feature-set can be linked to specific emotional correlates in an affective algorithmic composition system.

2.1. Emotional models and music

The 'circumplex model of affect' (Russell, 1980) is often used synonymously with the 2-Dimensional emotion space model (Schubert, 1999a), and/or interchangeably with other models of mood or emotion focussing on arousal (activation energy, or intensity of response) and valence (high or low positivity in response) as independent dimensional attributes of emotion, such as the vector model (Bradley et al., 1992). The two-dimensional model is usually presented with arousal shown on the vertical axis and valence on the horizontal axis, giving quartiles that correspond broadly, to happy (high arousal and valence), sad (low arousal and valence), angry (high arousal, low valence), and calm (low arousal, high valence). These models of affect are general models of emotion, rather than musical models, though they have been adopted by much work in affective composition. Other models of emotion, less commonly found in the literature shown in Table 3 include the Geneva Emotional Music Scale (Zentner et al., 2008) GEMS, and the Pleasure, Arousal, Dominance model (PAD) of (Mehrabian, 1996). The GEMS was specified in order to give a model for musical emotion, by analysing a list of musically meaningful emotion terms for both induced and perceived emotions to create a nine-factorial model of emotions that can be induced by music. These factors (including nine first-order and three second-order factors) can then be used in categorical cluster analysis as an emotional measurement tool. GEMS can be considered a *categorical*, and *dimensional* musical emotion model, as opposed to more generalized *dimensional* models which comprise fewer, less complex dimensions.

2.2. Perceived vs Induced

The distinction between 'perceived' and 'induced' emotions has been well documented in much of the literature (see for example (Västfjäll, 2001; Vuoskoski and Eerola, 2011) (Gabrielsson, 2001a)), though the precise terminology used to differentiate the two does vary, as summarised in Table 1.

Table 1. Synonymous descriptors of 'Perceived/Induced' emotions that can be found in the literature. For detailed discussion the reader is referred to (Gabrielsson, 2001a; Kallinen and Ravaja, 2006; Scherer, 2004)

"What is the composer trying to express?"	*"How does/did the music make me feel?"*
Perceived	Felt
Conveyed	Elicited
Communicated	Induced
Cognitivist	Emotivist
Observed	Experienced
Expressed	Experienced
"a response made about the stimulus"	"a description of the state of the individual responding" (Schubert, 1999b)

Musical parameters for *induced* emotions are not well documented, though some work in this area has been undertaken (Juslin and Laukka, 2004; Scherer, 2004). For a fuller discussion of the differences in methodological and epistemological approaches to perceived and induced emotional responses to music, the reader is referred to (Gabrielsson, 2001a; Scherer et al., 2002; Zentner et al., 2000).

3. Introducing algorithmic composition

Musical feature-sets, and rules for creation or manipulation of specific musical features, are often used as the input for algorithmic composition systems. Algorithmic composition (either computer assisted or otherwise) is now a well-understood and documented field (Collins, 2009, 2009; Miranda, 2001; Nierhaus, 2009; Papadopoulos and Wiggins, 1999). An overview of a basic affective algorithmic composition, in which emotional correlates determined by literature review of perceptual experiment might be used to inform the selection of generative or transformative rules in order to target specific affective responses, is presented in **Figure 1.**

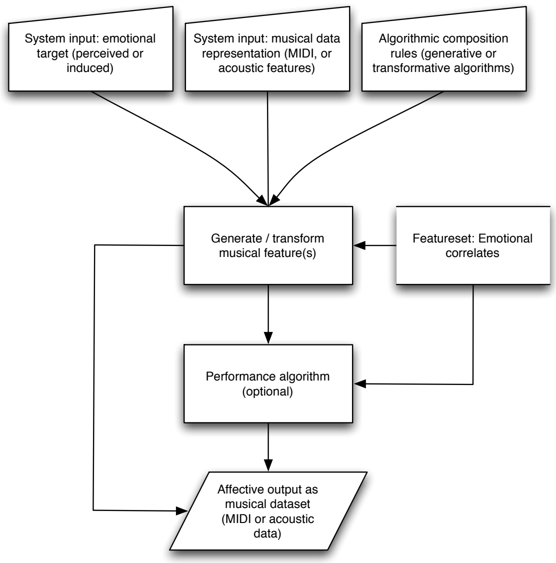

Figure 1. Overview of an affective algorithmic composition system. A minimum of three inputs are required: algorithmic compositional rules (generative, or transformative), a musical (or in some cases acoustic) dataset, and an emotional target.

This section introduces the musical and/or acoustic features used in algorithmic composition systems that are also found in literature as perceptual correlates for affective responses. An evaluation of the overlap between these two distinct types of feature is presented in the context of affective algorithmic composition, and a hierarchical approach to the implementation of musical feature-sets is proposed.

3.1. Musical and acoustic features

Musicologists have a long-established, though often evolving, grammar and vocabulary for the description of music, in order to allow detailed musical analysis to be undertaken (Huron, 1997, 2001). In computational musicological tasks, such as machine listening or music information retrieval for semantic audio analysis, complex feature-sets are often extracted for computer evaluation by means of various techniques (Mel-Frequency Cepstral Coefficients, acoustic fingerprinting, meta-analysis and so on) (Eidenberger, 2011). For the purposes of evaluating systems for affective algorithmic composition, the musical features involved necessary lie somewhere in-between the descriptive language of the musicologist and the sonic fingerprint of the semantic audiologist. The feature-set should include meaningful musical descriptors as the musical features themselves contribute to the data that informs any generative or transformative algorithms.

Whilst some musical features might have a well-defined acoustic cue (pitch and fundamental frequency, vibrato, tempo etc.), some features have more complicated acoustic (and/or musical) correlations. Therefore an awareness of the listeners' method for perceiving such features becomes important. Meter, for example (correlated with some emotions by (Kratus, 1993)), has been shown to be affected by both melodic and temporal cues (Hannon et al., 2004), as a combination of duration, pitch accent, and repetition (which might themselves then be considered 'low-level' features, with meter a 'higher-level', composite feature). Many timbral features are also not clearly, or universally, correlated (Aucouturier et al., 2005; Bolger, 2004; Schubert and Wolfe, 2006), particularly in musical stimuli, presenting similar challenges.

Musical features alone do not create a musical structure. Musical themes emerge as temporal products of these features (melodic and rhythmic patterns, phrasing, harmony and so on). An emotional trajectory can be derived in response to structural changes by listener testing (Kirke et al., 2012). For example, a reduction in tempo has been shown to correlate strongly with arousal, with a change in mode correlated with valence (Husain et al., 2002). A fully affective compositional algorithm should include some consideration of the effect of structural change — transformative systems would lend themselves particularly well to such measurement.

4. Existing systems, dimensions, and feature-sets

Existing systems for algorithmic composition targeting affective responses can be categorised according to their data sources (either musical features, emotional models, or both), and by their dimensional approach. These dimensions can be considered to be broadly bipolar as follows:

- *Compositional / Performative.* Does the system include both compositional processes and affective performance structures? Compositional systems refer synonymously to structural, score, or compositional rules. Performative rules are also synonymously referred to by some research as interpretive rules for music performance. The distinction between structural and interpretive rules might be interpreted as differences that are marked on the score (for example, dynamics might be marked on the score, and rely on a musicians interpretive performance, yet are part of the compositional intent). For a fuller examination of these distinctions, the reader is referred to (Gabrielsson, 2001).

- *Communicative / Inductive.* Does the system target affective communication, or does it target the induction of an affective state?

- *Adaptive / Non-adaptive.* Can the system adapt its output according to its input data (whether this is emotional, musical, or both)?

- *Generative / Transformative.* Does the system create output by purely generative means, or does it carry out some transformative / repurposing processing of existing material?

- *Real-time / Offline.* Does the system function in real-time?

A summary of the use, or implied use, of these dimensions amongst existing systems is given in Table 2. None of the systems listed target affective induction through generative or transformative algorithmic composition in real-time. This presents a significant area for further work.

Table 2. A summary of dimensionality (where known or implied by literature) in existing systems for affective algorithmic composition

System	**Emotional reactions to audio signal structure**	**Affective music production**	**athenaCL**	**Herman**	**RaPScoM, GeMMA**	**Affective variation in computer-generated musical sounds**	**Inmamusy**	**Ossia**	**KTH**	**ROBOSER, EmotoBot, Curvasom**	**Multiple agents communicating emotion**	**CMERS**	**Mind Music**	**Moodtrack**	**Neuromuse**
Data source(s)	Affective responses derived by statistical audio signal analysis, no direct musical feature-set	Emotion model	Circumplex model of affect, two musical features (tempo and harmonic complexity)	Single emotional control, musical features defined as rules	Circumplex model of affect, semantic categorisation of existing musical content	Pre-composed music with spectral modification	Multiagent control of musical featurset	Musical feature-set generated and evaluated by genetic algorithm	2-D model of affect (valence and arousal), musical feature-set as performance rules by weighted 'k-value'	Cell-based evolutionary algorithm and MIDI musical features	Emotion model	2-D model of affect (valence and arousal), musical feature-set as performance rules by weighted 'k-value'	Neural network of nodes with 2-D model of valence and arousal, time-signature used as musical feature	Hevner adjective cycle of emotion, bipolar musical feature-sets	EEG and parameterised synthesis model
Reference(s)	(Dubnov et al., 2006)	(Oliveira and Cardoso, n.d.)	(Mattek, 2011)	(Stapleford, 1998; Wiggins, 1999)	(Doppler et al., 2011; Rubisch et al., n.d.)	(Bailes and Dean, 2009)	(Delgado et al., 2009)	(Dahlstedt, 2007)	(Bresin and Friberg, 2000; Friberg et al., 2006)	(Eng et al., 2003; Manzolli and Verschure, 2005)	(Kirke, 2012) (Kirke and Miranda, 2011b)	(Livingstone et al., 2010)	(Eladhari et al., 2006)	(Vercoe, 2006)	(Le Groux and Verschure, 2009)
Compositional?	x		x	X	x	x	x	x	x	x	x	x	x	x	x
Performative?										x	x	x			
Inductive?															
Communicative?	x	x	x	X	x	x	x		x	x	x	x	x	x	x
Adaptive?								x	x		x	x	x	x	x
Generative?			x	X			x	x		x	x				x
Transformative?		x				X	x	x	x		x	x	x	x	
Real-time?		x			X	x			x	x		x	x	x	x
System	**Automated composition system**	**Emotional situated data integration**	**Generative model for musical emotion**	**EIS**	**Emotional Musical Data Abstraction**	**GERM**	**AMEE**	**CAUI, SDM**	**Primary music-emotion structural rules**	**Emotion-driven interactive music system**	**ELM**	**Experience-driven procedural music generation**	**DM**	**EMGUIGA**	**Combined EEG system**
Data source(s)	Neural network of affect, with genetic algorithm for generation of musical feature vectors	2-D model of affect (valence and arousal), musical feature-set for sieve based algorithmic composition	Genetic algorithm populated by musical feature-set	2-D emotion map and musical feature-set	Emotion model (listener defined affective responses to compositional features)	Musical feature-set and emotional model	Hevner adjective cycle of emotion, bipolar musical feature-sets	Affective responses to corpus with genetic algorithm, limited set of musical features	Musical feature-set and emotional model	Parameterized musical feature-set	Emotional cue model with eight musical features	Parameterized musical feature-set and weighted metrics for three moods	2-D model of affect (valence and arousal), musical feature-set as performance rules by weighted 'k-value'	2-D model of affect (valence and arousal), musical feature-set evaluated by genetic algorithm	2-D model of affect hierarchical structure of random motifs with algorithmically generated left-hand accompaniment
Reference(s)	(Jiang and Zhou, 2010)	(Huang, 2011)	(Birchfield, 2003)	(Chih-Fang and Yin-Jyun, 2011)	(Dzuris and Peterson, 2003)	(Juslin et al., 1999)	(Hoeberechts and Shantz, 2009; Hoeberechts et al., 2007)	(Legaspi et al., 2007; Numao et al., 2002a, 2002b; Sugimoto et al., 2008)	(Livingstone and Brown, 2005; Livingstone et al., 2007)	(Oliveras Castro, 2009)	(Juslin and Lindström, 2010; Winter, 2005)	(Plans and Morelli, 2012)	(Bresin et al., 2002; Friberg et al., 2000)	(Zhu et al., 2008)	(Kirke and Miranda, 2011a)
Compositional?	x	x	x	X	x	x	x	x	x	x	x	x	x	x	x
Performative?									x		x		x	x	x
Inductive?															
Communicative?	x	x		X	x	x	x	x	x	x	x	x	x	x	x
Adaptive?			x		X		x	x		x	x		x	x	x
Generative?	x	x	x	X		x		x		x	x	x		x	x
Transformative?					X		x		x	x		x	x	x	x
Real-time?				x		x	x	x				x	x	x	

4.1. Musical features in existing systems

The systems outlined in Table 2 utilise a variety of musical features. Deriving a ubiquitous feature-set is not a straightforward task, due to the lack of an agreed lexicon – perceptual similar and synonymous terms abound in the literature. Though the actual descriptors used vary, a summary of the major musical features found in these systems is provided in Table 3. Major terms are presented left to right in decreasing order of number of instances. Minor terms are presented top to bottom in decreasing order of number of instances, or alphabetically by first word if equal in number of instances. These 'major' features are derived from the full corpus of terms by a simple verbal protocol analysis. The most prominent features are used as headings, with an implied perceptual hierarchy.

Perhaps not surprisingly, the largest variety of sub-terms comes under the 'Melody (pitch)' and 'Rhythm' headings, which perhaps indicate the highest level of perceptual significance in terms of a hierarchical approach to musical feature implementation. Tempo is the most unequivocal – it seemingly has no synonymous use in the corpus. Whilst 'mode' and its synonyms are nominally the most common, the results also show a lower number of instances of the word 'mode' or 'modality' than 'pitch' or 'rhythm', suggesting those major terms to be better understood, or rather, more universal descriptors. Whilst 'timbre' appears only 3 times in the group labelled 'Timbre', which includes 5 instances of noise/noisiness and 4 instances of harmonicity/inharmonicity, it does seem a reasonable assumption timbre should be the heading for this umbrella set of musical features given the particular nature of the other terms included within it (timbre is the commonality between each of the terms in this heading). A similar assumption might be made about dynamics and loudness, where loudness is in fact the most used term from the group, but the over-riding meaning behind most of the terms can be more comfortably grouped under dynamics as a musical feature, rather than loudness as an acoustic feature.

Under the 'Melody (pitch)' label, there could be an eighth major division, pitch direction (with a total of 8 instances in the literature, comprising synonymous terms such as melodic direction, melodic change, phrase arch, melodic progression), implying a feature based on the direction and rate of change in the pitch.

Table 3. Number of generative systems implementing each of the major musical features as part of their system. Terms taken as synonymous for each feature are expanded in italics.

Modality	*Rhythm*	*Melody (pitch)*	*Timbre*	*Dynamics*	*Tempo*	*Articulation*
29	29	28	23	17	14	13
Mode / Modality (9) *Harmony (5)* *Register (4)* *Key (3)* *Tonality (3)* *Scale (2)* *Chord Sequence (1)* *Dissonance (1)* *Harmonic sequence (1)*	*Rhythm (11)* *Density (3)* *Meter (2)* *Repetitivity (2)* *Rhythmic complexity (2)* *Duration (1)* *Inter-Onset duration (1)* *Metrical patterns (1)* *Note duration (1)* *Rhythmic roughness (1)* *Rhythmic tension (1)* *Sparseness (1)* *Time-signature (1)* *Timing (1)*	*Pitch (11)* *Chord Function (2)* *Melodic direction (2)* *Pitch range (2)* *Fundamental frequency (1)* *Intonation (1)* *Note selection (1)* *Phrase arch (1)* *Phrasing (1)* *Pitch clarity (1)* *Pitch height (1)* *Pitch interval (1)* *Pitch stability (1)* *Melodic change (1)*	*Noise / noisiness (5)* *Harmonicity / inharmonicity (4)* *Timbre (3)* *Spectral complexity (2)* *Brightness (2)* *Harmonic complexity (1)* *Ratio of odd/even harmonics (1)* *Spectral flatness (1)* *Texture (1)* *Tone (1)* *Upper extensions (1)*	*Dynamics (3)* *Loudness (5)* *Amplitude (2)* *Velocity (2)* *Amplitude envelope (1)* *Intensity (1)* *Onset time (1)* *Sound level (1)* *Volume (1)*	*Tempo (14)*	*Articulation (9)* *Micro-level timing (2)* *Pitch bend (1)* *Chromatic emphasis (1)*

5. Conclusions

An overview of affective algorithmic composition systems has been presented, including a basic vernacular for classification of such systems (by proposed dimensionality and data source), and an analysis of musical feature-sets and emotional correlations employed by these systems. Three core questions have been investigated:

Which musical features are most commonly implemented?

Modality, rhythm, and pitch are the most common features found in the surveyed affective algorithmic composition systems, with 30, 29, and 28 instances respectively found in the literature. These features include an implicit hierarchy, with, for example, pitch contour and melodic contour features making a significant contribution to the instances of pitch features as a whole.

Which emotional models are employed by such systems?

Other dimensional approaches exist, but the 2-Dimensional model (or circumplex model) of affect is by far the most common of the emotional models implemented by affective algorithmic composition systems, with multiple and single bipolar dimensional models employed by the majority of remaining systems. The existing range of emotional correlates, and even in some cases the bipolar adjective scales used, are not necessarily evenly spaced in the two-dimensional model. Therefore selecting musical features that reflect emotions that are as dissimilar as possible, (i.e., as spatially different in the *emotion-space*) would be advisable when testing the applicability of any musical features implemented at the stimulus generation stage of an affective algorithm. The GEMS specifically approaches musical emotions, allowing for a multidimensional approach (Fontaine et al., 2007) and providing a categorical model of musical emotion with nine first-order and three second-order factors, which provides the opportunity for emotional scaling of parameterised musical features in an affective algorithmic composition system.

How can existing systems be classified by dimensional approach?

A number of dimensions are proposed, which could be considered to be bipolar in nature:

- Compositional and/or performative
- Communicative or inductive
- Adaptive or non-adaptive
- Generative or transformative
- Real-time or offline

A number of systems cover several of these dimensions, but a system for the real-time, adaptive induction of affective responses by algorithmic composition (either generative or transformative), including music which has been informed by listener responses to the effect of structural remains a significant area for further work.

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EMOTIONAL DATA IN MUSIC PERFORMANCE: TWO AUDIO ENVIRONMENTS FOR THE EMOTIONAL IMAGING COMPOSER

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Abstract

Technologies capable of automatically sensing and recognizing emotion are becoming increasingly prevalent in performance and compositional practice. Though these technologies are complex and diverse, we present a typology that draws on similarities with computational systems for expressive music performance. This typology provides a framework to present results from the development of two audio environments for the Emotional Imaging Composer, a commercial product for realtime arousal/valence recognition that uses signals from the autonomic nervous system. In the first environment, a spectral delay processor for live vocal performance uses the performer's emotional state to interpolate between subspaces of the arousal/valence plane. For the second, a sonification mapping communicates continuous arousal and valence measurements using tempo, loudness, decay, mode, and roughness. Both were informed by empirical research on musical emotion, though differences in desired output schemas manifested in different mapping strategies.

Keywords: music performance, emotion recognition, mapping

1. Introduction

Emotions form an important part of traditional music performance and expression. It is therefore not surprising that new technologies designed to sense emotion are finding their way into performance practice. Facial expression, physical gesture, and bio-physiological process provide just a sampling of the data streams available. A special class of algorithm abstracts from this information an actual emotion, making the emotion itself (rather than low-level data features) a driving force in the performance.

In this paper, two audio environments are presented that use a performer's emotional state to control audio processing and synthesis. Using a collection of physiological markers representing relevant biological processes, an algorithm outputs continuous arousal and valence coordinates representing the performer's emotional state at each instance of performance. In the first audio environment, these two coordinates drive a sonification model to accurately communicate the emotional information. In the second, the two coordinates control an algorithm for realtime audio processing of the musician's performance.

The audio environments were developed in collaboration with Emotional Imaging Incorporated (EII), a company specializing in media products infused with technologies for emotion recognition. In the current project, development was directed towards the Emotional Imaging Composer (EIC), described as "a multimedia instrument that translates biosignals into [emotionally] responsive environments in realtime." (*Emotional Imaging Incorporated,* n.d.) Previously, the responsive environment had taken the form of an abstract, fluid computer visualization. For the present research, a platform for responsive audio was designed.

Our systems are framed in the context of interactive affective music generation. Given the numerous systems that have thus far been implemented, we introduce our system through analogy to a typology introduced for computer systems for expressive music performance (CSEMP) (Kirke & Miranda, 2013a). The typology abstracts the algorithm for music generation from the tool for realtime interaction. For our purposes, the tools themselves are then distinguished by the degree to which the high-level emotional data stream is the driving force of performance, and how easily the tool can be controlled.

2. A Typology of Affective Music Generation Systems

Affective Music Generation (AMG) encompasses a diversity of computational practices directed towards communicating or expressing affect through music. New technologies enable realtime data streams to guide the algorithm and consequently the emotional progression of the piece. Closely related to affective music generation are so called computer systems for expressive music performance (CSEMP) (Kirke & Miranda, 2013b, p. 2). The goal of these systems is to create *expressive* performances or compositions, which are in some way more realistic or humanistic than the more "robotic" performances that might otherwise characterize computer generated music. For CSEMPs, it is not uncommon to design a system to compose music to match a particular emotion or "mood," though this feature is certainly not dominant (Kirke & Miranda, 2013b, Table 1.1). A point of distinction is evident, namely that musical expression is not necessarily synonymous with musical emotion. Having music express an emotion might contribute to its expressivity more generally (Juslin, 2003), but a performance might be expressive without having the direct goal of conveying an emotion to its audience (Davies, 1994). It is also the case that non-speech sound can communicate an emotion without being in any way musically expressive. The emotional space occupied by environmental sounds is a strong example (Bradley & Lang, 2000), and continuous auditory display of arousal and valence variation is another (Winters & Wanderley, 2013).

2.1. Systems for Algorithmic Generation

Nevertheless, computer systems for expressive music performance and affective music generation share common questions for design and implementation. The first question concerns content generation, including the type of input, the algorithm itself, and the sound output. With regards to input, a CSEMP has been classified as either "automatic" or "semi-automatic" depending on whether it accepts realtime input (Kirke & Miranda, 2013b). This distinction also applies to AMGs, but of equal or more importance is the type of emotional data driving the algorithm. This data might take the form of a high-level emotional model, which might be discrete or dimensional, or can be mapped from control data output if using a technology for realtime input.

Also similar to CSEMPs, a commonly used strategy in affective music generation is to translate empirically derived results from psychological studies into defined rules for the generation algorithm. However, the desired output schema closely guides this translation. An output schema might include manipulation of symbolic music or audio recordings, realtime sound synthesis/processing, or other techniques for content generation, but for the purposes of AMG, output schema is characterized by the degree to which the emotional data is responsible for content generation. A system that requires input of another type, whether it be symbolic music, audio recordings or live audio input, has less influence over content generation than a system in which sound or music comes directly from the algorithm. In the latter case, the system determines all content, in the former, a portion of the content has been generated independently from the system. Categorizing output in this way abstracts the AMG from a performance context, where a system might as a whole be relegated to a more or less prominent role depending upon aesthetic choices of the musicians involved.

The algorithm is the third part of the AMG that needs to be considered, but in principle sits between the input data and the output schema. Its importance is evident from the fact that it is possible, given the same input data and output schema, to have remarkably different acoustic results. In order to generate affective music, the algorithm must implement acoustic, structural, or performative features to express or communicate the desired emotion. It is natural to direct these choices from the large literature on features that convey or induce musical emotion, but their implementation will change depending upon choices made by the system designer. The designer might favor certain features over others, or include features that do not directly contribute to emotional communication or expression. By including a graphical user interface, mapping decisions might be provided to the user, contributing to flexibility and usability without changing the input data or fundamental output schema.

2.2. Technologies for Realtime Emotional Data in Music Performance

However, the question of algorithm for music generation only addresses part of the overall aesthetic of a performance. As with CSEMPs, one must additionally consider the possible technologies for realtime interactive control (Fabiani, Friberg, & Bresin, 2013). These technologies can be assimilated into a music performance, adding a "performer" or "performers" that in some way determine the emotional input data. For AMG, these technologies can be classified by the degree to which emotion is recognized and the amount of control provided to the user.

For this typology, a technology is capable of "emotion recognition" if it generates realtime emotional coordinates from an auxiliary data stream (e.g. biosignals, motion sensors). The output model might be discrete or dimensional, but in either case, the technology in some way "recognizes" an emotion from low-level control data input. In the context of CSEMP, these realtime emotional coordinates provide high-level, "semiotic" control (Fabiani et al., 2013).

By contrast to technologies for emotion recognition, this typology adopts the term "emotion sensing" to describe technologies used in AMG that do not include an algorithmic model for extracting emotional coordinates. Instead, data features from the input device (e.g. biosignals, motion sensors) are mapped directly to the generation algorithm. These data features may correlate with emotions—for instance, amount of motion correlating with arousal in a motion capture system—but the translation from these signals to an emotion-space is lacking. One could map input from a gestural controller (Miranda & Wanderley, 2006) to a set of emotionally salient parameters (e.g. tempo, loudness, etc.) and express an emotion like sadness (Bresin & Friberg, 2011), but if the output of the controller is mapped directly into the acoustic feature space, side-passing an emotion-model, it is classified in this typology as emotion sensing. Only if the gesture itself is first classified as sadness does it become a technology for emotion recognition.

The issue of emotion sensing versus recognition should be separated from a parallel consideration: the degree to which a user can directly control the input to the AMG. For example, the computer mouse has a high degree of control, and might be applied to realtime movement through an arousal-valence space. By moving this way, a performer can directly control the emotional input to the system, and the mouse would qualifying as a tool for emotion recognition. The term "recognition" suffices to distinguish it from the possible direct control of emotionally salient low-level parameters such as tempo and loudness. In that case, the mouse no longer outputs arousal and valence coordinates, and is thus classified as a tool for emotion sensing.

Other systems provide less control to a user. In the present case, physiological measures such as galvanic skin response, heart rate, and phalange temperature are the input to the system. These inputs are relatively more difficult to control than the computer mouse, but still might be applied to emotion sensing or recognition. Presently, realtime arousal and valence are derived from the measures, and used to drive the generation algorithm. In other cases, low-level data features (e.g. heart rate, temperature) might pass directly to sound generation parameters without being recognized as an emotion.

It is important to note that for interactive affective music generation, a high-degree of control is not always desirable. Technologies that are difficult to control (such as biosignals) allow less room for mediation, and might be considered to provide more "genuine" emotional data stream as input. A high-degree of control might be the best for conveying a performer's subjective feeling of emotion, but in performance, requires both honesty and attention on the part of the performer.

2.3. Summary

As in CSEMP, the tool for realtime interaction can be separated from the algorithm for music generation. The algorithm for generation is determined by its input, the generation algorithm, and output schema. Input data can come from either a "high-level" emotional model or low-level control input. The portion of performance content that is generated directly from algorithm categorizes the output schema. The generation algorithm implements structural, acoustic or performative cues determined by the system designer to communicate or express emotion given the input data and desired output schema.

Technologies for realtime control are determined by degree of emotion recognition and control. If the technology makes a translation from low-level data features to emotional coordinates (e.g. sadness, activity, valence), it is called "emotion recognition," otherwise, it is termed "emotion sensing." Degree of control is determined by the degree to which a performer can consciously manipulate input data, a feature that is not always desirable.

In light of the above typology, the two audio environments introduced presently use a tool for emotion recognition with a low degree of control. They feature two different output schemas: the audio-processing environment uses additional input from a performer's voice and the sonification environment generates content independently. The two translation algorithms implement cues based upon psychological results from music emotion, but are not directly comparable due to the difference in output schemas.

3. Details Regarding the Test Case

In this section we present details about the test case scenario used for the development of the audio environments. We discuss the biosensors used to collect physiological data, the emotion recognition engine in the Emotional Imaging Composer, and the musical and aesthetic aspects of the performance.

3.1. Biosensors

The performer's physiological data was recorded at 64hz using Thought Technologies' ProComp Infitini biofeedback system. The specific biosignals recorded were galvanic skin response (GSR), blood volume pulse (BVP), phalange temperature, heart electrical activity using an electrocardiograph (EKG), and respiration.

3.2. The Emotional Imaging Composer

The Emotional Imaging Composer takes the raw physiological data and processes it using four steps in order to produce arousal and valence data (Benovoy, Cooperstock, & Deitcher, 2008). The four steps are:

1. Pre-processing: raw signals are processed to reduce motion artifacts and high-frequency noise.

2. Feature Extraction: 225 features are extracted from the noise-filtered biosignals and their first and second derivatives. Examples of features include heart rate mean, acceleration and deceleration, and respiration power spectrum at different frequency bands.

3. Feature Selection: Redundant and irrelevant data is removed from the feature set using a greedy sequential forward selection algorithm.

4. Feature Space Reduction: the remaining features are projected onto a 2-

dimensional arousal/ valence space using Fisher discriminant analysis.

3.3. Performance Details

As Emotional Imaging's primary goal for the EIC is "to investigate the mapping of [emotional] states to expressive control over virtual environments and multimedia instruments," (Benovoy et al., 2008) a test case scenario was presented to guide the development of the audio environments. This scenario involved method-trained actress Laurence Dauphinais interacting closely with a small audience while performing "You Put A Spell On Me" (by Screamin' Jay Hawkins and made famous by Nina Simone) along with the corresponding audio, biosignal, arousal, and valence data. Since the EIC uses data regarding physiological processes over which performers have little conscious control, the intention of EII is for it to produce output that transparently reflects the inner emotional state of the performer. Though challenging, Dauphinais had previously demonstrated the ability to use her method acting training to reliably reach certain emotional states.

The video recording used to test the audio environments during development contains a single audio track that consists of both vocals and piano. Dauphinais improvised variations on the basic song, and used her method acting training to help her move through various emotional states. Her performance and the piano accompaniment were in the jazz vocal tradition. Since the video was recorded before the development of the audio environments, her performance does not take into consideration any additional digital processing or accompaniment. While this presented a challenge, it also reflects the desire of Emotional Imaging for the EIC to function in a wide variety of performance aesthetics. In order for the EIC to meet this goal, it has to be able to work in parallel to a previously existing performance tradition.

The research performed during the creation of the audio environments, therefore, centered on the effective mapping of emotional data to audio processing and synthesis in realtime musical performance. Additional goals were for the sonification environment to clearly present the data, and for the performance environment to use the data to augment the musician's acoustic sound production.

4. Sonification System

The sonification system was written in SuperCollider, an environment and programming language for realtime audio synthesis. The characteristic sound of the system was a resonant object that was excited by impulse in alternating stereo channels. The resonant object was created using the DynKlank UGen, which creates a bank of frequency resonators with independent control of center frequency, amplitude, and decay time (T60s) for each resonant mode.

Though initialized with resonant modes at 400, 800, 1200, and 1600 Hz, amplitudes of 0.3, 0.1, 0.1, and 0.2, and decay time of 1s for all, the GUI allows the user to create new sounds randomly by resetting center frequency, amplitude and decay of the four nodes. The new center frequency was between ±200Hz of the original, amplitude was randomly set between (0.1,0.5), and decay time between (0.5,1.5) seconds. The selection was implemented by pressing a button, which randomly generated a new visual ball representing the position in the arousal and valence space.

The front end of the GUI (Figure 1) displays an arousal and valence coordinate system with a small multicolored ball representing the current arousal and valence coordinate. By clicking once on the arousal valence graph, the sonification begins to play using the current AV position of the ball. By holding down the mouse-button, the user can drag the ball through the entire arousal/valence space hearing all of the possible sounds. Letting go of the mouse button snaps the ball back to it's "true" coordinate, which is either the origin if there is no data, or elsewhere if the data is playing through. Pressing the graph again turns off the sound of the sonification, and double clicking exposes the back end, which is located behind the video player, and allows more user control of the sonification mapping.

Adjacent to the arousal valence graph is a video player, which can be used to display corresponding live video if it is available. In the current context, a method actress sings through a song expressing different emotions, which are collected and identified by the Emotional Imaging Composer as arousal/valence coordinates. When pressing play in the video,

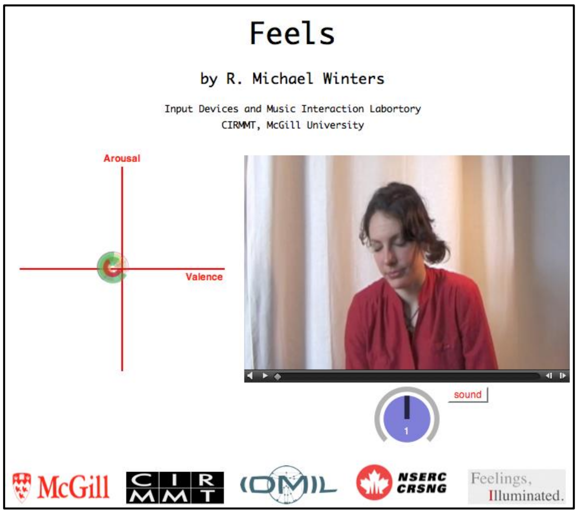

Figure 1. The primary user interface. On the left, an arousal and valence (AV) graph contains a multicolored ball centered on the initial AV coordinate. On the right, a movie player displays method actress Laurence Dauphinais, for whom the AV trajectory corresponds. Pressing play in the movie player starts the movie and the time-aligned AV data. The blue knob below the video player controls play-through speed. Clicking on the AV graph un-mutes the sonification. The user can freely move the ball in the space if desired to learn the mappings.

the video begins to play and the arousal/valence data begins to drive the ball in the adjacent graph. The data is time-aligned with the video, so speeding through the video, skipping to particular points, all creates a change in the arousal/valence graph that reflects the coordinate of that instant in time. Just below the video player, a knob allows the user to control the speed the video plays through. Speed could be anywhere between $e^{-1.5} \approx 0.2$ and $e^{1.5} \approx 4.5$ times the normal speed.

4.1. Mapping

A summary of the mapping decisions is provided in Figure 2. As discussed previously, the

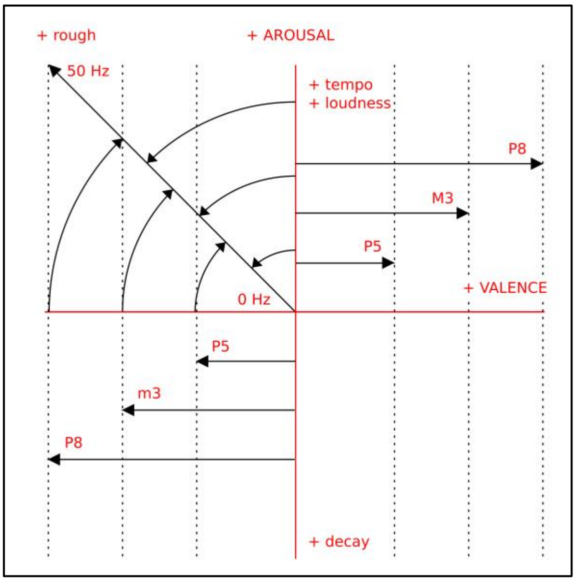

Figure 2. A summary of the mapping decisions on a two-dimensional arousal arousal/valence plot. Arrow direction indicates increasing strength.

fundamental sound is a resonant object that is excited through impulse, with impulses alternating between left and right stereo channel. The rate at which impulses were presented conveyed tempo. Arousal values were mapped exponentially from 0.75 to 5 impulses per second in each channel, creating between 1.5 to 10 impulses per second together. Loudness was also mapped to arousal, with the lowest arousal being 1/10th the amplitude of the highest arousal. Articulation was the third and final cue used for arousal, implemented by uniformly increasing or decreasing the decay times (T60s) of all resonant modes. At the lowest arousal, decay time was 2 seconds, at highest arousal, decay time was 0.5 seconds. These choices meant that each new excitation of the resonator occurred before the sound fully decayed.

Globally, valence was controlled by increasing “majorness” or “minorness” of the resonator as valence became more positive or negative respectively. Although at neutral valence there was only one sound, moving either positively or negatively in valence introduced three additional notes from either a major or minor triad. For example, given the initial fundamental of 400Hz with partials at 800Hz, 1200Hz, and 1600Hz, the neutrally valenced sound was most nearly G4. If increasing in valence however, B4, D5 and G5 would slowly increase in amplitude. The fifth, would reach maximum amplitude at ±0.5 valence. The third would reach maximum amplitude at ±0.75 valence, though it would be a major third (B4) for positive valence, and a minor third (B♭4) for negative valence. Finally, the octave (G5) reached maximum amplitude at ±1 valence.

Sensory dissonance was used to convey the second quadrant (negative valence, high arousal), and was implemented by creating an identical copy of the sound (including third, fifth, and octave), and pitch shifting. The amplitude of the copy increased with radial proximity to $3\pi/4$, being 0 at both $\pi/2$ and π. Within the second quadrant, sensory dissonance increased with radial distance from the origin. At maximum distance, the copy was pitch-shifted by 50Hz, at the origin, there was no pitch shifting.

4.2. Evaluation

The system was created with the express goal that emotional communication through audio should be as clear as possible. Informal evaluations from public demonstrations have been affirmative of the strategy. Holding the ball fixed in different regions of the AV space could convey markedly different emotions that expressed categorical emotions like sad, happy, bored, angry, and fear. Using sensory dissonance in the second quadrant was particularly salient for listeners. Though the major-happy/minor-sad cue is culturally specific, remarks from listeners at public demonstrations supported its viability as a cue for conveying the difference between positive and negative emotions of similar arousals. Listeners also liked the ability to generate new sounds by clicking a button. New sounds could refresh the listener's attention, which could otherwise diminish when using the same sound for long periods of time.

Interesting results were provided through listening to the sound in the background while watching the method actress. The auditory display of her emotions provided information that was not obvious through visual cues alone. For example, the sonification could be "nervous sounding" or "happy sounding" even when the cues from the actresses facial expression and gesture suggested otherwise. Because the sound was assumed to be the emotional representation that was "felt" by the actress, the added sound contributed to a deeper understanding of what the actress' emotional experience. Further, this auditory representation allowed visual attention to be directed towards the actor's expression rather the visual arousal and valence graph.

4.3. Future Work

Although the decisions implemented in this model were informed by research on the structural and acoustic cues of musical emotion, a more rigorous framework has been provided in (Winters & Wanderley, 2013), which considers possible environmental sources of auditory emotion induction, and additional structural and acoustic cues guided by a more psychologically grounded approach to feature selection. The additional psychoacoustic features of sharpness, attack, tonalness, and regularity for instance have not yet been implemented, but should be in future work.

5. Performance Environment

The test case scenario presented by Emotional Imaging presents different constraints from other approaches incorporating emotion data into music performance such as affective music generation systems (Wallis, Ingalls, & Campana, 2008) or performances in which all of the musical characteristics are generated in response to emotional data (Clay et al., 2012). In the test case we chose, the structure of the performance environment was heavily driven by the fact that the song determined the harmony, form, and rhythm of the singer's performance. In addition, it was desirable for the effects of the singer's emotion to be seen as part of the singer's performance rather than as an accompaniment. Due to these considerations we chose to implement a performance system that processed the singer's voice rather than generating an autonomous additional audio source.

The fact that the source material was a human voice raised other issues relating to performance practice. Juslin et al. note that the

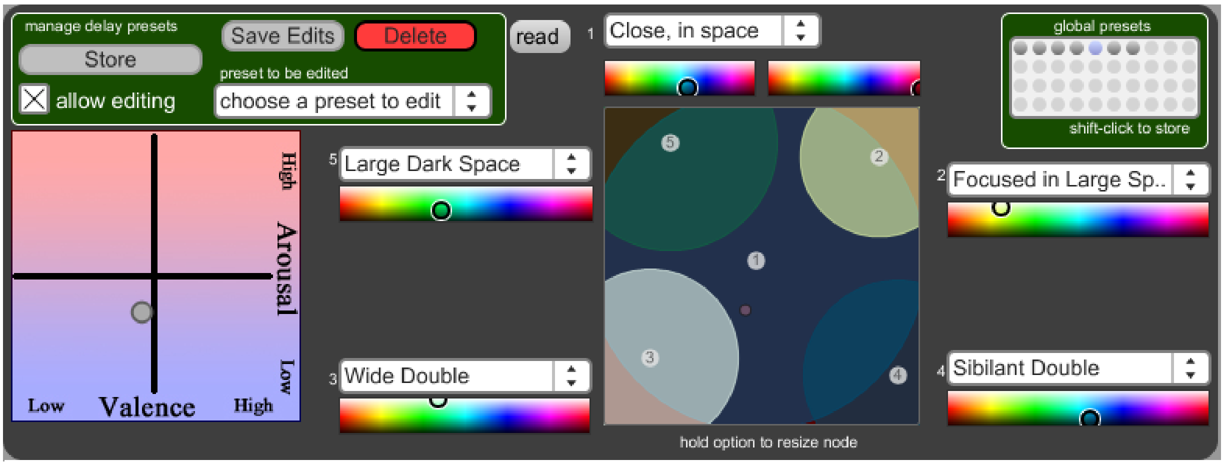

Figure 3: The interface for the two stage preset system. At the top left is the interface for saving and editing delay presets. These presets appear in the dropdown menus surrounding the nodal interface. Global presets are saved using the interface in the top right, and contain the locations of nodes as well as the delay presets assigned to them.

human voice is a primary factor in the development of emotional audio cues. We quickly identified that drastic alterations of vocal timbre through distortion, pitch shifting, and filtering not only sounded unnatural within the context of the song but also served to obscure the emotional cues already present within the voice. For this reason we chose to implement a spectral delay algorithm that enables the creation of virtual spaces representing different emotional states.

5.1. Spectral Delay

A spectral delay system divides an incoming audio stream into a discrete number of audio bands, and each band is then individually stored in an audio buffer. The buffer containing each band is then played back with its own delay, feedback, gain, and panning settings. We also implemented an optional additional amplitude envelope stage. This stage occurs after the gain stage, and a 32-step sequencer whose parameters are controlled by the output of the EIC triggers the envelopes. The spectral delay implemented for this project was developed in Max/MSP and draws upon prior work by John Gibson's work on spectral delays (Gibson, 2009) and Jean-Francois Charles' use of jitter matrixes to store frequency domain audio data (Charles, 2008).

5.2. Graphic Programming Interface and Preset Management

Two separate graphic user interfaces were developed in order for easy programming of the spectral delay as well as the mapping strategies. A two stage preset management system was also implemented, of which the first stage allows for the user to save presets containing spectral delay and sequencer parameters.

The second preset stage contains parameters pertaining to the mapping of different spectral delay presets to the two-dimensional emotion space. Five different delay presets are assigned to separate nodes. Each node consists of a central point and a radius within which the delay preset is activated. When the radii of multiple nodes overlap the parameters for the presets they refer to are interpolated. Parameters stored in this stage include the preset assigned to each node, the location and radii of each node, and the color assigned to each node. Five nodes were initially implemented in order to allow for one node for each quadrant of the emotional space as well as one node for a neutral "in-between" state. In practice, it was found that the performer navigated within a relatively small terrain within the emotional space and therefore an irregular assignment of nodes was more musically effective.

Several initial delay characteristics pertaining to emotional states were identified, including delay brightness, density, amplitude, stereo width, and length. Emotional cues contained within music performance as detailed by Juslin and Sloboda (Juslin & Timmers, 2010) were found to correlate to these characteristics as well. One useful facet of the spectral delay we implemented is that each characteristic can be realized by a variety of different approaches. For example, lowering the brightness would normally be achieved by lowering the gain of the higher frequency bands; however it can also be achieved by lowering their feedback, delay time, or panning. Many of these settings are consistent with real-world acoustics, such as the attenuation of high frequencies as sound radiates in a room, but the possibility for unnatural acoustic characteristics is retained. One example of a mapping is presented in **Figure 4**.

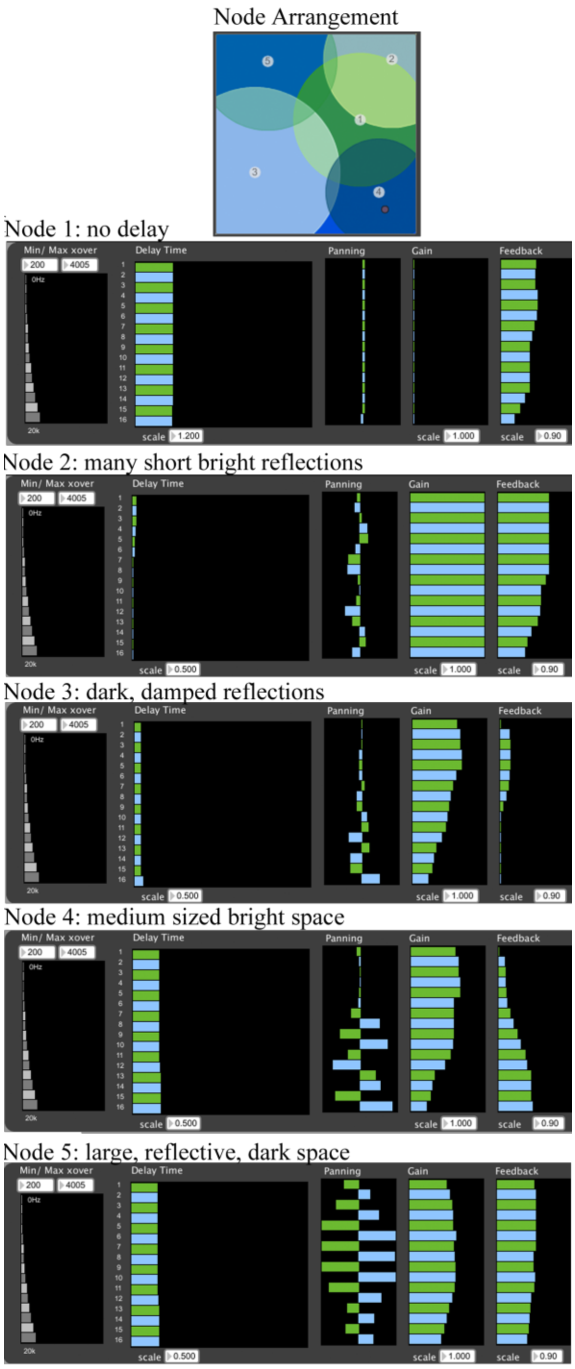

Figure 4: A spectral delay sample preset.

5.3. Evaluation

The video of the test case with emotional data from the EIC was used to evaluate the performance environment and mapping strategies. It was quickly found that creating spaces which correlate to emotional states was relatively easy to do; however, by themselves they did not serve to create the desired emotional impact due to the fact that listeners discern the emotional cues contained within the vocal performance as more relevant than those provided by the acoustic space. However, once the performer's emotional signals cause the delay to move from one delay preset to another the sonic change was easily perceived and made a stronger contribution to the perceived emotion of the performer. The importance of moving between delay presets in order to create emotional cues underscores the importance of the location of the nodes within the mapping preset. Since performers will tend to move within a limited number of emotional states, the borders between nodes will need to be located near the junctions of those states in which the performers spend the most time.

6. Conclusion

This paper presented two systems for interactive affective music generation. Using a collection of biosignals from the autonomic nervous system, the Emotional Imaging Composer and outputs realtime arousal and valence coordinates. In section 2 we presented a typology for affective music generation that drew upon analogies with computational systems for expressive music performance (Fabiani et al., 2013; Kirke & Miranda, 2013b). We distinguish our system as one relying on emotion recognition rather than emotion sensing and being relatively difficult to consciously control.

Though both audio environments use realtime arousal and valence in their generation algorithm, the sonification environment approaches sound generation for the purposes of emotional communication or interpretation and all content is generated from these coordinates. The performance environment targets live input from the human-voice for audio processing, thus modifying existing performance content. Though guided by emotionally salient structural and acoustic cues, their difference in desired output schema results in markedly different generation algorithms.

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Sonification of Emotion: Strategies for Continuous Display of Arousal and Valence

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Abstract

Sonification is an interdisciplinary field of research broadly interested in the use of sound to convey information. A fundamental attribute of sound is its ability to evoke emotion, but the display of emotion as a continuous data type has not yet received adequate attention. This paper motivates the use of sonification for display of emotion in affective computing, and as a means of targeting mechanisms of emotion elicitation in music. Environmental sound and music are presented as two possible sources for non-verbal auditory emotion elicitation, each with specific determinants and available features. The review concludes that the auditory-cognitive mechanisms of brain-stem reflex and emotional contagion provide the most advantageous framework for development. A sonification model is presented that implements cues that target these mechanisms. Computationally based strategies for evaluation are presented drawing upon the music emotion recognition literature. Additional aesthetic considerations are discussed that benefit usability and attractiveness of the display.

Keywords: sonification, psychoacoustic cues, affective computing

1. Introduction

Sonification is an interdisciplinary research of research broadly interested in the use of sound (usually "non-speech audio") to convey information (Kramer et al., 1999). A classic example of sonification, the Geiger counter, conveys the amount of radiation in the nearby environment using audible clicks. Although sonification has found many applications, this small sample exemplifies two compelling functions. Namely, sound can i) display a stream of information that is not visually obvious and ii) leave the eyes free to direct attention to other tasks. Like radiation, emotion is not always visually accessible, and displaying emotional information through sound does not require visual attention. Unique to emotion however, sonification can recruit resources from a cognitive apparatus that is well equipped for auditory emotion perception.

In the field of sonification, the subject of continuous emotion display has not yet received adequate attention. Sonification applications have included assistive technologies, bio-acoustic feedback, data exploration, alarms, and process monitoring (Hermann, Hunt, & Neuhoff, 2011), but the subject of emotion is rare. Though it has been recognized for its role in sound quality and interaction (Serafin et al., 2011), and is relevant to preference and pleasantness in sonification aesthetics (Vickers, 2011), only short, discrete sounds have thus far been applied. Such examples include using auditory icons to communicate emotional associations of the weather (Hermann, Drees, & Ritter, 2003) and using earcons for emotional communication in driver-vehicle interfaces (Larsson, 2010) and robotics (Jee, Jeong, Kim, Kwon, & Kobayahi, 2009), but the display of emotion as a continuous realtime data type is absent. The subject as a whole is much more at home in the realms of contemporary research in affective computing (Picard, 1997) and musical emotion (Juslin & Sloboda, 2010), where emotion expression and communication is considered computationally and music's affective capacity is studied in depth.

Furthermore, affective computing and musical emotion stand to benefit from the development of sonification strategies for emotion. Although embodied conversational agents (Hyniewska, Niewiadomski, Mancini, & Pelachaud, 2010) and emotional speech (Schröder, Burkhardt, & Krstulović, 2010) are the predominantly used modalities for affect display and communication, non-speech audio is an *unembodied* medium, requiring neither a face or a voice to be understood, and by extension, leaving visual and verbal attention un-taxed. When used in combination with other display modalities, this auxiliary channel may contribute to a more meaningful data interpretation.

Sonification of emotion can also be useful to the study of musical emotion. A great number of psychological studies have thus far been applied to determining the acoustic, structural (Gabrielsson & Lindström, 2010), and performative (Juslin & Timmers, 2010) elicitors for musical emotion. However, these results have yet to be applied to creating a "systematic and theoretically informed" manipulation of musical stimuli, which according to Juslin and Västfjäll (Juslin & Västfjäll, 2008, p. 574), would be a "significant advance" to stimuli selection. Parallel to psychological studies, music emotion recognition (MER) (Yang & Chen, 2011) has created models for musical emotion using sets of psychoacoustic features, reaching approximately 65% accuracy for categorical emotion recognition in large corpora of music (Kim et al., 2010, p. 261). Sonification offers the possibility of targeting the mechanisms for emotion induction that rely upon the same low-level acoustic cues as these algorithms, increasing (or even *decreasing)* recognition accuracy, leading to interesting conclusions.

This paper motivates the use of sonification for affective computing and presents strategies for continuous auditory monitoring of arousal and valence. After presenting relevant results from environmental sound, a framework is proposed founded upon two mechanisms for emotion induction in music. A sonification model that implements a select number of these acoustic cues is discussed. Goals and methods for evaluation are presented.

2. Background

Affective computing is defined as computing that relates to, arises from or deliberately influences emotion and other affective phenomenon (Picard, 1997). This definition is broad enough to include some uniquely musical pursuits, which would not normally be considered as related to affective computing. The first is music emotion recognition (MER), where automated, computational systems for emotion or "mood" recognition based on audio and/or text-based information have received increasing attention (Kim et al., 2010). The second are systems for affective music generation, where music composition is computationally infused with results from psychological studies of music emotion (e.g. Gabrielsson & Lindström, 2010). Within affective computing, music has been recognized as a "socially accepted form of mood manipulation," (Picard, 1997, p. 234) which for example has been applied to noted performance gains in sports (Eliakim, Bodner, Eliakim, Nemet, & Meckel, 2012), gaming (Cassidy & MacDonald, 2009), and driving mood (Zwaag, Fairclough, Spiridon, & Westerink, 2011).

Among these alternatives, sonification of emotion is most closely related to the development of affective music generation systems. Both share emotional data as input and create an "emotional mapping" to sound parameters. Furthermore, sonification can be listened to musically (Vickers & Hogg, 2006) and even integrated into affective music generation systems (Winters, Hattwick, & Wanderley, 2013). However, they can be distinguished both by the goals of the system designer and the way that they are meant to be listened to. Borrowing from the standard definition of sonification, the goal of a designer is to create a "transformation of data relationships into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation" (Kramer et al., 1999). In this light, the sound resulting from sonification is most comprehensively a *signal* that for the listener communicates or interprets important data relationships. If the data is emotion, than sonification, even when explicitly borrowing acoustic features from music, is simply a signal that communicates or interprets the data for the user.

The definition of sonification in fact, most closely parallels one of four non-exclusive areas of affective computing: technologies for displaying emotional information or mediating the expression or communication of emotion (Picard, 2009). Although this area most commonly makes use social signals (Vinciarelli et al., 2012) such as facial, gestural and vocal expressions in embodied conversational agents (Hyniewska et al., 2010), and the task of knowing the social display rules that govern *when* to display *which* affect is the "hardest challenge," (Picard, 2009, p. 13) there are contexts in which the relative simplicity of accurate realtime auditory display of emotion would beneficial.

For communication, these contexts arise when social displays of affect are unavailable, misleading, or inappropriate. A social display might be unavailable in cases when an agent is physically removed from or incapable of generating signals recognizable to the receiver. Social displays might be misleading if they are purposely masked, neutralized, or changed in magnitude (Matsumoto, 2009). A social display might be inappropriate if verbal or visual attention needs to be directed elsewhere, like when engaging in other more primary tasks. If paired with a social display, the auditory channel might be likened to the use of music in film, where sound contributes to the emotional expression of a multimodal scene. In visually based analysis tasks, the addition of the auditory channel might draw attention to data relationships not obvious if using visual-only methods.

Sonification of emotion is further motivated by increasingly sophisticated and diverse technologies for realtime emotion measurement and recognition. In these contexts, the subjective experience of emotion is often represented dimensionally (Fontaine, 2009), and the two-dimensional arousal/valence model of Russell is particularly prominent (Russell, 1980). To create a continuous sonification that would be successful in the use-contexts previously described, an objective and systematic mapping of arousal and valence appears most prudent. The content of the next section determines which of the many possible features of non-speech sounds make good candidates for emotion display, and how they might be mapped from realtime arousal and valence coordinates.

3. Determining Best Strategies

Potential sources for auditory display of affect come from two broad categories of sound: environmental sound and music. Though speech is another candidate, the stated goal is to create a display that does not conflict with verbal communication. Although some of the cues used in vocal expression of emotion might be shared by the auditory display (as in music; Juslin & Laukka, 2003), the goal here is not to use speech.

Within environmental sounds and music, there are additional requirements imposed by the conditions of realtime data monitoring as a background task in parallel to other more primary tasks. In sonification, this context is most often associated with process monitoring applications, and the present case is most closely a *peripheral* rather than direct or serendipitous display (Vickers, 2011). As noted by Vickers, common issues raised in process monitoring design are intrusion or distraction, fatigue and annoyance, poor aesthetic or ecological choices, and comprehensibility. These concerns are in turn grounded in the underlying need for appropriate aesthetic and semiotic choices. Through an analysis of acoustic features that communicate emotion in music and environmental sounds, this review shows that ultimately music provides the strongest theoretical framework for development due to the wealth of research and the continuous and malleable nature of its elicitors.

3.1. Emotion in the Acoustic Environment

Research on the acoustic elicitors of emotion in the natural environment has been most commonly presented in the psychoacoustic literature or in the pleasantness or annoyance of product sounds. However, recent research has sought a more ecological approach to sound perception in which psychological determinants take prominence to strictly signal characteristics, and the role of emotion becomes more complex. "Emoacoustics" (emotional acoustics) research (Asutay et al., 2012) embodies this trend towards a focus on listener and context, and contributes intriguing new methods and results.

Perhaps the most thorough review comes from Tajadura-Jiménez who categorizes "auditory-induced emotions" into four determinants (Tajadura-Jiménez, 2008, Ch. 4):

1. Physical Determinants
2. Identification/Psychological Determinants
3. Spatial Determinants
4. Cross-Modal Determinants

Physical determinants are those related to the signal itself and are best studied using "meaningless" sounds (Västfjäll, 2012) like broadband noise, and amplitude or frequency modulated tones, as is done in the psychoacoustics literature (Fastl & Zwicker, 2007). Factors related to identification enter when a sound has meaning due to the recognition and cognitive associations of the listener. Experiments using the *International Affective Digitized Sounds Library* (Bradley & Lang, 2007) have targeted this determinant and found similarities with corresponding affective pictures (Bradley & Lang, 2000). Spatial determinants arise when some aspect of the space contributes to the emotion. Issues of proximity, location, room size (Tajadura-Jiménez, Väljamäe, Asutay, & Västfjäll, 2010), and approaching or receding sound sources (Tajadura-Jiménez, Larsson, Väljamäe, Västfjäll, & Kleiner, 2010) have been studied in combination with different sound types (Hagman, 2010). Cross-modality effects occur when emotionally salient information from one modality impacts another. For sound, visual or tactile information might contribute to the emotional meaning of a sound, though this effect has been studied the least.

Although these categories are valid, only the first three pertain to audio-only display. From these, identifiability requires special consideration. As mentioned in the introduction, identifiable sounds (a.k.a. auditory icons; Brazil & Fernström, 2011) have been applied thus far to conveying emotional associations of the weather (Hermann et al., 2003). Although the affective space occupied by these sounds has been shown to convey a variety of emotions (Bradley & Lang, 2000), sounds notably fall upon two motivations, "appetitive" and "defensive," creating a 'V' shape in the AV space. If this trend were to continue for all identifiable sounds, it would leave gaps that could not be well communicated through sound.

Movement is another problem for the use of identifiable sounds. To convey a transition from high arousal, high valence to low arousal, high valence, would require the interpolation through many sounds. If this transition were to occur rapidly, the identifiability of these sounds might be compromised due to their short length. This problem might be avoided by using *evolutionary objects* (Buxton, Gaver, & Bly, 1994), which, as identified in the auditory icons literature, allow sound properties to be updated while playing (Brazil & Fernström, 2011). If using an evolutionary object, the sound would need to be able to occupy the entire AV space, so it might be best to start with a sound which is more or less emotionally neutral. A promising candidate for this is *self-referential sounds* (Tajadura-Jiménez & Västfjäll, 2008), or sounds related to ones own body and its natural movements (e.g. walking, breathing). The sound of a heartbeat for instance could be changed in tempo or loudness to convey arousal, and perhaps sharpness, roughness, and tonalness to convey valence.

The capacity of using spatial determinants for continuous display is worth mentioning, though is also limited. Increasing room size (reverberation time) creates a systematic decrease in valence and increase in arousal for sounds with neutral emotional connotation (e.g. clarinet, duck quack), but not for negative connotation (e.g. dog growl) (Tajadura-Jiménez, Larsson, et al., 2010). Evidence supporting this effect of neutral sounds is also present in (Västfjäll, Larsson, & Kleiner, 2002), though the effect on arousal was less pronounced. Arousal, in fact, decreased for the condition of highest reverberation, attributed to a decrease in "presence." Presence, though lacking a precise acoustic definition, has been defined as the perceptual illusion of non-mediation (Lombard & Ditton, 1997), and has been strongly connected to the emotion in auditory virtual environments (Västfjäll, 2003), perhaps most analogously correlated with the degree of "realism" (Frija, 1988). Creating the illusion of "approach" is possible by increasing loudness, and creates an increase in emotional intensity, but only for identifiable sounds deemed "unpleasant" (Tajadura-Jiménez, Väljamäe, et al., 2010). Finally, in general, sounds perceived as coming from behind the individual are more emotionally arousing (Tajadura-Jiménez, Larsson, et al., 2010). The use of spatial effects for emotion display or expression is drawn into question as incongruent visual information can diminish the strength of the desired auditory illusion (Larsson, Västfjäll, Olsson, & Kleiner, 2007).

The results are most clear-cut with psychoacoustic literature using broadband-noise, and amplitude or frequency modulated tones (Fastl & Zwicker, 2007). Composite models for sensory pleasantness (p. 245) and psychoacoustic annoyance (p. 328) have been developed using well-defined metrics for roughness, sharpness, loudness, tonality, and fluctuation strength. These have been shown to predictive of ratings of pleasantness and annoyance of product sounds, though they were not designed to be able to predict the position in a full 2-D arousal valence model (Västfjäll, 2012). They make good candidates as features for sonification, though using ecologically valid stimuli should not be abandoned. Results from sonic interaction design (SID) have shown that "naturalness" creates a systematic increase in valence compared to synthesized sounds with similar spectral centroid and tonality (Lemaitre, Houix, Susini, Visell, & Franinović, 2012). However, as in SID, it might be best to consider naturalness as an overall aesthetic property that should be conserved, contributing to the attractiveness of the sound and "usability" of the sonification (Norman, 2004).

This review has accessed different possible features for emotion communication in environmental sounds. If using identifiable sounds, it would be best to use evolutionary sounds, perhaps in some way self-representational. Use of spatial effects can be considered if one is mindful of visual dominance. Psychoacoustic features are the most promising for sonification, but naturalness is a global property that should be conserved. Overall, it would appear that the strongest emotional determinant of environmental sound—identifiability—is not viable for sonification, dramatically diminishing the framework as a whole. The field of emotional acoustics is still developing, and future results might be more favorable. For the time being, a much stronger framework is founded in contemporary research on music and emotion, which will be discussed in the next section.

3.2. Mechanisms of Musical Emotion

On the surface, it would seem that the most useful results for sonification come from the wealth of results linking structural, acoustic, and performative cues in music to defined regions of the arousal/valence space. Instead however, a more rigorous approach first determines which psychological mechanisms are favorable for emotion elicitation given defined properties such as cultural specificity, volitional influence, and induction time. These mechanisms in turn encompass subsets of the available structural/acoustic feature space, making the process of selection easier.

Many psychological studies have been conducted to determine what structural, acoustic, and performative parameters contribute to emotional communication in music (Gabrielsson & Lindström, 2010; Juslin & Timmers, 2010). Additionally, new computational approaches to feature determination have been introduced in the field of music emotion recognition (Yang & Chen, 2011). This literature affirms that there is no dominant single feature, and musical emotion is best predicted using a multiplicity (Kim et al., 2010). The literature on performance cue utilization (Juslin, 2000) has also advanced—recent results have introduced defined ranges for communication of discrete emotions (Bresin & Friberg, 2011).

Collectively, these results offer an abundance of possible features for emotion communication in sonification, but music research offers a more fundamental approach, that of the auditory-cognitive mechanism. In this vein, a collection of six mechanisms for emotion elicitation in music has been proposed (Juslin & Västfjäll, 2008), two of which can be used for continuous auditory display: *brain-stem reflex* and *emotional contagion.* Both have a low-degree of cultural and volitional influence, fast induction speed, and a medium dependence upon musical structure (Juslin & Västfjäll, 2008, Table 4). It is worthy of note that the psychoacoustic features from the environmental sounds literature that are the most viable for sonification are accounted for by these mechanisms, and as noted in (Tajadura-Jiménez, 2008, p. 26), mostly the brain-stem reflex.

Acoustic features drawing upon the brain-stem reflex recruit innate structures of the brain that bear upon the organism's survival. As noted in (Juslin & Västfjäll, 2008, p. 574), these features are most commonly studied in the psychoacoustics literature and include sharpness, loudness, roughness, tonality, and fluctuation strength. In the music literature, a close relative of sharpness is the height of the spectral centroid. Likened to roughness is sensory dissonance, and tonality (a.k.a. "tonalness;" Egmond, 2009, p. 79) refers to how tone-like the timbre is as opposed to broadband. The spatial cues discussed in section 3.1, might be considered in this list in that spatial hearing is also shared and important to an organisms survival, though effects that are dependent upon the sound identification are likely cognitively mediated.

Emotional contagion is a process whereby emotion is induced by perceiving the expression of the stimulus itself and then "mimicking" it internally (Juslin & Västfjäll, 2008). The theory suggests that because music shares many of the acoustic features used in vocal expression of emotion, music becomes like a *super-expressive voice* (Juslin, 2001). Further, musical features are decoded by an "emotion-perception module" (Juslin & Laukka, 2003, p. 803) of the brain that does not distinguish between music and the voice. Evidence supporting this claim comes from an extensive review of literature in musical and vocal expression showing that a number of prominent features governing expression of five discrete emotions were shared in music and speech (Juslin & Laukka, 2003, Table 7). The cross-modal features relevant to this proposed module are tempo, intensity, intensity variability, high-frequency energy, pitch-level, pitch variability, pitch contour, attack and microstructural regularity (taken at the note-to-note level; Bunt & Pavicevic, 2001).

Implementation of these reflex and contagion features requires two levels of acoustic content, timbral and note-based. For the brain-stem reflex and psychoacoustics, spectral content and intensity must be manipulated—the sonification must include a structure that allows malleability of sharpness (amount of high-frequency energy), tonality (amount of noise versus tonal components in the spectra), roughness (including fluctuation strength), and loudness. To use emotional contagion features, a note-based structure must be available for manipulation of tempo, pitch, and attack.

The strength of these features is their low cultural influence, low volitional influence, induction speed and their dependence upon structure. This structure does not have to be "musical" necessarily, for these mechanisms are on the one hand biological, and on the other processed by an emotion-perception module that processes speech as well (Juslin & Laukka, 2003, p. 803). Other acoustic features that rely upon different mechanisms can (and perhaps should) be used in sonification, but they can be expected to be more culturally dependent, with potentially lower induction speed, and subject to volitional influence. Such a feature would be the major-minor mode, which in western classical music can be used to convey positive and negative valence. However, this connotation is not learned until the age of six to eight (Gabrielsson & Lindström, 2010, p. 393), and thus might be accounted for by the mechanism of musical expectancy.

3.3. Summary

Having compared mechanisms for emotional elicitation in both environmental sounds and music, it is clear that sonification of emotion finds more substantive support in the mechanisms described in musical emotion research. From environmental sounds, emotion determined through identification and appraisal of the sound was found to be a strong factor influencing emotion. However, the emotional space occupied by these sounds is incomplete, and the problem of movement suggests the use of emotionally neutral *evolutionary* or *self-representational* sounds for which acoustic properties can be easily manipulated. Though not well researched, "naturalness" should be conserved at a global level to maximize pleasantness.

Ultimately however, the results from this literature are much less developed than those from musical emotion, and factors such as cultural dependency, induction speed, degree of volitional influence have not been adequately accessed. From music research, two viable mechanisms for sonification have been proposed, each with well-defined psychological properties. Further, the *brain-stem reflex* accounts for the psychoacoustic and spatial results in the environmental sounds literature that would otherwise be most promising for sonification. The additional mechanism of *emotional contagion* presents additional musical features for sonification including tempo, attack, pitch information, and regularity.

4. Sonification Model

In designing the sonification model, the goal was to create a simple sound capable of accurately conveying the entire arousal and valence space. Details of the implementation and further discussion can be found in (Winters et al., 2013), but are summarized presently.

A single note forms the basis of the model. This note is created as a bank of resonant modes with independent control of center frequencies, amplitudes and decay times. The resonant object is excited through impulse in alternating left-right stereo channels. The choice of this sound was motivated by its "naturalness"—it is capable of generating sounds that resemble materials like glass, wood, metal, etc. For sonification, tempo, and loudness are mapped to increasing arousal, and the decay time increases with decreasing arousal. Increasing positive or negative valence is conveyed by slowly increasing the loudness of the fifth, third (M3/m3), and octave above the original note. Sensory dissonance is conveyed in the second quadrant by taking an identical copy and pitch-shifting upwards. Loudness of the copy increases with radial proximity to the line $3\pi/4$, and the pitch shift increases with distance from the origin.

4.1. Evaluation and Future Work

The sonification model presented has not yet been formally evaluated, which is the next step for validation. Of utmost importance is determining how well it conveys the underlying arousal/valence space. With this established, it will be necessary to perform user testing to evaluate sonification in the context of realtime peripheral process monitoring.

The decisions for tempo, loudness, and roughness are supported by the present discussion. Tempo is a feature from the *emotion contagion* mechanism, roughness is a feature of the *brain-stem reflex,* and both share loudness. Tempo and loudness increased with increasing arousal as in speech, and increasing roughness and loudness both increased with sensory *un-pleasantness.* The decisions for major-minor and decay are musical features that are not supported by the present discussion but were found to be useful for conveying valence and decreasing arousal respectively. In fact, these two decisions contributed more to the aesthetic appeal of the display than the decisions of loudness, tempo, and roughness. Although mindful that when using features not accounted for by brain-stem reflex and emotion contagion, desired psychological properties (e.g. low cultural specificity) are not guaranteed, the use of cultural associations has been supported in the design of process monitoring sonifications (Vickers, 2011) as well as in aesthetic computing (Fishwick, 2002). Drawing upon a listener's cultural associations can create a convincing display that enhances aesthetic appeal, but the designer should be mindful of its limitations. "Major-happy, minor-sad," for example is culturally learned and may not necessarily be understood by children under six to eight years old.

A yet undeveloped benefit of using strategies from music research, and perhaps most attractive for evaluation, are the growing number of models for music emotion recognition (Yang & Chen, 2011). Using audio-only features, these systems are capable of recognizing emotions categorically or dimensionally, and some systems are designed for time-varying, "second-by-second" emotion detection (Coutinho & Cangelosi, 2011; Schmidt & Kim, 2011). Because these models are sometimes designed for large corpora of music, stretching beyond those of western-classical tradition, the features used for recognition may be less culturally specific. For evaluation, these models can provide a preliminary metric of the accuracy of communication in the arousal valence space.

As of yet, several of the features supported in this analysis have not been implemented. From the brain-stem reflex, these include sharpness, tonalness, and fluctuation strength. From emotional contagion, these include pitch-level and its variation, contour, intensity variability, and attack. The spatial cues of increasing reverberation time and the auditory-illusion of "behind" might also be investigated. The framework of resonant synthesis creates sounds that are relatively more "natural" than other synthesis techniques. This strategy should be continued in further implementations, though using self-representational or evolutionary sounds might be assessed as well.

5. Conclusions

Realtime continuous auditory display of arousal and valence has not yet received adequate attention in the sonification literature, though the pursuit of technologies for realtime emotion recognition makes the data-type eminent. Benefits of sonification include displaying emotional information when visual or verbal cues are unavailable, misleading, or inappropriate, and providing an auxiliary channel for emotional display that can contribute to emotional expression or visual-based data analysis.

Determining the best strategies for display requires careful aesthetic and ecological choices, for which research on the emotional impact of environmental sound and music provides two possible categories for the designer. Currently, the most robust foundation for development is presented by research in musical emotion and specifically cues recruiting the mechanisms of brain-stem reflex and emotional contagion. These mechanisms account for most of the viable acoustic cues from environmental sound and propose additional ones that are shared with speech. These cues can be expected to have a low degree of cultural influence, a high induction speed, and a low degree of volitional influence.

The sonification model discussed explicitly uses some of these features, though others are presented for future work. To evaluate the model, it may be possible to use models for music emotion recognition as a preliminary design metric. With the accuracy of the mapping strategy accessed, user testing needs to evaluate how well the sonification performs when verbal and/or visual attention is already occupied.

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