**Author(s):** Bisesi, Erica; Toiviainen, Petri

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# The Relationship Between Musical Structure and Emotion in Classical Piano Scores: A Case Study on the Theme of *La Folia*

Erica Bisesi[*#1], Petri Toiviainen[§2]

[*] *Department of Speech, Music and Hearing, KTH, Stockholm, Sweden*
[#] *Department of Musicology, Comenius University, Bratislava, Slovakia*
[§] *Department of Music, University of Jyväskylä, Jyväskylä, Finland*
[1] bisesi@kth.se, [2] petri.toiviainen@jyu.fi

## ABSTRACT

We explored the relationship between musical structure and emotion on different variations of *La Folia* – a musical theme of Portuguese origin based on a standard harmonic progression. Our approach aims to extend previous research by investigating more factors and comparing different models for music emotion. In a pilot study, 12 participants rated the emotion associated to the stimuli on a graduate scale from 1 to 10, according to 3 different models for music emotion: the valence/arousal-based emotion model (Russell, 1980), a discrete emotion approach (Izard, 1972), and the Geneva Emotional Music Scale (GEMS) (Zentner et al., 2008). Stimuli were commercial recordings of the first 8 bars of 32 variations of the Theme of *La Folia* by A. Scarlatti, C. P. E. Bach, S. Rachmaninov and F. Liszt, with different combinations of 9 factors that were judged and averaged by 2 musical experts using a 5-point rating scale. Preliminary results are: *(i)* there exist significant correlations between structural parameters and descriptors for emotions in all of the models; *(ii)* correlations between structure and emotion are more remarkable for the valence/arousal-based emotion model and for the GEMS model, and are higher for register, note density, dynamics, accentuation and articulation; *(iii)* agreement among raters for the DES model is significantly lower than for the other two models. On the base of these results, we planned two new experiments focussing only on the valence/arousal-based emotion model and on the first-order GEMS model. They are: a second listening test based on a real music design (20 out of the previously selected 32 stimuli, corresponding to pieces featuring more extreme variability in the musical structure, with different combinations of 21 factors), and a new listening test based on a controlled and balanced design (24 variations with selected combinations of 4 factors, arranged and recorded in a deadpan performance by the first author). 24 participants (12 musicians and 12 non-musicians) have been involved in the current study, following the same procedure outlined above. We expect to extend understanding on the relationship between structure and emotion following more accurate, computational analyses of musical features, as well as by defining new predictors for emotion that are more appropriate for specific musical style(s) – like factorial analysis or multidimensional scaling.

## I. INTRODUCTION

How does music emotion depend on structure beyond mode and tempo? Clynes (1977) related the emotional quality of an event to its loudness and tempo contours. Sloboda (1991) related structural elements such as sequences and unexpected harmonies to emotional responses. Juslin (2000) explored the relationship between basic emotions and the musical surface (tempo, dynamics, articulation). Juslin et al. (2002) presented a computational model of expression in music performance where generative structure rules, emotional expression and movement principles are integrated in a common picture (GERM model). Gomez & Danuser (2007) examined relationships between several structural features and both self-reports of felt pleasantness and arousal and different physiological measures. Zbikowski (2010) explored relationships between remarkable passages (dissonances, modulations) and emotion. Previous studies exhibit several limitations, e.g. some musical factors (highly dissonant harmony, unfamiliar rhythmic patterns) were not represented, correlation between factors poorly considered, and verbal reports not regarded. The question may be also clarified by separating emotion in notated music into *immanent emotion* (emotion that is latent in the score) and *performed emotion* (emotion that is contributed by the individual performer). We have been applying the same distinction to musical accents, defined generally as events that attract attention; immanent accents occur at phrase onsets, downbeats, melodic peaks and harmonic dissonances, while performed accents may be agogic, dynamic, articulatory or timbral (Bisesi & Parncutt, 2011; Friberg & Bisesi, 2014; Bisesi et al., paper in preparation).

Classical models of music emotion include *dimensional* approaches (classification of emotions as a mixture of two core dimensions, *valence* and *arousal*, representing pleasure-displeasure and activation-deactivation continuums that are orthogonally situated in the affective space; Thayer, 1989; Watson & Tellegen, 1985), the *circumplex* model (Russel, 1980), *categorical* approaches (discrete sets of universal and innate basic emotions, which typically include fear, anger, disgust, sadness, and happiness, but may also include emotions such as shame, embarrassment, contempt, and guilt; Ekman, 1999; Izard, 1972; Juslin, 2001; clusters of words grouped by similarity of meaning; Hevner, 1936; Farnsworth, 1954; Schubert, 2003; Zentner et. al., 2008). Following a different perspective, recent approaches to the study of emotion stressed the importance of grounded cognition (focussing on mental representations), enactivism and embodied cognition (focussing on the dynamic interaction between an acting organism and its environment) (Barsalou, 2008; Clark, 2016; Colombetti, 2013; Hotton & Yoshimi, 2010; Pessoa, 2013; Varela et al., 1991).

## II. AIMS

We explore the relationship between musical structure and emotion on different variations of *La Folia* – a musical theme of Portuguese origin based on a standard harmonic progression, a slow sarabande in triple meter serving as 'bookends' for a set of variations within which both the meter, the melodic line, and the chord type may vary (Figure 1).


**Figure 1. The musical Theme of *La Folia.***

We aim to extend previous research on music emotion by *(i)* investigating a larger number of factors that might affect emotional responses, and by *(ii)* comparing different models of music emotion.

# III. METHOD

In this paper, we present the results of a pilot study consisting in a listening test of commercial recordings of different variations on the Theme of *La Folia*. That study was double-aimed: to provide a preliminary overview of the main factors influencing the emotional response beyond mode and tempo, and to compare three different models of music emotion: the valence/arousal-based emotion model (Russell, 1980), a discrete emotion approach (Izard's Differential Emotional Scale (DES); Izard, 1972), and the Geneva Emotional Music Scale (GEMS) (Zentner et al., 2008).

1) *Stimuli.* Commercial recordings of the first 8 bars of 32 variations of the Theme of *La Folia*, composed in 4 different musical styles: 10 Baroque-style variations by A. Scarlatti (*29 Partite sopra l'aria della Follia*), 6 Classical-style variations by C. P. E. Bach (*12 Variationen über die Folie d'Espagne*), 5 Romantic-style variations by F. Liszt (*Rhapsodie Espagnole. Folies d'Espagne et Jota aragonesa*), and 11 post-Romantic style variations by S. Rachmaninov (*Variations on a Theme of Corelli, Op. 42*) (see Table 1). To select the stimuli, we conducted a preliminary listening test where we asked 1 non-musician and 1 amateur musician to describe all of the variations included in the 4 compositions listed above (81 in total) in terms of emotions; then we selected those variations that were associated to a higher number and variability of predictors for emotion.

**Table 1. Musical stimuli used in the study.**

| Composer | Var. No. | Composer | Var. No. |
|---|---|---|---|
| *A. Scarlatti* | 2 | *F. Liszt* | 1 |
| | 5 | | 4 |
| | 9 | | 8 |
| | 10 | | 9 |
| | 12 | | 12 |
| | 13 | *S. Rachmaninov* | Theme |
| | 16 | | 1 |
| | 19 | | 5 |
| | 20 | | 6 |
| | 24 | | 9 |
| *C. P. E. Bach* | 1 | | 10 |
| | 3 | | 12 |
| | 5 | | 14 |
| | 7 | | 17 |
| | 8 | | 18 |
| | 9 | | 19 |

2) *Music Analysis.* We performed intuitive analyses of all of the pieces, focusing on 9 different features in the structure and/or in the performance: harmonic dissonance, melodic range, register, complexity of rhythmic figuration, note density, tempo, dynamics, accentuation, and articulation. Selection of the musical features was based on previous work (see Gabrielsson & Juslin, 2003). Features were judged and averaged by 2 musical experts using a 5-point rating scale ranging as follows for each feature: harmonic dissonance (1 = consonant, 5 = dissonant), melodic range (1 = narrow, 10 = wide), register (1 = low, 10 = high), complexity of rhythmic figuration (1 = simple, 10 = complex), note density (1 = low, 5 = high), tempo (1 = slow, 5 = fast), dynamics (1 = soft, 5 = loud), accentuation (1 = light, 5 = heavy), articulation (1 = legato, 5 = staccato). The two musical experts were a musicologist who is also a professional pianist, and an expert musicologist who is also an amateur pianist.

3) *Participants*. 12 participants: 6 musicians and 6 non-musicians, age = 53.33 ± 29.44%, 7 males and 5 females, 2 German speakers and 10 Italian speakers.

4) *Procedure.* Stimuli were randomly presented on the computer screen in a 4-stage procedure by means of an interface developed in *Psychopy*, an open-source platform in Python for running psychology and neuroscience experiments. Both the instructions, the tasks and the predictors for emotion were presented to the participants in their mother language. Each stage corresponded to a different emotion model: (1) the valence/arousal-based emotion model (2 predictors for emotion: valence and arousal; Russell, 1980), (2) the DES scale (10 predictors: anger, contempt, disgust, fear, guilt, interest, joy, sadness, surprise, shame; Izard, 1972), (3a) the first-order GEMS model (9 predictors: joyful activation, nostalgia, peacefulness, power, sadness, tenderness, tension, transcendence, wonder; Zentner et al., 2008), and (3b) the itemized GEMS model (43 predictors: admiring, affectionate, agitated, allured, amazed, amused, animated, calm, dancing, dazzled, dreamy, energetic, fascinated, feeling of spirituality, feeling of transcendence, fiery, happy, heroic, impatient, in love, inspired, irritated, joyful, meditative, melancholic, moved, nervous, nostalgic, overwhelmed, relaxed, sad, sensual, sentimental, serene, softened-up, soothed, stimulated, strong, tearful, tender, tense, thrills, triumphant; Zentner et al., 2008). In stages from 1 to 3, participants were asked to rate the emotion associated to each piece on a point scale from 1 to 10. In stage 4, they were asked to select the 5 words that they thought better described the emotion associated to the piece, and rate the selected words on a point-scale from 1 to 3. In order to get used to the tasks, participants received first a practice trial with only two stimuli.

# IV. RESULTS

## A. Agreement Among Raters

The agreement among the raters in terms of the individual variation is estimated by the average Pearson's correlation $r$ between all pairs of raters across all music examples, see Table 2. Regarding the GEMS model, a new list of first-order factors has been defined by refactorizing the 43 adjectives investigated in Task 4 inside the 9 first-order factors they belong to (cf. Figure 2 in Zentner et al., 2008). In general, the agreement among raters is quite low, indicating a possible overlapping of descriptors for music emotion for pieces exhibiting similar structure. Note that the agreement among raters in the refactorized GEMS model is higher than in the ultimate first-order GEMS model. Note also that the agreement among raters in Task 2 is comparatively lower than in Tasks 1, 3 and 4, indicating that the DES model is presumably less appropriate to describe musical emotion.

**Table 2. Average Pearson's correlation *r* between all pairs of raters, across all of the music examples, and for all of the models for music emotion (V/A: valence/arousal model; DES: Differential Emotion Scale; GEMS: Geneva Emotional Scale).**

| Average Pairwise Correlation *r* | | | |
|---|---|---|---|
| **Task 1 (V/A)** | | **Task 2 (DES)** | |
| *valence* | .24 | *anger* | .22 |
| *arousal* | .40 | *contempt* | .08 |
| | | *disgust* | .05 |
| | | *fear* | .10 |
| | | *guilt* | .09 |
| | | *interest* | .04 |
| | | *joy* | .10 |
| | | *sadness* | .27 |
| | | *surprise* | .04 |
| | | *shame* | .09 |
| **Task 3 (first-order GEMS)** | | **Task 4 (refactorized GEMS)** | |
| *joyful activation* | .20 | $f_{joyful\ activation}$ | .27 |
| *nostalgia* | .23 | $f_{nostalgia}$ | .39 |
| *peacefulness* | .16 | $f_{peacefulness}$ | .36 |
| *power* | .27 | $f_{power}$ | .36 |
| *sadness* | .23 | $f_{sadness}$ | .14 |
| *tenderness* | .32 | $f_{tenderness}$ | .09 |
| *tension* | .17 | $f_{tension}$ | .32 |
| *transcendence* | .14 | $f_{transcendence}$ | .03 |
| *wonder* | .01 | $f_{wonder}$ | -.02 |

## B. Main Effects

For all of the tasks, we performed 2-way repeated-measures ANOVA on factors *Piece* and *Emotion*. Results are reported in Table 3. As predictors for emotion in Task 4, we used the new set of 9 first-order factors resulting from the refactorization of the 43 adjectives rated by the participants during Task 4 (cf. Figure 2 in Zentner et al., 2008). In Task 1, all of the factors *Piece, Emotion* and *Piece x Emotion* are significant at the 95% confidence level ($p < 0.05$), while in Tasks 2 and 3 only the factors *Emotion* and *Piece x Emotion* are significant at the same level. As an example, Figures 2 reports mean ratings to predictors for emotion in Task 1. The vertical bars denote a 0.95 confidence interval. Note the high variability in the average ratings across the stimuli.

## C. Correlations Between Musical Structure and Emotion

Table 4 shows correlations between emotions and structural/expressive features. Values that are significant at $p < 0.05$ are indicated in red. In general, Models 1 and 3 (i.e. the valence/arousal and the first-order GEMS model) display a larger number of significant correlations between structure and emotion.

**Table 3. Two-way repeated-measures ANOVA for all of the tasks. $\eta^2_P$ is the estimation of the effect size.**

| | **Task** | | | |
|---|---|---|---|---|
| | **1 (V/A)** | | **2 (DES)** | |
| **Effect** | *F* | *p* | *F* | *p* |
| *Piece* | 5.97 | <.001 | .59 | .96 |
| *Emotion* | 37.46 | <.001 | 92.65 | <.001 |
| *Piece x Emotion* | 2.99 | <.001 | 1.89 | <.001 |
| **Effect size** | $\eta^2_P$ | | | |
| *Piece* | .34 | | .05 | |
| *Emotion* | .09 | | .21 | |
| *Piece x Emotion* | .21 | | .14 | |
| | **3 (first-order GEMS)** | | **4 (refactorized GEMS )** | |
| | *F* | *p* | *F* | *p* |
| *Piece* | .90 | .63 | 1.25 | .17 |
| *Emotion* | 55.43 | <.001 | 72.03 | <.001 |
| *Piece x Emotion* | 3.16 | <.001 | 4.65 | <.001 |
| **Effect size** | $\eta^2_P$ | | | |
| *Piece* | .07 | | .1 | |
| *Emotion* | .14 | | .17 | |
| *Piece x Emotion* | .22 | | .29 | |

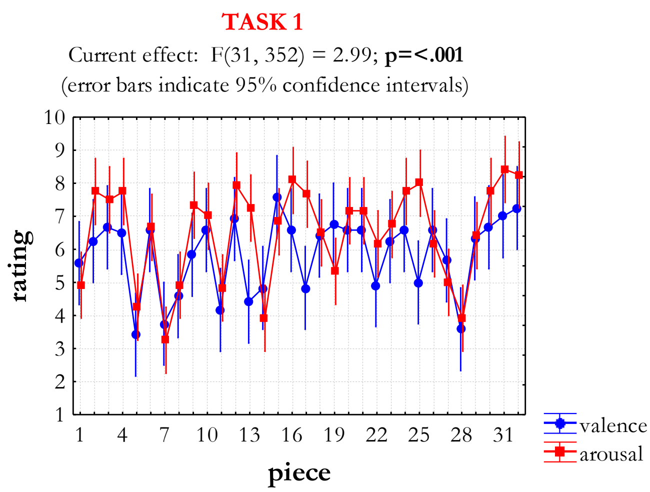


**Figure 2. Mean ratings for predictors in Task 1.**

# V. CONCLUSION AND FUTURE IMPROVEMENTS

Our pilot study indicates that there exist significant correlations between structural parameters and descriptors for emotions in all of the models. Correlations between structure and emotion are more remarkable for the valence/arousal-based emotion model and for the first-order GEMS model, and are higher for register (higher valence and joyful activation), note density (higher arousal and power, lower peacefulness and sadness), tempo (higher arousal and power, lower peacefulness), dynamics (higher arousal and power), accentuation (higher arousal, anger, power and tension, and lower tenderness), and articulation (higher arousal and power, lower sadness and nostalgia). When refactorizing the 43 items-based GEMS model inside the 9 first-order factors these items belong to, new correlations between structure and emotion emerge. These correlations are in principle consistent

**Table 4. Correlations between emotion and structural/expressive features for the three models considered in the study. Values whose significance is higher than 95% are printed in red. Significant correlations/anticorrelations whose absolute value is higher than .25 are enlightened in grey.**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | peacefulness | -0.10 | -0.12 | -0.01 | -0.04 | -0.25 | -0.27 | -0.15 | -0.24 |
| | power | 0.11 | 0.20 | 0.13 | 0.13 | 0.32 | 0.35 | 0.36 | 0.37 |
| | sadness | -0.04 | -0.22 | -0.12 | -0.10 | -0.26 | -0.24 | -0.20 | -0.20 |
| | tenderness | -0.17 | -0.05 | 0.04 | -0.15 | -0.15 | -0.19 | -0.20 | -0.32 |
| | tension | 0.19 | 0.05 | -0.01 | 0.12 | 0.23 | 0.23 | 0.15 | 0.29 |
| | transccendence | 0.01 | -0.06 | -0.03 | 0.00 | -0.14 | -0.17 | -0.08 | -0.14 |
| | wonder | 0.07 | 0.00 | 0.06 | 0.06 | 0.04 | 0.01 | 0.02 | 0.02 |
| | $f_{\text{joyful activation}}$ | -0.04 | 0.18 | 0.20 | -0.01 | 0.30 | 0.23 | 0.10 | 0.10 |
| | $f_{\text{nostalgia}}$ | -0.19 | -0.19 | -0.08 | -0.19 | -0.37 | -0.41 | -0.26 | -0.43 |
| | $f_{\text{peacefulness}}$ | -0.17 | -0.19 | -0.10 | -0.19 | -0.38 | -0.39 | -0.26 | -0.41 |
| | $f_{\text{power}}$ | 0.12 | 0.11 | 0.03 | 0.18 | 0.16 | 0.34 | 0.49 | 0.47 |
| | $f_{\text{sadness}}$ | -0.11 | -0.17 | -0.13 | -0.10 | -0.24 | -0.25 | -0.22 | -0.21 |
| | $f_{\text{tenderness}}$ | -0.12 | -0.03 | 0.03 | -0.03 | -0.18 | -0.18 | -0.15 | -0.22 |
| | $f_{\text{tension}}$ | 0.30 | 0.07 | -0.06 | 0.08 | 0.35 | 0.24 | 0.02 | 0.26 |
| | $f_{\text{transccendence}}$ | 0.03 | -0.06 | -0.07 | 0.04 | -0.12 | -0.03 | 0.00 | -0.02 |
| | $f_{\text{wonder}}$ | -0.02 | 0.10 | 0.06 | 0.00 | 0.11 | 0.06 | -0.01 | -0.01 |
| 4 | admiring | -0.03 | 0.04 | 0.01 | -0.01 | -0.01 | 0.05 | 0.04 | 0.03 |
| | affectionate | -0.06 | 0.02 | 0.07 | -0.03 | -0.06 | -0.07 | -0.08 | -0.14 |
| | agitated | 0.18 | 0.07 | -0.02 | 0.04 | 0.32 | 0.15 | 0.00 | 0.17 |
| | allured | 0.06 | -0.01 | -0.01 | 0.06 | 0.06 | -0.02 | -0.07 | 0.02 |
| | amazed | 0.06 | -0.04 | -0.04 | 0.04 | 0.02 | -0.01 | -0.06 | -0.02 |
| | amused | -0.03 | 0.07 | 0.16 | -0.02 | 0.11 | 0.03 | -0.04 | -0.04 |
| | animated | 0.06 | 0.16 | 0.09 | -0.00 | 0.41 | 0.32 | 0.15 | 0.23 |
| | calm | -0.14 | -0.14 | -0.11 | -0.21 | -0.33 | -0.33 | -0.24 | -0.37 |
| | dancing | -0.02 | 0.07 | 0.13 | 0.10 | 0.01 | -0.03 | -0.02 | -0.04 |
| | dazzled | -0.05 | 0.10 | 0.01 | -0.03 | 0.12 | 0.11 | 0.00 | -0.02 |
| | dreamy | -0.10 | -0.07 | 0.04 | -0.07 | -0.12 | -0.17 | -0.14 | -0.21 |
| | energetic | 0.12 | 0.09 | -0.01 | 0.07 | 0.30 | 0.36 | 0.31 | 0.39 |
| | fascinated | -0.01 | 0.03 | 0.06 | 0.02 | 0.04 | 0.07 | 0.03 | 0.03 |
| | feeling of spirituality | 0.05 | -0.06 | -0.00 | 0.06 | -0.11 | -0.05 | -0.01 | -0.04 |
| | feeling of transcendence | -0.04 | -0.04 | -0.00 | 0.00 | -0.10 | -0.07 | 0.03 | -0.02 |
| | fiery | 0.13 | 0.05 | 0.04 | 0.12 | 0.09 | 0.17 | 0.25 | 0.21 |
| | happy | -0.04 | 0.12 | 0.07 | -0.04 | 0.08 | 0.03 | 0.01 | -0.03 |
| | heroic | -0.01 | 0.08 | 0.04 | 0.17 | -0.01 | 0.10 | 0.27 | 0.20 |
| | impatient | 0.14 | 0.02 | 0.03 | 0.08 | 0.20 | 0.10 | 0.02 | 0.16 |
| | in love | -0.04 | 0.02 | 0.07 | 0.06 | -0.01 | -0.01 | 0.00 | -0.03 |
| | inspired | -0.07 | -0.05 | -0.07 | -0.09 | -0.10 | -0.13 | -0.12 | -0.17 |
| | irritated | 0.32 | -0.03 | -0.21 | 0.07 | 0.09 | 0.13 | -0.05 | 0.15 |
| | joyful | -0.08 | 0.05 | 0.13 | -0.07 | 0.09 | 0.10 | 0.05 | -0.02 |
| | meditative | -0.07 | -0.14 | -0.13 | -0.12 | -0.26 | -0.29 | -0.17 | -0.25 |
| | melancholic | -0.11 | -0.13 | -0.10 | -0.12 | -0.28 | -0.31 | -0.18 | -0.29 |
| | moved | -0.03 | 0.03 | 0.04 | -0.01 | 0.01 | -0.03 | -0.00 | -0.00 |
| | nervous | 0.21 | 0.11 | -0.02 | -0.01 | 0.32 | 0.27 | 0.04 | 0.19 |
| | nostalgic | -0.13 | -0.16 | -0.13 | -0.19 | -0.32 | -0.35 | -0.23 | -0.35 |
| | overwhelmed | 0.18 | -0.06 | 0.00 | 0.04 | 0.01 | 0.14 | 0.09 | 0.12 |
| | relaxed | -0.04 | 0.02 | 0.01 | 0.02 | -0.02 | -0.00 | -0.02 | -0.07 |
| | sad | -0.09 | -0.16 | -0.11 | -0.06 | -0.21 | -0.22 | -0.19 | -0.18 |
| | sensual | -0.06 | 0.02 | 0.02 | 0.01 | -0.06 | -0.04 | -0.04 | -0.06 |
| | sentimental | -0.14 | -0.11 | -0.02 | -0.10 | -0.22 | -0.17 | -0.07 | -0.18 |
| | serene | -0.04 | 0.03 | 0.02 | -0.05 | -0.06 | -0.04 | 0.01 | -0.06 |
| | softened-up | -0.08 | -0.05 | -0.05 | -0.11 | -0.18 | -0.19 | -0.12 | -0.21 |
| | soothed | -0.06 | -0.13 | 0.01 | -0.00 | -0.16 | -0.11 | -0.05 | -0.07 |
| | stimulated | -0.06 | 0.10 | 0.01 | -0.04 | 0.08 | 0.13 | 0.07 | 0.06 |
| | strong | 0.05 | 0.03 | -0.05 | 0.03 | 0.01 | 0.17 | 0.26 | 0.23 |
| | tearful | -0.10 | -0.10 | -0.10 | -0.15 | -0.18 | -0.18 | -0.16 | -0.18 |
| | tender | -0.06 | -0.10 | -0.03 | -0.01 | -0.16 | -0.16 | -0.14 | -0.13 |
| | tense | 0.04 | 0.02 | 0.02 | 0.06 | 0.03 | 0.02 | 0.02 | 0.08 |
| | thrills | -0.02 | 0.08 | -0.06 | 0.11 | 0.03 | 0.04 | 0.06 | 0.09 |
| | triumphant | 0.01 | 0.05 | 0.07 | 0.14 | -0.02 | 0.05 | 0.26 | 0.21 |

compared to the first-order GEMS model, although somehow different and overall higher. To interpret this result, given the different procedures adopted to rate emotions in Tasks 3 and 4, a more refined statistical analysis is required. The DES model performs worse also in terms of agreement among raters, since the average Pearson's correlation between all pairs of informants and across all music examples is comparatively lower than for Models 1 and 3. In general, both the agreement among raters and correlations between structure and emotion are quite low for all of the models, indicating a possible overlapping of descriptors for music emotion. These effects might be related to the circumstance that all of the models of music emotion considered in this study have been defined over a wide spectrum of musical genres, while we are focussing on only one musical genre – even though considering different variations of the same theme. Future improvements might include deeper investigation of this aspect, e.g. by means of factorial analysis or multidimensional scaling.

On the base of these preliminary results, we planned to perform a more rigorous study, differing from the pilot test in two main aspects: first, the DES model and the 43 words-based GEMS model are no more being included; second, our current study consists in a more complex design including two separate experiments, each of which is more accurate in terms of both selection of stimuli (only the previous pieces featuring the most extreme variability in the musical structure are being considered, and new pieces have been expressly composed as well), and parameterization in terms of musical structure and expression (analysis of features by means of *Humdrum* (Huron, 1995), *Director Musices* (Bisesi, Friberg and Parncutt, paper in preparation), the Margulis (2005) model of melodic expectation, and the *MIR Toolbox* (Lartillot, 2014)). The first experiment is an updated listening test based on a real music design, with only 20 of the former 32 commercial recordings and a selection of 21 features (harmonic unfamiliarity, roughness and inharmonicity, harmonic surprise, harmonic tension, tonal clarity, melodic size, melodic range, melodic tension, register, complexity of rhythmic figuration, note density, tempo, tempo variations, dynamics, dynamics variations, metrical, melodic and harmonic accentuation, articulation, and entropy). The second experiment is a new listening test based on a controlled and balanced design, where 24 variations with selected combinations of 4 factors are arranged and recorded in a deadpan performance by the first author (average pitch variation / register, harmonic tension, rhythmic complexity, note density). Participants are 12 musicians and 12 non-musicians, who have been asking to rate each piece on a rating scale from 1 to 5 in terms of the 11 predictors for music emotion included in Models 1 and 3. Results will be presented at the conference.

We expect that the updated design will extend our understanding on the relationship between structure and emotion, by including a list of features larger than considered before, as well as by predicting a more specific, style-dependent set of predictors for music emotion. Our approach links together music theory/analysis, music psychology and empirical aesthetics. We are challenging these three disciplines to work more closely together and take each other's ideas and methods more seriously.

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