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ARTIFICIAL INTELLIGENCE – BE AWARE – ELEVATOR MUSIC DOES NOT FIT FOR ALL

Comparison between non-musicians and musicians with AI architectural plan

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ABSTRACT

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AI technology is supporting and assisting humans at in increasing speed and in various ways. In music, a massive number of technological solutions and software applications are involved in the user experience (UX) whether it is listening to music, eGames, shopping behavior, brainwaves, health care, mental orientation, music production and performance, music rehearsing or focus-oriented demands in professional fields (surgeons, flight pilots). Still, big gaps exist in user assumptions, which may be biasing the further utilization of AI technology. User experience in music is a very unique process with individual variances. When reflected in emotions, the individual responses are largely connected to background experiences and skills of a person, e.g. musical competence. Previous literature has been attempting to solve causalities in emotional response regarding certain music qualities. However, studies are unambiguous in their conclusive implications on this, partly due to somewhat weak efforts to analyze, select and produce theoretically firm musical contents supporting the musicianship levels, or the trained ear of the user/listener, to describe it. In this study, 10 audio stimuli were carefully designed and selected by using jazz music as the representative genre. In jazz, the variation of colors, sounds and ambience are in favor of this type of research setting, where two different groups – non-musicians and musicians – are compared in their emotional responses. Design science research (DSR) and specifically experimental research was applied with qualitative and quantitative methods to analyze the differences between fifteen participants. The results contribute to the literature by implicating two important issues; (i) the fine-quality of provided music is an essential factor and (ii) listener's musical competence needs to be solved to match the offered music content. Based on the results, digital AI app is designed for more efficient matching. Digitalized music services (AI) are massively offering music tracks to listeners based on quite loosely personalized parameters and furthermore, even a non-existent analysis of the tensions, which can arouse very strong extreme emotions, such as overjoy and anxiety – depending on the musical experience or musicianship of the listener. In many cases, present music services may lead to biased suggestions which are opposing the expectations of the listener. In other words, and also metaphorically, elevator music is not the solution.

Keywords: AI, architecture, emotional response, music, tensions

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Tekoäly tukee ihmisen toimintaa kasvavalla nopeudella ja monialaisesti. Musiikkialalla, teknologiset ratkaisut ja ohjelmistot kytkeytyvät käyttäjäkokemuksiin monien eri kanavien kautta. Näitä ovat esim. musiikin kuuntelu, saatavuus ja tarjonta, peliala, kuluttajakäyttäytyminen, aivotutkimus, terveysala, musiikin tuottaminen ja esittäminen, musiikin harjoittelu ja musiikin hyödyntäminen ammatillisissa erikoisaloissa (kirurgit, lentäjät). Käyttäjäkokemuksiin sisältyy kuitenkin oletuksia, jotka saattavat olla virheellisiä tai ainakin poikkeavia tekoälyn generoimassa tarjonnassa. Käyttäjäkokemus ilmenee musiikissa hyvin yksilöllisesti. Erityisesti musiikin tuntemukset liittyvät paljolti yksilön omaan taustaan, kokemuksiin ja musiikilliseen ymmärrykseen. Aikaisemmissa tutkimuksissa musiikin laadun ja tuntemusten suhdetta on analysoitu, mutta usein kausaliteetti on jäänyt ohueksi. Tämä voi osaltaan johtua siitä, että musiikkinäytteiden teoreettiset perusteet jäävät heikoiksi ja yhteyttä kuuntelijan musiikilliseen ymmärykseen ei tunnisteta. Tässä tutkimuksessa on analysoitu 10 musiikillista näytettä, joiden taustalla on teoreettinen perustelu laadusta ja erityisesti musiikillisesta jännitteestä. Näytteet edustavat jazz-musiikkia, jossa värien, tunnelmien ja tilan vaihtelu mahdollistavat analyysin kahden erilaisen ryhmän välillä, muusikkojen ja ei-muusikkojen. Tutkimusmenetelmänä on sovellettu Design science research (DSR) suunnittelututkimusta ja edelleen kokeellista tutkimusta (Experimental research), jossa on yhdistetty kvantitatiivista ja kvalitatiivista tutkimusta triangulaationa. Tulosten perusteella painottuvat kaksi tekijää; (i) musiikin laadun hienojakoisuus ja (ii) kuuntelijan/käyttäjän musiikillinen tausta ja ymmärrys, jotka olisi tunnistettava kohdennetuissa musiikkipalveluissa ja -sovelluksissa. Digitaaliset tekoälyä (AI) hyödyntävät musiikkisovellukset tarjoavat käyttäjilleen usein kappaleita, jotka perustuvat melko heikohkoon yksilökohtaiseen parametrointiin. Lisäksi musiikin sisältämiä hienojakoja, teoreettisia jännitteitä, ei juurikaan hyödynnetä tekoälyn tarjonnassa. Tulosten perusteella on luotu arkkitehtuurinen sovellusmalli tekoälyn tuloksellisempaan käyttämiseen. Musiikilliset ominaisuudet saattavat usein liittyä vahvoihin käyttäjien tuntemuksiin, kuten onnellisuusteen tai ahdistukseen, riippuen käyttäjän musiikillisesta ymmärryksestä. Monissa tapauksissa tekoäly saattaakin erehtyä ehdottamaan käyttäjälle sisältöä, jonka vaikutus ilmenee päinvastaisena oletettuun nähden. Toisin sanoen ja metaforisestikin todettuna, hissimusiikki ei ole ratkaisu.

Asiasanat: AI, arkkitehtuuri, jännite, musiikki, tekoäly, tuntemus

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1 INTRODUCTION

AI is supporting end-users heavily in music business today by suggesting contents with assumed high customer experience (Cohen, 2022; Saxena, 2022). As offerings may be vastly associated with big data, a fine-grained analyze with individual characteristics may fall short in unsuccessful results (Unlabeled, 2019; Souppouris, 2016; Sloboda, 1991; Sloboda, 2007). Much research is needed for a broader focus on the quality of music (density) and personal orientation and skills of the user/listener (Eerola & Vuoskoski, 2011).

Musical training existence is quite an important factor when trying to understand a person's individual experience and emotions for observed musical content (Santosh et al., 2020; Eerola & Vuoskoski, 2011; Fuentez-Sanhcés, Pastor, Eerola, Escrig, & Pastor, 2022; Garcia & Hand, 2016; Arthurs, Beeston & Timmers, 2018). Non-musicians and musicians very often deliver mixed results (differences / no differences) when their responses to audio stimuli are analyzed (Fredrickson & Coggiola, 2003; Kristop, Moreno & Anta, 2020; Lahdelma & Eerola, 2016; Schellenberg, 1996; Schellenberg, Adachi, Purdy & McKinnon, 2002; Krumhansl & Shepard, 1979; Boltz, 1989). Interestingly, a lot of brain wave and brain activity research has been conducted between non-musicians and musicians, with varying results regarding functional differences in brains (Angulo-Perkins, Aubé, Peretz, Barrios, Armony & Concha, 2014), abilities to process temporal patterns (Zhao, Lam, Sohi & Kuhl, 2017) and emotional response of sadness and fear in music (Park, Gutyrchik, Bao, Zaytseva, Carl, Welker, Pöppel, Reiser, Blautzik & Meindl, 2014). Furthermore, musicians seem to differ from non-musicians in cognitive skills (Levitin & Tirovolas, 2009), comprehension of emotional musical contents of tempo, harmony, intensity (Juslin & Laukka, 2003), musical performance perceptions (Besson, Schön, Moreno, Santos & Magne, 2007), and stronger emotional musical response (Blood & Zatorre, 2001).

Harmony analysis has mainly been restricted to single chords, *triads,* with three or more simultaneous pitches and as isolated from musical context (Lahdelma & Eerola, 2016). When emotions are concerned, knowledge is lacked on complex or intelligent musical content, regarding advanced harmony and melody. However, quite much is known already about the impact of music in

humans, i.e. emotions, emotional responses, body movement and brain research, namely brainwaves responses (Bigliassi, Karageorghis, Hoy & Layne, 2019; Das, Somsubhra & Neogi, 2020; Bhatti, Majid, Anwar & Khan, 2016; Hu, Lu & Wang, 2022). Mainly, musical content or stimuli applied in studies have not been in the high focus area, regarding the quality, accuracy to meet the respondent's expectations and emotions and micro-adjustments for theoretically established contents. Still, careful selection of musical stimuli is in an important role in emotional response research (Byrnes, 1997; Lychner, 1998; Madsen, 1997). Instead, the mainstream studies up to date, have been emphasizing the tempo, rhythmical and/or simple scale elements in music, affecting human response (Plut & Pasquire, 2020; Kunikullaya et al., 2021; Zhang, Chec, & Yanga, 2019).

1.1 Research objectives

The main emphasis of this study is to associate tensions and perceptions in audio stimuli to the observed responses and build an architectural model of AI- assisted process favoring the personal characteristics of the user. The tensions applied in stimuli are intentionally selected from jazz genre representations, with combinations of tension-release moments and sections, specifically in jazz solo and jazz harmony contents, in order to separate the details affecting the emotional responses between non-musicians and musicians. In addition, harmony is presented as part of the musical context with high-quality excerpt selection, and proofed by third-party musician.

Stimuli sections are selected in purpose for theoretically argued high-tension vs. low-tension (or relaxed) levels. Furthermore, in harmony stimuli, a variety of dissonance containing chords in different tension levels are tested. In addition to the emotional response, studies are also analyzing the effects of music via physical movement or brain wave research. It is important also to review these studies while focusing on the emotional response, to better understanding for the holistic entity of human behavior, experience and responsiveness. When this knowledge is increasing, it is likely that with the support of digitalized devices, software and services, the user experience can be better met with the supply side of the offerings, whether being business services from the private sector or health care services from the private/public sector.

The applied stimuli are used as an artefact, carefully designed from the theoretical point of view to better meet the respondents' expectations, i.e. dissonancy, chord qualities, ambience and improvised single note lines, which all lead to the tension levels and further, the release levels. Based on the emotional response results and analysis, a digital application architecture plan is designed in AI-governed context. Recent studies with tension-release and theoretically established audio stimuli are very scant. Furthermore, the responses differ between personal characteristics in musicianship. According to Eerola & Vuoskoski (2011), musical expertise is an important factor for emotional response research, with genre-specificity and stimulus density.

This study contributes to the current literature by comparing non-musicians' vs. musicians' responses with carefully selected, rationalized and theoretically established musical sections with different tensions. Currently, music services conducted by AI suggest a large variety of tunes and styles to users – based often on loose or non-existing profiling of a persona's musicality - which may end up being quite biased and not enjoyable. Tensions in music, even during the same song, can arouse strong emotions (overjoy vs. anxiety), depending on the musical experience of the listener. There is no software at the moment to identify, associate or control the targeted user experience result. The results of this study reveal some differences between the represented groups, which may lead to increased understanding for more tailored and unique offerings when applied in individual services, digital app, well-being and overall focused supply of targeted digital services, regarding musical/audio content.

1.2 Research methods

This study is directed to govern stimulus density and musical expertise. The research problem is to define and find if emotional response depends on the musicianship and on the carefully designed and selected audio stimuli. In previous literature the audio stimuli are not approached deeply from the music theory, i.e. tensions around dominant V and the immediate release periods. Dominant V is referring to chord harmony or scale degree, creating high instability and tension, required to be solved (detailed description in appendix 1) (Benward & Saker, 2009). Furthermore, audio stimuli with such density levels and tension-release combinations have not been studied in this detail earlier, especially in association with emotional response. The research problem is to define and find if emotional response depends on the musicianship and on the carefully designed and selected audio stimuli. In previous literature the audio stimuli are not approached deeply from the music theory, i.e. tensions around dominant V and the immediate release periods. Following the multidisciplinary research concept, this study combines a pragmatically oriented information system research approach with behavioral/cognitional science research. The information system research is associated with design science research (DSR), proceeding to experimental research (ER) by applied statistical tests comparing two test groups, representing non-musicians and musicians. By forming two groups, musicians/non-musicians, it is possible to compare the effect of provided artefacts by analyzing the observed results of emotional responses. This is perfectly following the DSR principles. According to the emotional research literature, the personal responses may be very unique and different among experienced feelings and more accurate services and offerings are needed to meet the expectations.

This research study is focusing on audio impulses, in the form of structured music, which are tested and analyzed with two participant groups, non-musicians and musicians, for emotional response and provide a digital app architecture for post project execution. The digital app description is the final

outcomewhich will support and enhance the analysis & offering when target user characteristics are sufficiently known and identified. There are numerous beneficial uses for this type of accurate servitization, e.g. user experience (UX), user expectations (UE) and health services.

1.3 Thesis structure

Related literature of emotional response is reviewed in Chapter 2 by introducing research results on emotional response in general and especially in music. The referred literature is retrieved mainly from scientific journal articles within the academic disciplines of music, music education, music therapy, psychology, neuropsychology and human behavior. The additional approach of AI is presented as a modern tool to connect emotions to behavioral patterns. In Chapter 3, tensions in music are reviewed and specified in the level of music harmony and soloing in jazz music. In the harmony, there are multiple simultaneous predefined notes creating the ambience and larger sound, while the soloing in this research is improvised and mostly observed as one note lines (one existing note at the time). Data is presented in Chapter 4 and results are discussed in Chapter 5. Finally, the digital app architecture, based on results, is created in Chapter 6 and Chapter 7 concludes the study.

2 EMOTIONAL RESPONSE

The following literature review is categorized to the combinative fields in order to understand the current knowledge and potential existing gaps still to be researched. The categorized themes - emotions, as far as brain activity and AI - in the literature are presented next with related studies.

2.1 Emotional response

Emotional response is a psychological concept. It contains processes of decision making, thoughts, feelings and behavior. Furthermore, the thought process can be classified in subconscious and conscious systems. These systems should also be also considered when choices are made by individuals and customers in the business field. (Kahneman, 2011.)

Individuals are very unique in characteristics and profiles. They differ also in the explicit-implicit frameworks. Under explicit, emotion processing is processed actively and consciously and under implicit, these processes are more automated and unconscious. In addition, the individual variation in how the emotions are internally regulated is very large which makes the generalization of emotional responses and its implications very challenging. Many factors behind the variation are present; personal circumstances, cultural connections and background and earlier experiences. Thus, in order to understand where emotional responses are rooted, both explicit and implicit frameworks are needed. (Gyurak, Gross & Etkin, 2011.)

The exact definition of emotional response varies between scientific schools. To refer to one, it is 'brief, intense, physiological, and mental reaction' (King & Meiselman, 2010). However, the majority of these definitions still contain both explicit and implicit factors described above. According to Cardello & Jaeger (2021) and Schouteten (2021), emotional response is reviewed by two distinctive schools; Theory of Emotional Construct and A Classical View. To present some concrete further definition steps for above approaches, emotional response concepts can be reviewed as follows:

- Implicit response (unconscious, automatic)
- Explicit response (conscious, actively processed)
- Physiological response (activated autonomic nervous system, body movement)
- Behavioral response (body movement, facial expressions, implicit/explicit)
- Cognitive response (explicit thoughts, opinions, choices associated or influenced by implicit process)

2.2 Emotional response in music

Emotions are a complex set of responsive human system reacting to different impulses (Garza-Villareal et al., 2014; Roy, Lebuis, Hugueville, Peretz & Rainville, 2012; Mitchell, MacDonald, Brodie, 2006; Zhao & Chen, 2009). Similarly, as multiple colors are formed of a few source colors, emotions can be tracked down to a few basic sources. In some studies, these emotions are in five classes – happiness, fear, sadness, anger, disgust and surprise (Ekman & Davidson, 1994) while Picard & Picard (1997) find six classes - happiness, fear, disgust, sadness, joy and anger. In a seemingly rationally built world, the role of emotions is often underestimated, although feelings are one of the main drivers for intelligence and behavioral patterns (Kanjo, Al-Husain & Chamberline, 2015).

In music, the emotion-association is very strong and brains are very affected by external audio information, in terms of emotions and feelings (Markov & Matsui, 2014; Day, Lin, Huang & Chuang, 2012; Liu et al., 2015). Moreover, the brain parts that receive auditive musical information and process emotions, are very closely located (Eerola & Vuoskoski, 2011; Poyanfar & Sameti, 2014). Music is positively associated with activities in creation, mental health, consciousness, trust (Gao, Fillmoreb & Scullina, 2020), deep sleep (Amudha, 2021), release of dopamine (Gebauer & Kringelbach, 2012; Juslin, 2019) lower blood pressure (Niaz et al., 2020) and lower levels of stress, adrenaline and cortisol (Ameen, 2018; Gao, Sui, Yang & Zhang, 2015). Even shops and restaurants have received economic benefits by playing music in their premises to customers (Turley & Millimam, 2000; North, Shilcock & Hargreaves, 2003). The research on the relationship between music and human is ever increasing, but still scant and somewhat challenging, since humans are very subjective and unique on the responsiveness levels. Also, the research needed requires many cross- and multi-discipline characteristics, where several scientific fields are simultaneously needed for explanatory power, i.e. neurology, music, and brain science, at least.

Gao et al. (2020) find that short-term memory was enhanced by embedding classical music both to college students' immediate study environment and during their deep sleep. The passing rates of the mathematics course were 18% higher compared to the control group. Especially, instrumental classical music, opposite to lyrical music, seem to foster learning and sleeping (Jäncke et al., 2014; Harmat et al., 2008). Furthermore, according to gender-based study on brain activity to music, Parkington & Mansouri (2018) and Miles et al. (2016) show that females are better-off in connecting and associating with musical content than males.

Musical preference can be a very individual thing with different levels of liking concerning specifics or genre of music (Schäfer & Sedlmeier, 2011; Fuentez-Sanhcés et al. 2022; Santosh et al., 2020; Eerola & Vuoskoski, 2011; Garcia & Hand, 2016; Arthurs et al., 2018). While Fredrickson (2000), Fredrickson & Coggiola (2003) and Lahdelma & Eerola (2016) do not find large differences between non-musicians' and musicians' perceptions in music, Kristop et al. (2020), Anta (2013),

Schellenberg (1996), Schellenberg et al. (2002), Krumhansl & Shepard (1979), Marmel, Tillmann & Delbé (2010), Tillman & Lebrun-Guilland (2006) and Boltz (1989) report differences between these groups.

If emotions can be systematically analyzed and organized in our understanding, this outcome would pursuit potentially unlimited targets of benefits generating systems, tools and applications, e.g. individually customized services and products and recommendations to customers that have very high likelihood to match customer expectation, profile and behavior.

2.3 Emotional response and brain activity in music

Brain activity has been in a rising research focus in recent years in emotional response research, i.e. brain signal analysis derived from EEG (Tagluk & Isik, 2019; Salama et al., 2018; Kwon, Gang & Oh, 2013). The complexity of the research and consecutive implications or generalizations are challenged by individual differences which can vary a lot and contain very unique person-specific characteristics (Bhatti et al., 2016; Garcia & Hand, 2016). However, a holistic understanding of mainstream brain science development can be better specified when external stimuli, i.e. auditive signals in the form of music, are carefully examined in connection to brain activity. The effect of music on brains is are proven to be very strong; positively associated with light physical exercise (Bigliassi et al., 2019), enhanced well-being (Priest & Karageorghis, 2008), increased reading ability (Lessard & Bolduc, 2011), enhanced written language ability (Bialystok & DePape, 2009), better verbal memory and meta-cognitive skills (Deutch et al., 2004; Gómez-Gama et al., 2004; Ho et al., 2003), and reduced depression and anxiety (Gold, Solli, Krüger & Lie, 2009; Jung, 2011; Urich, Houtmans & Gold, 2007).

Despite the positive associations, there are quite contradicting results as well. Savan (1998) finds that the music by Mozart increases the concentration level of challenging students measured, where Cripe (1986), Gregoire (1984) and Reardon & Bell (1970) report opposite results with students having mental health issues. When researched workers both in repetitive tasks and complex tasks under auditive stimuli, some were annoyed, some preferred instrumental music more than lyrics (Furnham & Bradley, 1997; Freeburn & Fleischer, 1952; Perrewe & Mizerski, 1987), while in other studies the repetitive simple task performance was increased or being eased with the musical stimuli (Konz, 1962; Smith, 1961).

In a brain wave analysis, benefits are reported in various consequent outcomes. Kwon et al. (2013) show that brainwaves during an EEG show positive association with relaxation and behavior among patients with schizophrenia who participated 13 group music therapy sessions over 7 weeks, compared to a control group with no variation to the standard therapy.

Mollakazemi et al. (2021) study the relationship between cardiac rhythms and brainwaves when listening to music of their choice with different tempos. Their finding is that there are potential positive associations between calming

music (slow tempo) and brainwaves and when combined with cardiac stages, the significance of tempo is dominating over the music style (or cognition).

These results can be quite easily adapted in customer/user/patient intervention, when a change for better is needed. For instance, patients with schizophrenia and under acute psychosis were analyzed with steady brainwaves under the influence of their selected music while the control group without the stimuli had severe reactions of high levels of slow brainwave activity (delta, theta), common to the disease (Morgan et al., 2010). Pouladi et al. (2010) find that brainwave activity during an EEG depends on the musical elements of rhythm and tempo, which are known to be very important basic factors influencing the brain (Krumhansl, 2000). When testing different musical genres (Western classical, Indian classical, guitar music) and noise, Santosh et al. (2020) report positive associations with cognitive, attention, memory and language processing skills under familiar music genres, measured by EEG activity. In early stage of perception, musical elements of time (Tillmann & Lebrun-Guillaud, 2006) and pitch (Peretz & Zatorre, 2005), can be identified separately in brain activity when suddenly introduced in the musical piece (Zhang et al., 2019). When comparing the participant's emotions from their manual annotations (written observations) to selected musical pieces (242) across genres, to the EEG, Cabredo et al. (2012) find correlations with EEG especially when the subject experience in their annotations is strong.

2.4 AI supporting user experience and choices

AI can be harnessed to control emotions (Er, Cig & Aydilek, 2012), business transactions (Hu et al., 2022), shopping (Rodgers, Yeung, Odinho & Degbey, 2021), healthcare (Kwon et al., 2013), concentration (Gao et al., 2015) and eGames (Plut & Pasquier, 2020), which all are becoming strongly sought features both in practice and in scientific multi-disciplinary research (Juslin, 2019; Oakes & North, 2013; Roschk, Loureiro & Breitsohl, 2017). AI-assisted shopping is one of the fastest growing fields at the moment with international mega-companies; Alexa with Amazon, Google Assistant, Genie with Alibaba and Xiaodu with Baidu (Chattaraman, Kwon, Gilbert & Ross, 2019). These AI-assistants are not only for shopping, but also for entertainment, data search and home devices control (Li & Sung, 2021). One particular element in AI-assisted processes is the power experience of the user, which impacts the purchase decision (Hu et al., 2022). They analyzed AI-assisted shopping experience and found that when perceived power is positive, the likelihood for intention for shopping increases, and also reduces the perceived risk. Similar results are reported in Oakes & North (2013), Roschk et al. (2017) and Luo, Tong, Fang & Qu (2019).

When AI is interpreting brainwave information and acting based on it, especially in auditive signal research, i.e. music, the application development is becoming very attractive (Sonawave, Bharatesh & Lomas, 2021; Sugimoto et al.,

2008). Multiple studies regarding music affections to emotions exist (chapter 2.1), and regarding brainwave information (chapter 2.2), but very few where AI is adopted to the applied concept (Sonawave, Bharatesh & Lomas, 2021; Sugimoto et al., 2008). However, the brainwave analysis with the adoption of AI can bring yet unseen possibilities and innovations in the near future across industries. Kunikullaya et al. (2021) report that a special type of music, in this case scales (ragas) in Indian music, reduced stress consistently with randomly selected groups compared to the control group, measured by the EEG brain activity. Game industry has been using audio, sounds, effects and music a long time already to enhance the user experience when playing. According to Plut et al. (2020), there are strong demands for generative (responsive and generated musical elements, i.e. tempo, key to the tension levels in game) game music with supported AI for better UX. Similarly, to shopping behavior, AI has been applied to analyze customers' facial recognition and match/update fitting music for emotional building for purchase decision under ideal circumstances (Rodgers et al., 2021).

Further, in combining an EEG brainwave analysis with AI and music, the literature is scant but rising. In Sonawane et al. (2021), AI detects music songs by brainwaves based on the data analysis in test run with 20 participants, and with 94.02% accuracy. The notable detail is that only one second of brainwave activity is needed for the AI decision of identification of the song. Sugimoto et al. (2008) provide an empirical setting with applied constructive adaptive user interface (CAUI) as part of the AI tool for creating music to reach a certain emotion, i.e. stress, joy, sadness, relaxation. These states were measured by EEG and the practiced model is predictive. Brainwaves have been able to produce targeted single notes, with a supported stimulus (Folgieri & Zichella, 2012), associated with research on converting EEG to music (Dan, Chao-Li & De-Zhong, 2009). Moreover, machine learning has been applied to decrease the pressure at work by analyzing the brainwave EEG and adjusting the mood with the proper music for the best possible outcome (Li, 2022). A combination of AI-assisted training with specific music and light therapy is also a meaningful factor to affect positively to decrease anxiety and depression (Shin, Park, Hwang & You, 2019).

The reproduction of the received information to the targeted output, whether it is musical notes, aimed mood, concentration level, command (in game, text, visual) is in the essence of the current state of the combined brainwave, AI and music research.

In this chapter, emotional responses have been reviewed firstly on a general level and then in the music field. Together with emotional responses in music, the functions of brainwaves and AI developments are considered, since emotions are an important part of brains and can be partly integrated with external AI interventions, for example for better user experience, choices and behavioral patterns.

3 TENSIONS IN MUSIC

Musical content can create multiple reactions in a human body, mind and brains, e.g. music may produce high-level body relaxation, also calmness in mind and detected stability in brainwaves (Gold et al., 2009; Priest & Karageorgis, 2008; Jung, 2011, Urich et al., 2007). Furthermore, a complex, disturbing or aggressive musical content may be associated with restless body movement, inability to focus or stressed brain activity (Scullin, Gao & Fillmore, 2021; Sallustro & Atwell, 1978; Lerner, Papo, Zhdanov, Belozersky & Hendler, 2009). Tension in music can be described as an expectation or anticipation of forthcoming relief of release for the listener (Kliewer, 1975). Tension is also considered one of the four factors affecting the user response qualities, i.e. Russell's circumplex model (1980) or Thayer's model (1989), figure 1.

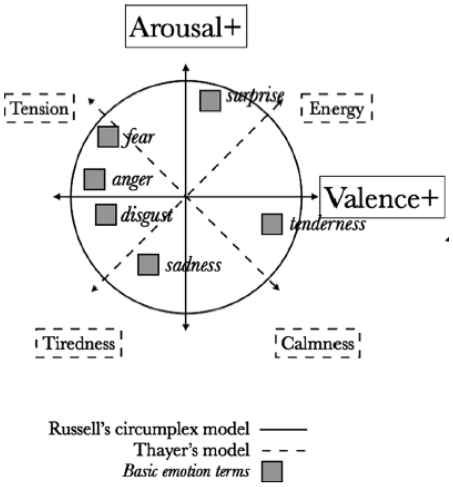

FIGURE 1 Dimensional models of emotions, two layered models (adapted from Eerola & Vuoskoski, 2011)

In Russell (1980), the two-dimensional framework is based on arousal and valence, which were further progressed with the four-dimensional framework of tension, energy, calmness and tiredness in Thyler (1989). In Fuentes-Sánchez et al. (2022), tension arousal, hedonic valence and energy arousal responses were analyzed in connection with musical familiarity and preference. The findings show that non-familiar music is associated with tension and overall emotional activity and responses. Also, tensioned music is a strong factor activating the emotions, especially sadness (Eerola & Vuoskoski, 2011) and contextual prediction is associated with tensions (You, Sung & Yang, 2021). Tensions can be very individual-specific as well as genre- or style specific (Fredrickson & Coggiola, 2003). From the musical theory point of view, there are well established rules and

laws, which govern the fundamental principles of how tensed or relaxed certain harmony, chords, scale or single notes are in relation to the root key, i.e. the home base scale. In the following, the literature review is focused on the tension factor adapted in the dimensional Thayer's (1989) model, and explained the roots of tensions among harmony and melody-based musical content.

3.1 The concept of tensions in harmony and melody

When analyzing the tensions in music, especially in harmony and melody parts, intervals (the distance between two notes) and combination and sequence of notes play a significant role for the experienced outcome. The combination of tones usually forms a harmony (or chords) and the sequence of notes forms a line, which is called a solo in improvised music. When traditional songs usually have usually a key (a harmonic home base) in which it is composed, all the elements of harmony and melody in the song can be related to that key. In this sense, it is quite natural and obvious that some tones will belong more to the key than other notes, having an "in" sound. These tones will sound balanced and do not create any great dissonance, which is referred to as tension. Furthermore, notes outside the home base key also sound more "out" and have a dissonant and tensioned feeling.

In practice it can be observed that in many jazz-based harmonies and solos, musicians are applying both in and out notes intentionally to create certain levels of tensions (Levine, 1989; Crook, 1991). In case of tensioned tones, e.g. in jazz solo, the solo lines (musical phrases during improvisation) may contain several "out-lines", which in various incidents create extra-strong tensions with smooth release tones to the original root chord in the end of a solo line or phrase (Sting 1985; Corea, 1989). This type of extra tension creation is very typical to the modern jazz or progressive jazz genre. It is not a new innovation, since there were musicians already during 1950s and 1960s with strong expressive improvisations where unavailable tones were used (Davis, 1959; Davis, 1969). Also, classical music contains a rich variation of tension filled compositions with a much longer history compared to jazz music, i.e. Shostakovich Symphony 10, Tchaikovsky Symphony 6 or Bruckner Symphony 5 (Talk Classical, 2016).

Certain lines (solo-lines) and chords (harmony) can be quite exactly identified with contained tension levels, based on the theoretical foundations of music. The more detailed analysis of the theoretical concepts is presented in appendix 1. In this study, the selected audio stimuli for jazz solos and jazz harmony are carefully designed to meet the required and identifiable tension levels for a unique emotional response level analysis between musicians and non-musicians. The hypothesis of the study is provided next.

3.2 Hypothesis for audio stimuli – jazz solos and jazz harmony

Recent studies show that non-musicians are adapting to and accepting a certain amount of dissonancy (tension) when music is conducted and organized with accuracy and balance (Lahdelma & Eerola, 2016a; 2016b; Tol, Edwards & Heflick, 2016). Also, in this study, it is assumed that musicians receive the audio samples differently compared to non-musicians, especially when entering professional levels of highly structured jazz solos or jazz harmony. While a professional musician listens and receives music with a developed analytical ear, they are more capable to enjoy the complex particulars of the content than a non-musician (Levitin & Tirovolas, 2009; Besson et al., 2007; Blood & Zatorre, 2001), who may receive the same content with a neutral or opposite experience, i.e. temporary uncomfortable anxiety or confusion.

However, audio stimuli have not been studied in this detail for offerings, where theoretical backgrounds of selected musical content are on a deep level, regarding the tensions in solo line or harmony. In the jazz solo line, it is expected according to the music theory, that in dominant V the tension building is high when tensioned notes are used. Similarly, the jazz harmony contains sections with dissonant chords in different circumstances of musical groove via separated audio samples. In harmony the dissonant chords (tension) are overwhelmingly used, even during the most relaxing periods of the song, with the most enjoyment style. The expectancy for emotional response is that when professionally applied, the dissonant (tension) chords can actually in a proper environment/song produce an extremely relaxed experience for the listener. However, the professional jazz musician may well receive complex jazz solos/harmonic setting even relaxing, while a non-musician listener may receive the opposite, feeling tensions.

In the hypothesis for both jazz solo lines and jazz harmony, the excepted emotional responses stem from the previous research as follows:

Hypothesis 1 / Jazz solo: *Compared to non-musicians, musicians are more able to enjoy and experience the increasing tensions and dissonance in music - especially in jazz solos – due to higher competence and trained ear (musicianship).* Related literature supporting the orientation of skilled emotional response by musicians vs. non-musicians can be found in Juslin & Laukka (2003), Blood & Zatorre (2001) and Nusbaum & Silvia (2010).

Hypothesis 2 / Jazz harmony: *Non-musicians are able to consent more to complexity, tensions and dissonance in music - especially in jazz harmony, compared to the single note jazz solos – via shared emotional responses with musicians.* Related literature supporting receptiveness in dissonant music harmony can be found in Besson & Schön (2007), Lahdelma & Eerola (2016), Arthurs & Beeston (2018), Fredrickson & Coppola (2003), Parncutt & Radovanovic (2021) and Tol et al. (2016).

Hypothesis 3 / Jazz solo: *Intentionally selected audio stimulus representing so called 'elevator music', will separate non-musicians and musicians due to high errors in foundational fine-grained qualities of music, potentially being clearly detected only by musicians, referring to the density, pitch, tonality and while non-musicians'*

receptiveness remains very high. Related literature supporting differences between non-musicians and musicians in music quality can be found in Unlabeled (2019), Souppouris (2016), Sloboda (1991) and Sloboda (2007).

The selected stimuli are representing five single-line jazz solos and five jazz harmony sections from recorded jazz albums with observed tension-release occurrences backed with theoretical concepts. The tension levels differ from stimulus to stimulus and they are presented in the following table 1 and table 2.
The solo of Chick Corea consists of multiple periods of tension-release turnovers. He seems to be very capable of adjusting tension filled colors in any moment of the solo by playing "outside" of the context or "inside" of the context. The outside playing is emphasized particularly in certain harmonic sections and with frequent variation of tension-released pairs. It is assumed that musicians and non-musicians are reflecting differently to this type of high-tension proposed stimulus. Diana Krall's solo is very convenient, traditional and non-disturbing – thus described with low tension and high release combinations, i.e. the tensioned parts are passing with immediate release of tones. There should not be big trouble for musicians and non-musicians to receive this stimulus as emotionally positive.

TABLE 1 Single-line jazz solos from selected excerpts (initial setting)

	Performer	Song, excerpt time	Year	Tension	Exp. sign*
1.	Chick Corea / Acoustik band	Sophisticated lady, 18″45 - 21″05	1989	Tension high-release low	mus. +, non-mus. -
2.	Diana Krall / When I look in your eyes	Let's face the music and dance, 1″27 – 3″08	1999	Tension low-release high	mus. +, non-mus. +
3.	Dane Alderson / Yellowjackets & WDR Big band	Downtown 1″37 – 3″50	2022	Tension high-release high	mus. +, non-mus. -
4.	Café Music BGM channel	Instrumental Café Music, 1:13″22 – 15″24	2022	Tension low, release low	mus. - non-mus. +
5.	Joshua Redman / New Port Jazz Festival	Just in time, 3″38 – 5″42	1993	Tension high, random release	mus. + non-mus. -

*Expected sign refers to the hypothesized positive (+) or negative (-) experience

Dane Alderson's bass solo in the third stimulus is very hectic with fast tempo bebop styled (1940-1960 jazz scene) lines. The solo contains several high-tension periods with semi-immediate release tones. The solo phrases are mixing blues lines towards the end of the solo. The assumption of received emotional response is deviating between non-musicians and musicians. The fourth stimulus, Café Music BGM, is retrieved from a generic music channel equipped with homogenous long play type background music. It has low or none tension and it is very easy listening, closest to so called elevator music. An assumption of some level of bored experience may be expected from musicians, while non-musicians may receive this rather pleasant.

The last stimulus is a firework art of jazz, solo performed by famous Joshua Redman, in a tune called "Just in time". This solo includes numerous tensions and intentionally without immediate release tones. Thus, the tension is maintained in rather long periods throughout the solo. Towards the end of the solo the release moments increase with more thematic approach, i.e. melodic lines. It is assumed that non-musicians deviate from musicians in this stimulus.

For the emotional response each participant is requested to identify the 1) time-point for tension, 2) length of tension, 3) expectation of tension (building up), 4) time-point for resolved tension and 5) free description of experienced emotions and feelings of the specific audio stimuli. These types of factors have not been studied in earlier research. In addition to the open-ended answer, the respondents are provided with a list of emotions which would be closest to their experienced feelings. The jazz harmony excerpts are presented in table 2, with album details, performers, time points and tension levels. Some empirical studies have shown a positive association with a higher tolerance of dissonance by non-musicians, when the timbre of the arrangement is larger, i.e. performed with strings or a larger group of represented instruments.

TABLE 2 Jazz harmony tension audio stimuli from selected excerpts

	Performer	Song, excerpt	Year	Tension level	Expected sign*
1.	Gonzalo Rubalcaba / Inner Voyage	Here is that rainy day, 0″00 – 3″20	1999	Released ballad	mus. + non-mus. +
2.	Yellowjackets / Greenhouse	Greenhouse, 0″00 – 2″10	1991	Tensioned ballad	mus. + non-mus. -
3.	Sarah McKenzie / Secrets of my heart	You must believe in spring, 1″20 – 4″40	2019	Released/Tensioned with vocal	mus. + non-mus. +/-
4.	Yellowjackets & WDR Big Band	Downtown, 0″00 – 1″58	2022	Tensioned fast	mus. + non-mus. -
5.	Elaine Elias	Desafinado, 0″00 – 1″46	2016	Released fast	mus. + non-mus. -

*Expected sign refers to the hypothesized positive (+) or negative (-) experience

The first jazz harmony stimulus is very calm, including slowly moving chords with the song theme further. This ballad should be relaxing, mostly containing released moments and rare tensions are identifiable, but sophistically arranged. Both non-musicians and musicians should agree on the pleasing reflection of low-tense atmosphere. The second stimulus is also a ballad, but a very tense, rather oppressive slowly moving string arrangement, which could easily fit to a movie soundtrack. The mood is also quite sad and a bit frightening in tension progression. The assumed hypothesis between non-musicians and musicians is deviating.

Sarah McKenzie sings a lovely song in the third stimulus, but there are also a lot of tensions harmonically in the composition. The chords in the song are continuously moving and tensions are also released when introduced. For musicians,

advanced harmony is assumed to be receptive, while non-musicians may receive this more complex or confusing. The fourth stimulus is very tensioned and fast jazz tune, with frequent details performed by a section of big band horns and a rhythm section. The melody is rather complex and very rhythmic. Musicians should enjoy this type of advanced setting, hypothesized as positive, while non-musicians are expected to receive this with confusion, due to the high tense moment with a fast tempo.

The last stimulus is a sensitive Latin-based song performed by Elaine Elias. The harmonic content is rich, varying and contains some tensions but the overall harmony is released. The rhythmic Latin-based content in the harmony may bring a fresh angle among the stimulus, being the only representative of the genre.

Whether the listener is an advanced jazz musician or an experienced jazz listener, the cognitive affections on the emotional level or in brain activity may be stronger than compared to the listener without such background or knowledge. Furthermore, the listener being themselves an advanced musician, the correlations between tension-release and emotional response should be even stronger due to sensitiveness for improvisation, harmony, color creation and solo structuring.

When comparing the tension-release sections to stable sections or periods in improvised solos or in harmony, there is expectations in the hypothesis for difference on the cognitive affection in emotional response. Stable sections should associate with steady, calm and peaceful responses while tension-release are generating preparedness, emotional activity, either positive or negative.

In this chapter, the scope of tensions in music is reviewed from the literature point of view, as well as the research setting and hypothesis for this research conduct. Two types of stimuli are applied as an artefact in order to analyze the respondent's emotional reactions and prepare for comparative analysis between musicians and non-musicians. The empirical research continues next with data description.

4 DATA DESCRIPTION AND EMPIRICAL METHOD

The data of this study is gathered by applying the experimental design method, by analyzing 15 individual responses with two separate groups – non-musicians and musicians, five persons each. The artifact of carefully selected high-quality music samples are played to the participants in a quiet room/environment, and on individual basis. The responses are collected by applying triangulation method, i.e. both qualitative and quantitative research methods are used. The detailed data description and applied methodology is reviewed next.

4.1 Data collection and audio stimuli

The primary data was collected from 15 participants, seven being musicians (jazz) and seven non-musicians. By this method, it is possible to compare the groups and their emotional response levels, in addition to the individual emotional recognition identification and analyzing process.

The selected 10 music samples represent theoretically well-established foundations for tension and release periods with two main categories; improvised jazz solo and arranged jazz harmony. The samples were checked and confirmed with a professional musician to meet the set requirements on a theoretical level. In jazz solo samples (5), there are continuing section(s) of solos in both dominant V harmony (tension) and tonic I harmony (release). The jazz harmony arrangements represent samples (5) from distinctive and unique approaches with variations of stable harmony with and without dissonant chords and with additional elements of vocal lead and/or strings. Similar research in literature is typically experimental research when audio stimuli are analyzed with individual responses (Er et al., 2021; Bigliassi et al., 2019; Li, 2022).

4.2 Design science research and experimental research approach

This study applies the context of design science research (DSR) and more specifically experimental research (ER) approach. In DSR, the common approach is to combine an observed phenomenon, e.g. from surrounding environment, with a firm knowledge base and foundation, e.g. theory, model or concept, for the researcher to build, develop, evaluate and justify the functionality, goodness to prove the validity of the original observation. Following the illustrated model of information research system by the seminal work of Hevner (2004), it is a strong

guideline that the research process is conducted with steps by systematic order and content. Some small variations can be found in literature for these steps, but it is crucial that the chosen process steps are followed and that those steps are in accordance with the generic idea and core of design science research. Table 3 defines one example of offered steps for the execution of DSR (adopted from Van der Merwe, Smuts & Gerber (2017), also see Geerts (2011).

TABLE 3 Research process steps of design science research (DSR) (adapted from Geerts, 2011 and Van der Merwe et al., 2017)

RESEARCH STEPS	REQUIREMENTS	IMPLICATION
1. Identify the problem	Understanding the relevance, current solutions and weaknesses	Problem existing and clearly defined
2. Offer objectives for solution	Knowledge of the methods, techniques, feasibilities and possibilities	Firm, consistent and credible path to solution offered
3. Create an artefact to solve the problem	Capability to identify existing and innovate new artefacts (model, construct, method, stimuli etc.)	Simple and straightforward artefact is decided and ready to use for the research
4. Demonstrate the artefact	References for literature with existing artefact, proof of test solutions with new artefact	Artefact is functional and working in reaching the solution to the problem
5. Test and evaluate the artefact	Skills to apply correct methodology(ies) for evaluation techniques	Correct research method(s) is applied for tests and results analyze
6. Communicate the problem and solution	Ability to communicate the essential content of the research process, problem and solution to the audience	Consistent and compact research report with analysis of utility, novelty and efficiency of the solution

Especially in IS (information systems), the research process entity of DSR is a combination of environment and knowledge base, which is carefully joined together by the researcher in the middle (figure 2). The key points of the successful governance of DSR are to identify the relevance of the problem, the business needs, with rigorous applications which are critically and scientifically practiced in a correct research manner. From the philosophical approach, DSR can be classified as a coherence of positivist and/or interpretivist orientation due to the multi-disciplinary nature of IS research. From the interpretivist school to pragmatic orientation, DSR can be associated with pragmatic approach, where phenomena are commonly more empirical-based than theory-based (March & Storey, 2008; Hevner, 2004; Goldkuhl, 2018).

This study of tensions in music by emotional responses applies the design science research system, due to several supporting factors; there is high need to understand more of the unique characteristics of individual response rather than generalizing emotional responses to a large group of individuals. The value-added factor in this research system regarding to this study, is to separate individuals by their unique dichotomy of musicianship, when applying the audio

stimuli as the artefact. Design science research is highly associated with this type of research and the research setting with applied research methods.

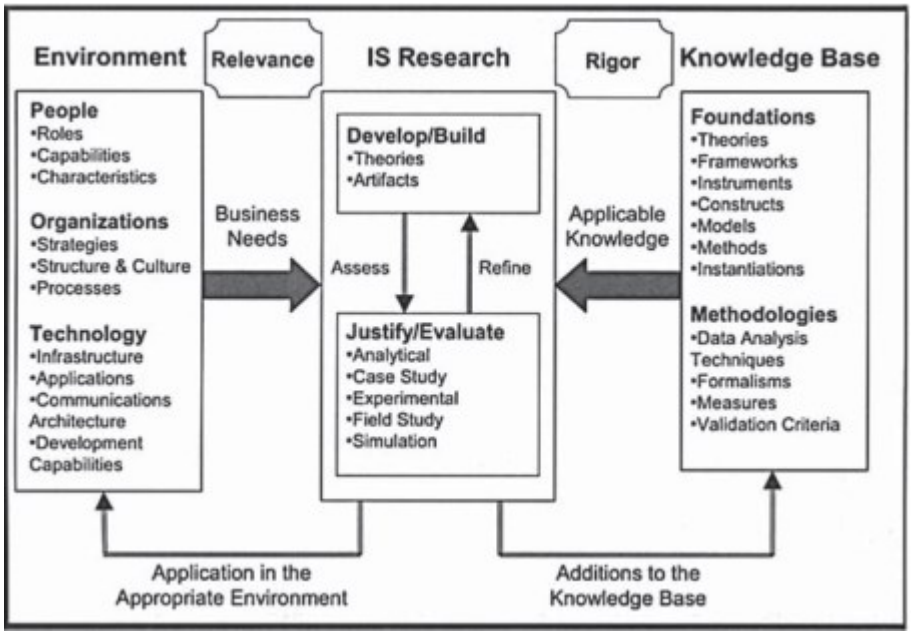

FIGURE 2 The design science research framework by Hevner (2004)

The experimental research itself is a conceptual research method within the design science research framework, as described in Hevner (2004), in table 4, under the IS research section in the middle. It is the researcher's responsibility to choose the best combinations of methods which can optimally justify and evaluate the validity of the created or developed solution, by the artefact. While this study employs two groups based on the separation of musicianship, the experimental research is an appropriate selection for the evaluation and justification.

In general, the experimental design, similarly to its consolidated root concept design science research, has pre-determined and systematic steps to follow in the research process. These steps can have minor variations in related literature, nevertheless the aimed process remains the same. The quite generic steps are described as; 1. Observation, 2. Description/identification, 3. Hypothesis, 4. Isolation and test and 5. Conclusion. The experimental method can be defined as determination of the cause of the observed problem by isolating the assumed causes and comparing the controlled results (Devonis, 2013). It is very important to plan ahead the objective and valid experiments and collect the data in a systematic way. The following features of experimental research are often dominant; confounding variables should be minimized or eliminated and variability should be reduced in the experimental results (Devonis, 2013).

4.3 Triangulation research method

As described in previous subheadings Design science research (DSR) and Experimental research (ER) subheadings and in connection of this study to the methodological and philosophical research found in DSR and ER, the applied context in this research is ontological and pragmatic-oriented DSR where inside the actual analysis ER is associated in the evaluation of a created artefact for a possible solution for the problem (Van der Merwe, 2020). By forming two groups of five by the musicianship, it is possible to compare the effect of provided artefacts by analyzing the observed results of emotional responses. This is perfectly following the DSR principles.

The approach for the analysis is triangulation, i.e. a combination of qualitative and quantitative research method. The respondents are providing both open-ended descriptions of their emotions and numerically evaluated intensity of emotions. For the open-ended questions and numeric questions, each audio stimulus is answered separately. In numeric questions, Likert scale is applied. As there are 15 respondents, 7 non-musicians and 8 musicians, the gathered data contains multiple inputs for each question.

The qualitative answers are analyzed in grouping and the approach is hermeneutical, i.e. aim to understand respondents' actions (causes for emotions raised). The applied method is inductive, with answered text coding and themes based on coding. Finally, content analysis is formed through word clouds for each of the groups. In addition, respondents are asked to specify certain time points in the stimulus to see if they can identify tensions. In case they are not able, they may skip that question. This additional information (skipped/specified) may increase our understanding of the level of their analytical decision-making process when emotions are interpreted and compared between groups.

Quantitative answers are analyzed firstly with Likert average calculation and finally with the t-test for statistical significance of the possible differences between the groups. The actual data is gathered either in one-on-one room or via prepared Webropol, including the audio clips, if the respondent is not able to physically join the session. Thus, ER is harnessing carefully the knowledge base of scientific empirical techniques, by applying the triangulation of qualitative and quantitative methods to verify the functioning and solutions achieved with the artefact.

4.4 Architectural AI harnessed digital app with MINDS

While AI is a vital part of interpreting users' actions, reactions and emotions in the digital world and consumption, more systematic and organized apps are needed to make better propositions and suggestions for the users – not to talk

about professions where emotion or activeness control would be crucial (surgeon, flight captain or any profession where such control is needed for maximal output). MINDS-model is described next with conceptual framework and background motivation.

Globalization, service dominance and digitalization and internationalization have raised the expectation of individuals to a whole new level, which requires strong efforts to create better and more accurate value, which means that the value should be created together and with the network shared with all parties involved (Vargo & Lusch, 2004). In regards to audio stimuli fit with personal characteristics of the listener or music users, the deeper knowledge of the target's emotional response to the offered music is very critical, with or without being a business case. The benefits can well exist on the health sector as well, referring to mental health, stress or anxiety (Fredrickson & Coggiola, 2003). It all boils down to more accurately offered service, i.e. music/audio, which fulfills the needs of the respondent and solves some of the problems involved in the need. In addition, the value is being created with the community of users for iterative increasing matching of supplied service and demand needs, i.e. value co-creation.

For this purpose, the MINDS-method, Management and Interaction Design for Service (Teixeira et al., 2017), is applied for the architectural plan in Chapter 6, in order to utilize the research results of this study. The ideal outcomes of MINDS are associated with the co-value creation elements, value-proposition and value-drivers for users (Tuunanen, Myers & Cassab, 2010), where the individual path of the user is described in gradually detailed visualization in Affinity Diagram, Storyboard and UX/Wireframe Sketch with six moments, shown in detail in empirical modeling in Chapter 6. Next, the MINDS-model is presented in figure 3, as adopted in Teixeira et al. (2017).

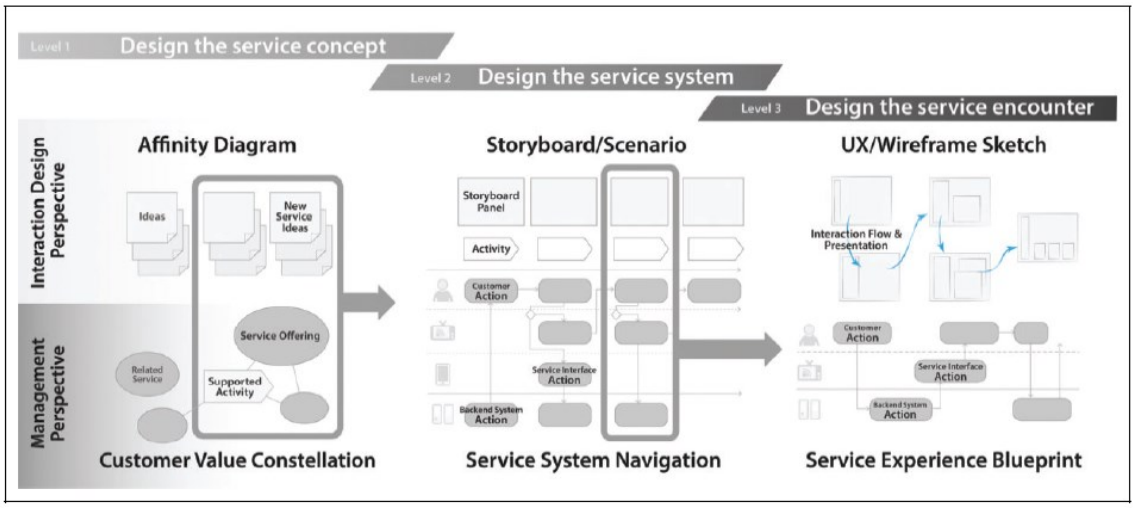

FIGURE 3 Management and INteraction Design for Service (MINDS) concept framework (Teixeira et al. 2017)

The MINDS-concept is exceptionally suitable and optional to harness and govern the systematic combination of leveraged technology-orientation (even a

complex one) in harmony with the seemingly simple user experience (Teixeira et al., 2016). The main benefit of applying this type of framework is, that in practice the individuals are receiving what they need and are expecting – with better, easier and higher user experience and fulfilling emotional response. The whole process should be seemingly simple for the user, regardless of how complex the back-office transactions may be. The referred studies above emphasize and reflect somewhat 'futuristic' stages, where unique user experiences are actually generated by differentiated automatization via AI, IoT and robotization. These cyberizationed services without human intervention are in close target.

This MINDS-model is applied in Chapter 6, based on the empirical results. The aim for the AI app is to systematize and organize complex emotions control regarding carefully designed audio stimuli. The emotions control can be set by the user or by the software pre-sets for the aimed activity level. The final output is to harness AI to either increase or decrease the activity level, or maintain it on stable levels. The variation of usability and benefits of this type of deep control automatized support is limitless.

5 TENSION-RELEASE EMPIRICAL RESULTS

The empirical analysis is conducted next by two separate steps regarding jazz solo tension-release and jazz harmony tension-release data retrieved from the respondents. Both steps include descriptive statistics as well as quantitative and qualitative parts. These will be explained in detail in the following sub-sections. Fifteen (15) respondents participated in both steps and they answered questions based on 10 audio samples; five on jazz solos and five on jazz harmony. The results are discussed and reviewed in the last sub-section.

In table 4, the respondents' profiles are presented. The participants were selected from the local network and the separation between a musician and a non-musician was known and identified in the selection for the two groups.

TABLE 4 Demographics of participants

Gender		Age		Educational level	
Male:	N=7, 46.7%	18-24	1	Higher education:	20%
Female:	N=8, 53.3%	25-34	3	Vocational college:	80%
		35-44	4		
		45-54	2		
		55-64	4		
		65-74	1		

The analysis is conducted by qualitative and quantitative methods, thus having characteristics of a triangulation research method approach.

In the qualitative analysis, the approach is hermeneutical, where the aim is to understand respondents' actions (causes for emotions raised) and the method is inductive. Furthermore, coding and thematic identification are applied, based on respondents' open answers. Also, a content analysis in formed word clouds for each of the groups is presented. Since questions were aligned in sequential form, i.e. there were added questions for some specific requirements of the audio sample, the respondent had a possibility to skip the sequential question in case they were not able to answer the sequential questions (added ones). This piece of data (question skipped / question completed) may also be important to increase the understanding of the level of their analytical decision-making process when emotions are interpreted and compared between groups.

In the quantitative analysis, descriptive statistics are firstly presented. Secondly, the Likert scale numeric average is formed between the groups and, thirdly, calculated with statistical significance by an applied t-test with appropriate discussion of parametric/non-parametric test setting. The quantitative analysis is equipped with descriptive statistics as well.

The following sub-sections analyze the jazz solo tensions and jazz harmony tensions between two groups.

5.1 Jazz solo tension-release emotions among musicians and non-musicians

In the jazz solo tension-release analysis, the participants were provided five audio samples each with different levels of tensions, based on theoretical foundations, as closely explained in table 1. The questionnaire was built on a sequential path of questions, starting with the basic information of the respondent; gender, musicianship and email address. The full questionnaire is available in appendix 1. Then, the respondent was equipped with a short description on the type of questions asked and instructions on how to approach the answers on a in personal and subjective level.

All stimulus questions for the jazz solo were identical in form; first a qualitative open question about experience/feelings of the solo, then four quantitative questions, containing one Likert scale question and three dichotomous scale questions. The dichotomous questions included specifics on starting point of the tension (i), length of tension (ii) and building up phase of the tension (iii). The respondents who were able to provide specific time points for these three dichotomous questions, were offered a sequential question for the requested time-point identification.

The qualitative analysis starts with coding the respondent's answers, referring to questionnaire sections 4a, 5a, 6a, 7a and 8a. As explained earlier, all of these audio samples were theoretically formed to represent different levels of tension-release phases, as follows in table 5.

TABLE 5 Theoretical and pragmatical characteristics of jazz solo stimulus

Stimulus	**Theoretical tension-release**	**Pseudo feeling/experience**
4a	high tension – low release	tense
5a	low tension – high release	easy
6a	high tension – high release	tense with relief
7a	low tension – low release	somewhat boring, 'elevator'
8a	high tension – random release	tense, challenging

It is expected that the only stimulus producing consistently identical feeling or experience should be 5a where tension is low and where ever tension is expressed, it is also released. Musicians should receive this sophistically established tension, where also non-musicians have assumable an easy and rather safe experience of the receiving (tension-release is not complex at all). Why this should not happen in 7a, with musicians, is that the solo does not provide any dramatic changes in tension-release field, which may be received as boring or not interesting. The stimulus 7a is very close to 'elevator music'.

The results analysis begins with the qualitative part. In table 6, the coding and themes are presented, based on the open questions 4a-8a related to observed personal experience and feelings.

TABLE 6 Qualitative analysis of open-ended questions 4a-8a

Group (1,2)* 1=non-mus. 2=mus.	Audio stimuli	Coding group	Theme « negative » hits	Theme « positive » hits	Retrieved summary, sign (+ / -)
1	4a	dramatic-neg critical	4		-
1	4a	receptive		3	
2	4a	intimidate	2		+
2	4a	pleasure & receptive		6	
1	5a	none	0		+
1	5a	amenable & receptive		7	
2	5a	unsatisfied	2		+
2	5a	welcoming		6	
1	6a	disorganized, disappointed, critical	5		-
1	6a	skilled, bright		2	
2	6a	blunt	2		+
2	6a	groovy, musical-pos, empowered		6	
1	7a	none	1		+
1	7a	motivating, joyful, musical-pos		6	
2	7a	flat, critical, musical-neg	7		-
2	7a	lifting		1	
1	8a	distancing, unnerving	5		+
1	8a	professional, uplifting		2	
2	8a	none	1		+
2	8a	caring thrill, professionalism, highly receptive		7	

According to the results, non-musicians and musicians share similar types of experiences and feelings with stimulus no. 5a, which contains theoretically low tensions, and which are rather quickly solved in the solo. The song and solo are considered easy listening in the stimulus. There are very few things or none in the solo that should bother or disturb any listener of the provided types. For other stimuli, actually all hypothesized signs hold and are verified. This is a very interesting result, since it confirms that non-musicians and musicians eventually share a very narrow field of tension-release represented music. When analyzing stimulus outside 5a, the following observation is overwhelming; non-musicians are pleased and receptive only when the tension levels are on a lower side, i.e. stimulus 7a, in addition to previous 5a. When tension levels are increased, in stimuli 4a, 6a and 8a, non-musicians experience irritation, distancing, dissatisfaction, unnerving and even anxiety in relation to tension. In other words, higher

tension associates with higher distancing among non-musicians. The reversed correlation is observed with musicians, the more tension is added, their positive activeness is increased by high receptiveness, uplifting mood, joyfulness, supporting motivation and respected professionalism. Furthermore, an interesting detail is observed with stimulus 7a, an example of 'elevator' music, which is well-received among non-musicians, but the opposite among musicians. Musicians gave crunching and negative feedback on how they experienced the stimulus. They noted of course the low-no-tension content in the solo, but in addition to the musical environment and quality, fine pitch problems with the instruments and overall laim articulation, performance and phrasing of notes. None of these issues were mentioned among non-musicians. Musicians expressed very opposite from non-musicians, with a negative output result. The word cloud is presented in figure 4 and figure 5, from interesting stimulus7a, where emotional responses were contradicting.

FIGURE 4 Non-musicians' responses to 'elevator' stimulus 7a (positive)

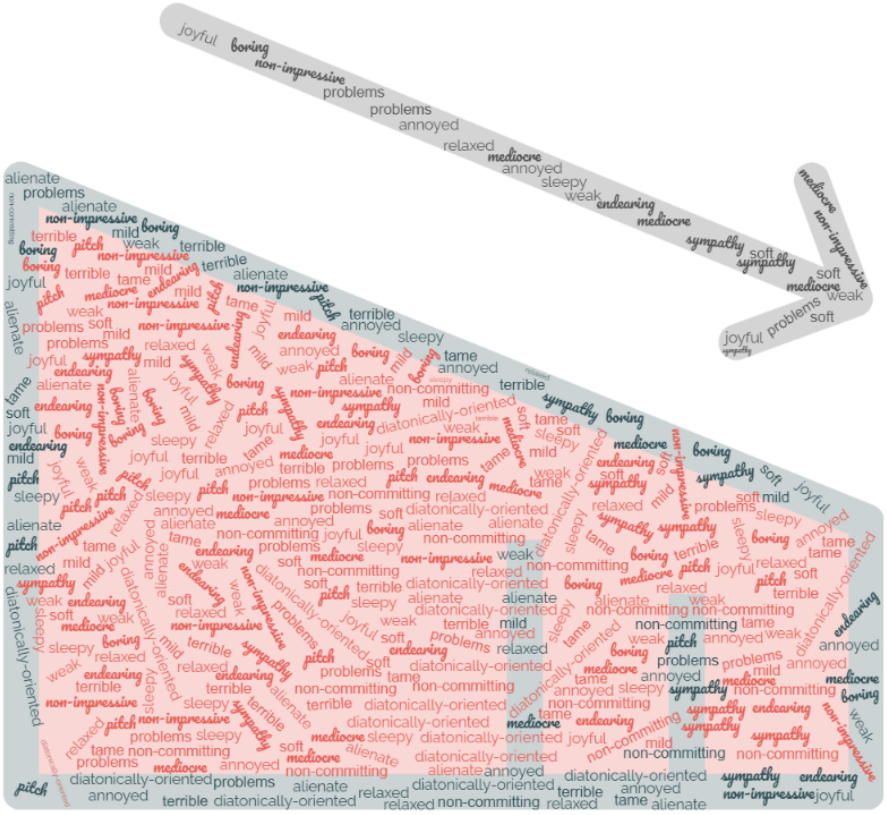

FIGURE 5 Musicians' responses to 'elevator' stimulus 7a (negative)

These results support all of the set hypothesis in the analyzed jazz solo series. The implications of the results suggest that in order to provide musical content for the aimed user experience, moods, feelings or activity level increase/decrease, the user profile must be known for musicianship to have potential for successful outcomes. High tension does not produce increased emotional joy for all listeners, it only does so with professionally oriented musicians. For non-musicians, the impact is reverse – they receive negatively associated emotions. In regards to AI, the generalization of music types, especially with jazz solos, can only be shared with low-tense content if the recipients are mixed between non-musicians and musicians. Figure 6 illustrates the effect of different tension-release combinations for five different stimuli.

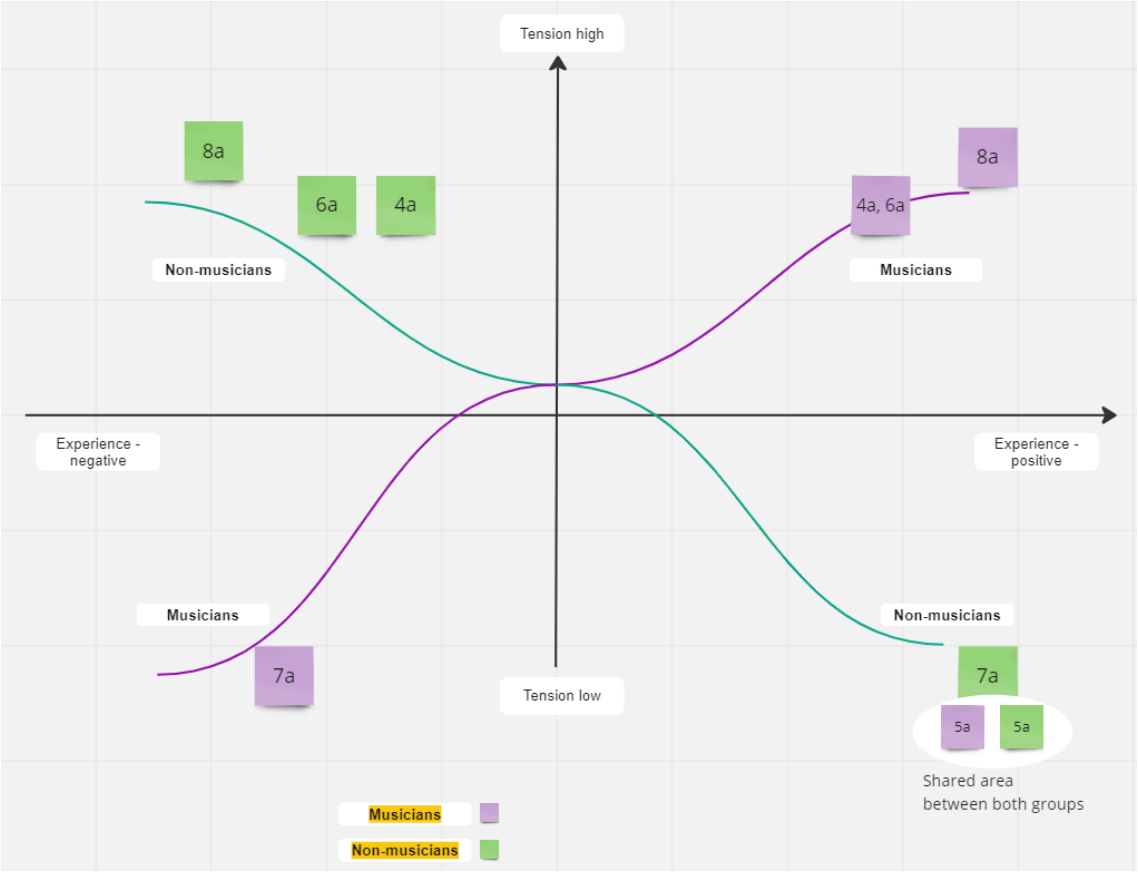

FIGURE 6 Effect of observed experiences of jazz solos among respondents

In the quantitative analysis both groups were compared for potential differences in observed tension levels, referring to questionnaire questions 4b-8b, for five offered stimuli and to questions 9b-13b for other five stimuli. Questions (b) were identical, regardless of the tension levels and frequency. Descriptive statistics are presented in table 7 and statistical t-test values in table 8, for jazz solo and jazz harmony.

An additional analysis was conducted regarding questions 4c/4c2-8c/8c2, where respondents were asked the ability to identify the one or multiple starting points of the tension and consecutively provide one or two examples of these exact time-points. These questions were asked in the jazz solo part. According to the results, across stimuli, 60% of non-musicians were able to identify tensions with associated time-points while with musicians the share was higher, 73%. It requires trained ear, musicianship and experience to organize the perceived musical content in analytically formed response, which explains the higher percentage share for musicians. This result had an expected outcome, and it was an interesting finding in the research.

TABLE 7 Descriptive statistics for tensions, jazz solo and jazz harmony

Non-musicians (1) Musicians (2)	Sum	Average	Standard dev.
Jazz solo			
1	86	2.87	1.75
2	111	2.95	1.46
Jazz harmony			
1	66	2.4	5.73
2	123	3.14	2.67

Descriptive statistics show slightly lower average for non-musicians (2.87) compared to musicians (2.95). When Likert scale values are provided in increasing tension values (1-5), musicians seem to observe tensions across stimuli .08 points stronger compared to non-musicians, however, with lower variance – measured by standard deviation (1.46). The descriptive statistics, compared to the jazz solo, are more deviant in jazz harmony observations between the groups; non-musicians (2.4) and musicians (3.14.) have a similar magnitude with jazz solo tensions but with a greater difference (0.74). This describes that harmonically, musicians detect more tensions across stimuli than non-musicians, regardless of the tension levels and frequences. Again, variance is much higher with non-musicians when jazz harmony is concerned. This may refer individually great differences when versatile harmony content is offered. To see if this holds statistically, two groups are compared with a t-test again, with non-parametric, two-tailed and heteroscedastic assumptions. Non-parametric and two-tailed method is assumed and applied, since the relationships between variables is not accurately known beforehand due to unique research setting where cross-disciline elements are combined. Heteroscedasticity is chosen over homoscedastic distribution of variance for similar reasons – distributions of two distinct groups may not be identical (UCLA, 2021). Table 8 shows the p-values, t-values and degrees of freedom (dg) for the statistical t-test.

TABLE 8 Statistical t-test values between non-musicians and musicians

t-test	p-value	t-value	dg*
Jazz solo	0.61	2.23	13
Jazz harmony	0.13	2.36	13

*dg is the degree of freedom

After implementing the t-test for comparing the statistical differences between the groups in jazz solo, no deviation was observed (p-value 0.61). Further tests were conducted for each question between the groups and the only one close to statistical difference was stimulus 10a, with the p-value of 0.029 (within 5% limit). Stimulus 5a was theoretically established as low-tension and high-release, which associates as easy listening. Non-musicians found this with no tension, while musicians were able to pick some detailed and rapidly transient tensions

in the solo. A statistical t-test was conducted with non-parametric, two-tailed and heteroskedastic distributions between the groups.

For the jazz harmony, no statistical deviance between groups is observed, t-value is 0.13. When testing the questions separately between groups, the first stimulus shows statistical significance of 0.001. In that stimuli, non-musicians receive no tensions (average 1.16), while musicians observe clearly more tensions (average 2.38). This stimulus, 10b, is slowly evolving into quite an oppressed string section with a dramatic but stable harmony. This stimulus is the same one which is deviating the groups in the open-ended answers in the next sub-section. Non-musicians expressed negative emotions, while musicians received it positively. The stimulus itself is quite clean in harmony chords but with a tense arrangement. Musicians may pick up the ambience of the entity of harmony, while non-musicians do not observe the ambience in musical tension but more in emotional scale as oppressed. The comprehensive qualitative analysis is conducted in the next chapter.

5.2 Jazz harmony tension-release emotions among musicians and non-musicians

Jazz harmony tension-release emotions among musicians and non-musicians. In the jazz harmony analysis, the research was conducted with similar approaches compared to the jazz solo analysis. Both qualitative and quantitative analyses were executed, and the results are presented for both methods below. The respondents were firstly provided with a short description of the questions offered, the nature of questions and instructions on how to genuinely reflect to the audio stimuli regarding the harmony. For all five jazz harmony samples the questions were identical regardless of the tension levels and frequency of harmonic tensions. The detailed descriptions of the samples, hypothesis of expected emotions and theoretical foundations of the tension contents are provided earlier in table 2.

The analysis includes five different audio stimuli, which all represent unique levels and combinations of tension-release harmonic settings. The questions can be found in appendix 1 Questionnaire, in parts 9a-13a and 9c-13c for qualitative and 9b-13b for quantitative. The fundamental tensions are associated as follows in table 9.

TABLE 9 Theoretical and pragmatical characteristics of jazz harmony stimulus

Stimulus	**Theoretical tension-release**	**Pseudo feeling/experience**
9a	released ballad	very relaxed, slow
10a	tensioned ballad	tense, oppressive
11a	released & tensioned w/ voc.	Relaxed, tense, sad
12a	tensioned fast	very tense, urgency
13a	released fast	semi-tense, demanding

The expectation of similar types of experiences between two groups should join mostly in 9a, since that is a very calming harmony in the music with slow changes, although the harmony is itself very sophisticated and well-established. The jazz trio in 9a is a world-class representative and all musicians are creating the harmony entity together. As hypothesized, the rest of the stimuli have differences, since there is a gradually increasing complexity in the harmony, arrangements of it. In 10a and 12a the harmonic tension is very deep and supported by longitudinal slow strings in 10a and by a fast-forwarding harmonic score in 12a. Stimulus 11a is one equipped with a beautiful professional leading vocal. Musicians should find this positive, but it is not clear, how non-musicians receive a harmony with both tense and relaxed elements, also with quite deep sadness in the harmonic setting. The last stimuli, 13a, is a fast Latin type harmony, also with a vocal in it. The harmonic content is quite advanced, fast changing, sort of relaxing, but still joyful. The qualitative analysis is based on the respondents' reflections to 9a-13a, which are open-ended and free wording to describe the raised experiences, moods and emotions from the stimuli. The results are presented in table 10.

TABLE 10 Qualitative analysis of open questions 9a-13a

Group 1=non-mus. 2=mus.	Audio stimuli	Coding group	Theme « negative » hits	Theme « positive » hits	Retrieved summary, sign (+ / -)
1	9a	None	2		+
1	9a	Nurturant		5	
2	9a	Blue feel	1		+
2	9a	Deep touch, receptive, analytical		7	
1	10a	Dark blue, weepy touch	5		-
1	10a	Musically noble		2	
2	10a	Oppressive	3		+
2	10a	Touching, spiritual, musically rich		5	

1	11a	Blue feel, ambiguous	2.5		+
1	11a	Hope, rich		4.5	
2	11a	Burden like	1		+
2	11a	Strong emotions, acceptance		7	
1	12a	Poor, strained	3		+
1	12a	Cautioned-good, lightful		4	
2	12a	None	0		+
2	12a	Musically playful, boosting, upper class, receptive		8	
1	13a	Fear	1		+
1	13a	Vibes, receptive		6	
2	13a	Critical	3.5		+/-
2	13a	Respectful, high moods		4.5	

Compared to the hypothesis, all other stimuli were confirmed accordingly except 12a, which is a positive surprise. Regardless of fast tempo and intense harmony, both groups had positive responses with this stimulus.

It seems that harmony in music is a strong identifiable factor joining musicians and non-musicians together. The only stimulus where both groups clearly disagree on the observed emotions, being negative or positive, is the second one 10a, in which the harmony is tense and rather intimidating. In all other stimuli, these groups were in the same square of positive experience and emotions. Stimulus 10a is tense and oppressed, which scared non-musician a bit, while musicians enjoyed the produced moods and colors. In stimulus 11a there were vocals in the clip and the overall harmonic mood was relaxed, but rather sad (very minor -based). Musicians received this positively as with lingerish, tender and with a spectrum of colors, while non-musicians had mixed reflections; partly negatively oriented longing, darkness and fogginess and partly positively oriented relief, new beginning-like, comforting and feeling of love. Very interesting distinct emotions within a group regarding identical stimulus. In 12a, the stimulus content was very tense, with fast tempo and lots of harmonic variation. Groups received this distinctively, as expected; musicians loved fully the harmonic fireworks with adventurous and empowering emotions, while non-musicians mainly felt troubled, irritated and confused. The last stimulus 13a was very interesting with the outcome; non-musicians received positive emotions with descriptions such as springful, promiscuous, love and sun while musicians were seemingly more mixed. For the half-of musicians the stimulus was boring and breathless while the other half received it as swinging, peaceful, pleasant and approachable. This stimulus was also the only one that had a rhythmically

playful Latin-beat, which could explain the easiness for non-musicians to associate with the content with happy feelings.

The results for jazz harmony confirm the set hypothesis, except for the Latin-based stimulus, where the observed emotions were opposite for both groups. Opposed with jazz solo analysis, these results reveal that harmony content in music is a very sensitive issue and functions as glue between the groups, regardless of the musicianship. Musicians and non-musicians receive similar musical contents very differently in jazz solos, but not in jazz harmony. Even during a distressed, dissonant and complex music harmony, both groups are clearly more receptive compared to jazz solo, where single line tones are emphasized. When tension in harmony is increased, the differences between non-musicians and musicians also tend not to increase. Figure 7 illustrates the emotional ranges for the offered five jazz harmony stimuli.

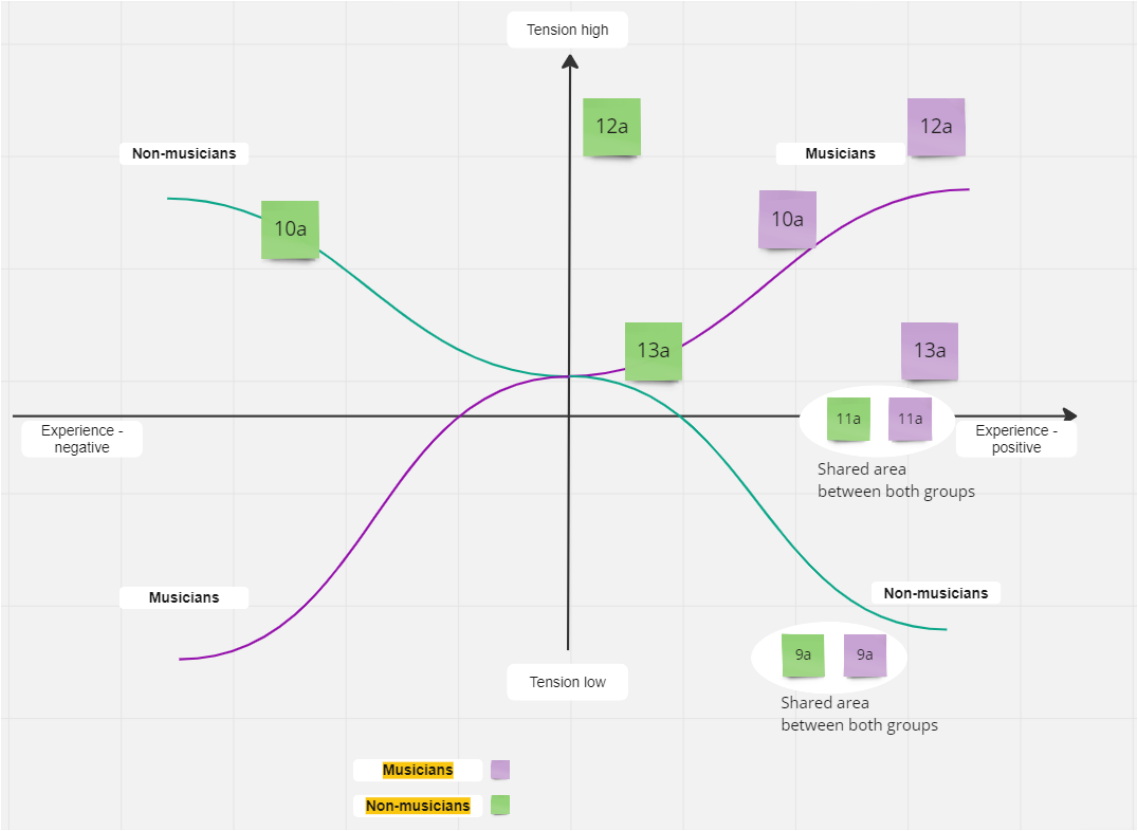

FIGURE 7 Experienced receivings with jazz harmony stimuli

6 AI DIGITAL APPLICATION ARCHITECTURE DESIGN

The empirical analysis conducted in the previous chapter showed that tension-oriented music, whether being instrument solos or harmony-based, is a very sensitive issue for users and listeners. By assuming general implications of tense or non-tense music impacts on listeners many things can go wrong. The need to profile the listener in order to provide them carefully designed, screened and analyzed musical pieces, is very high or even imperative. It is shown that the emotional paths of the listeners deviate with the tense of the offered music. The deviation is even quite extreme in some cases; while musicians receive tensioned music as being pleasant, inspiring and joyful, non-musicians have the opposite emotions; anxiety, irritation, confusion. While this is the outcome, the future developments of AI-assisted music offerings, including the quality and UX matching, to listeners and users, or even for professional purposes (to relax, activate, get focused) is in the core. By careful mapping, profiling and matching the emotional response accuracy can be enhanced. For this purpose, the AI digital app architecture model is constructed by applying the MINDS-method, which is described next.

The designed app is called "Emotion Control UX Digital Culture" and the framework of MINDS (Teixeira et al., 2017) is closely connected to the service design field, with a high focus on value creation to the listener and music end-users, even to professionals where emotion control is a vital part of the work. The globalization, service dominance, digitalization and internationalization have raised the expectation of users to a whole new level, which requires strong efforts to create value with the user (Vargo & Lusch, 2004). The ideal outcomes of MINDS are associated with the co-value creation elements, value-proposition and value-drivers for users (Tuunanen et al., 2010), where the user path is described in gradually detailed visualization in Affinity Diagram (figure 8), Storyboard (figure 9) and UX/Wireframe Sketch with eight moments (figure 10).

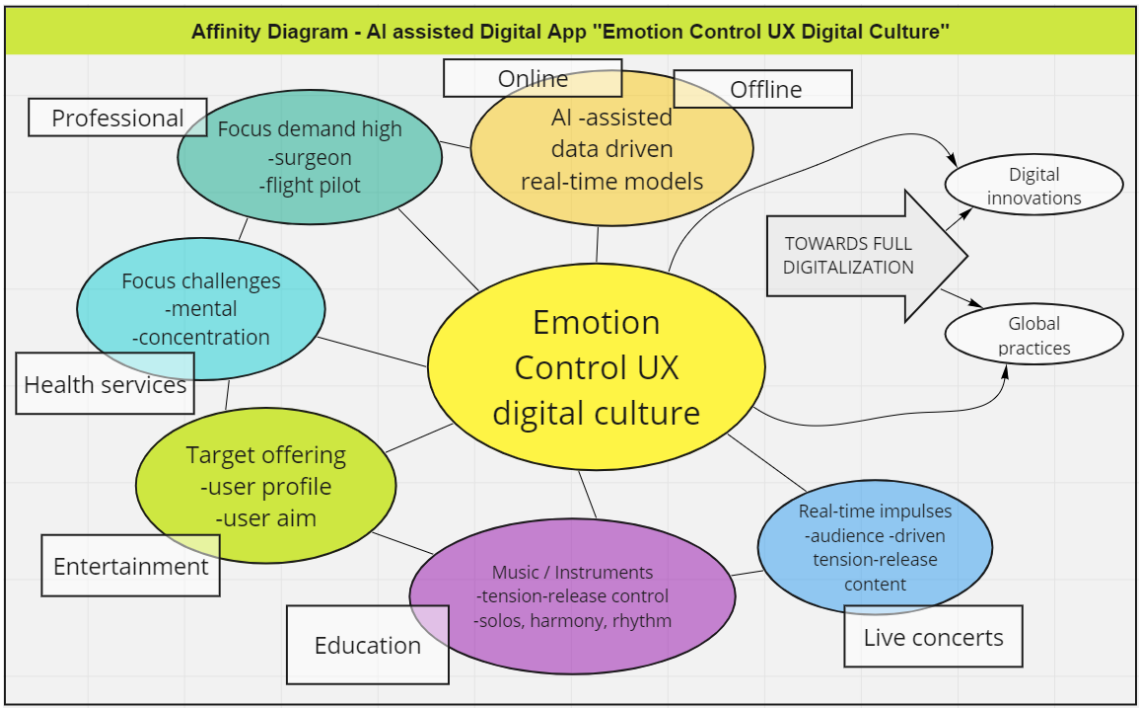

FIGURE 8 Affinity diagram of Emotion Control UX Digital Culture

In the affinity diagram, the user is surrounded with an entity of prerequisite gates where personalized data is provided to AI first and then several options are available for the user for benefits. The optional fields can be related to focus orientation/professional jobs, health services, entertainment, education and even live concerts. In this description, only one of these fields, "Target offering, is chosen for more detailed architectural design. The purpose of this field is to provide users as matching musical content selection as possible to meet the aimed emotional response. The main aim of the affinity diagram is to provide the holistic entity of the variety end-user benefits for different user groups. Next, storyboard is presented for the chosen Target Offering field.

In the Storyboard, six scenarios of activities are presented (figure 9). It is highly important that the software App and the user are in active communication in the beginning phases, where profiling data is gathered. The more detailed data is submitted, the better and more efficient the app is becoming in reaching the targeted aim of the emotional response level. This idea follows the generic path of utilizing big data for the benefit of the end-users.

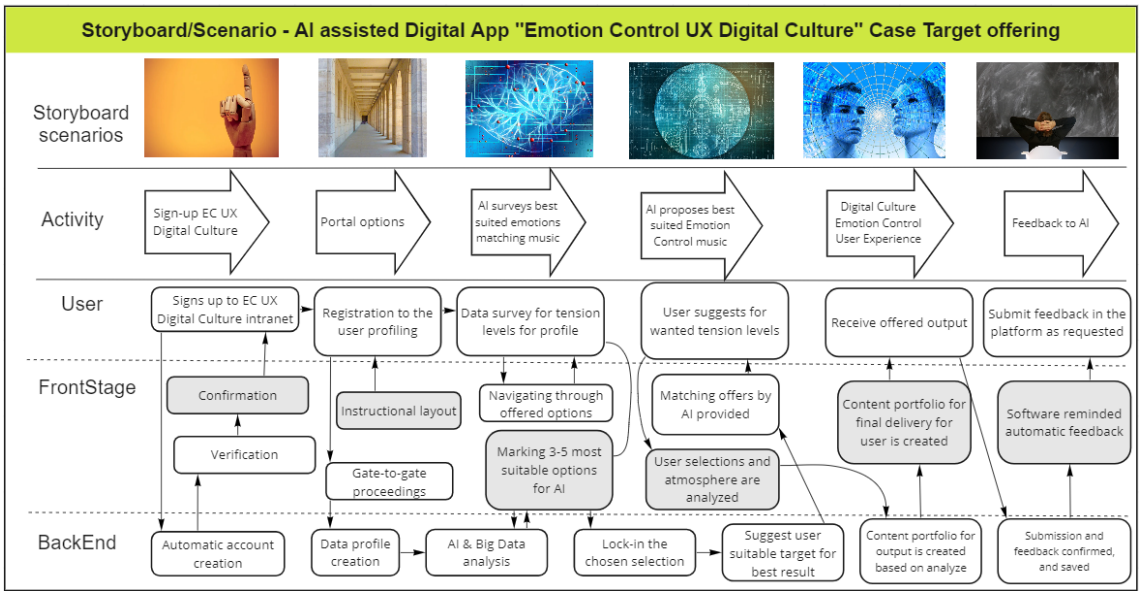

FIGURE 9 Storyboard scenarios for Emotion Control UX Digital Culture

The UX/Wireframe Sketch is illustrated with Service Experience Blueprint moments #1-8 (figure 10). The user signs up and completes the initial personal characteristics online test and submits to AI analyzation for best matching individual emotion control suggestions. The iterative path selections continue supported by AI and the user also has a possibility to interact with the peers who are joined in the online platform. The Emotion Control UX Digital Culture will continue to guide the user ahead for continuously enhancing propositions and suggestions to match the aimed emotions.

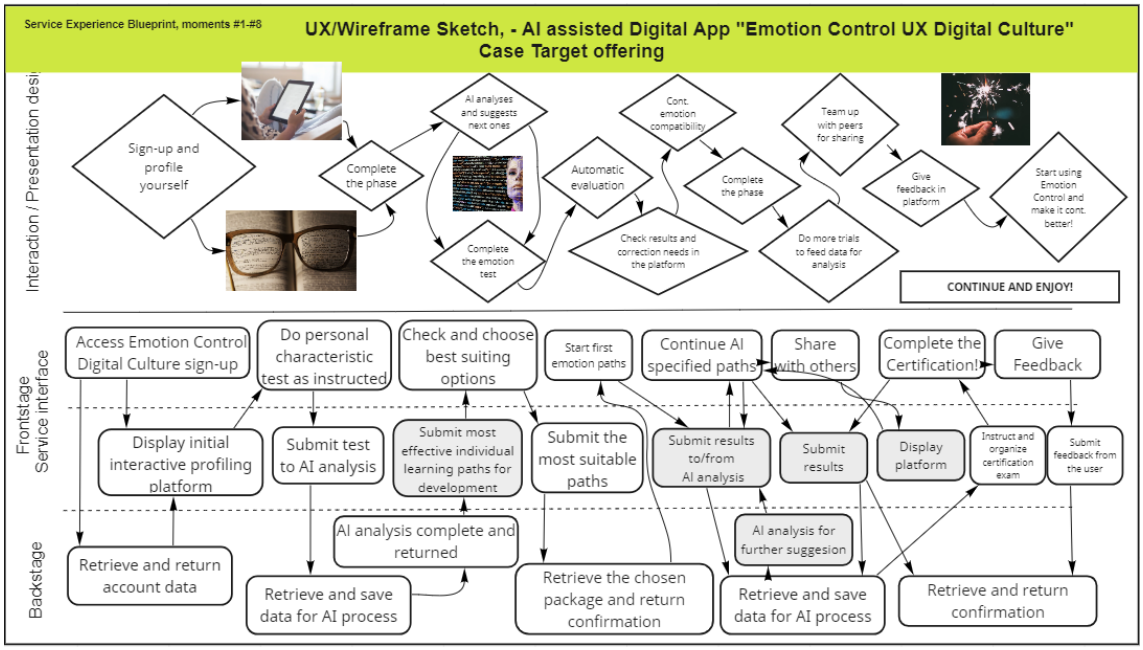

FIGURE 10 Service Experience Blueprint, moments #1-8

7 CONCLUSIONS

The emotional responses in musical context cannot be easily generalized. This can be a huge issue in music business ecosystems, where music platform offering services are applying artificial intelligence (AI) to associate and optimize user experience (UX) and expectations with the best matching musical pieces. To the extent of existing literature, individual factors are very meaningful and may vary a lot. In order to analyze the emotional responses on deeper levels, the musical content should be sophisticated and harnessed with density. Most of the musical stimuli in the literature are excluded from the musical content, being simplified chords, melodies or scales, which may cause biased or incomplete interpretations to meet user expectations. In this study, the music excerpts are carefully selected based on theoretical foundations on the tension levels of the music and focused on two different contexts; improvised solo and chord harmony. To identify these targets with a variety of outcomes, all stimuli are selected within one genre – jazz. In jazz music, improvisation and harmony are strongly rooted and largely presented in recordings and live performances.

The research was conducted with applied experimental research within the larger context of design science research approach. Fifteen respondents were selected to the research with upfront knowledge of their musicianship; eight musicians vs. seven non-musicians. They were provided 10 stimuli with 5 jazz solos and 5 jazz harmony containing excerpts. All excerpts were unique to the tension levels, according to the theoretical foundations. The participants' responses were recorded both via numeric and non-numeric answers, thus the analysis was carried through by the applied triangulation method. The focus of the research was to compare emotional responses between the two groups, aiming to find unique group-based characteristics with varying tension levels in the excerpts.

According to the results, which were reached by coding, thematic analysis and word clouds (qualitative part) and Likert scale combined with average comparison by a t-test (quantitative part), non-musicians and musicians responded with contradicting emotions regarding jazz solos and with seemingly consisting emotions regarding jazz harmony. In jazz solos, non-musicians were identified with more negative emotions in increasing tension contents, while musicians associated with positive emotions. The only exception, where responses were joined, was a low tensioned and gentle jazz solo preceded with a vocal theme. Also, it is found that one intentionally chosen 'bad fine-grained quality', so called 'elevator music', was dividing non-musicians and musicians to the extremes. For the jazz harmony part, the results were rather interesting; non-musicians and musicians shared nearly all excerpts on their emotional response levels, regardless of the tensioned contents. It seems that music harmony allows listeners to more dissonant (tensioned) perceptions without feeling irritated or distant, compared to the jazz solos, where clearly more dissonant solos were immediately dividing responses contractively between the two groups but consistently within the group.

An AI digital app architecture was designed based on the received results and there is a certain need for identified specifics, especially when artificial intelligence supported digital music products, platforms and streaming services are concerned. While it is shown that listeners and users are very sensitive in their receptiveness and emotional responses, AI-adopted services should be harnessed with more complex user profiling data than currently in use. Generalizations in joining musical content to expected emotional responses are hardly successful when the user data is incomplete. As implications, iterative user data collection, combined with adequately saturated profiling and continuous feedback from users, when AI-assisted musical content offerings are designed and executed, are highly recommended.

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APPENDIX 1 THEORY OF TENSIONS IN HARMONY AND MELODY

Intervals are defined as the difference in the pitch between two notes or sounds, meaning two notes are always needed to create an interval. There are two types of intervals, consonant and dissonant. Dissonant intervals are associated usually bases for tension creation in harmony. The Western music is based on 7-note scales, also seven base intervals are recognized, in addition to a doubled first note interval, which is called 'unison'. To list the proceeding seven intervals starting from the scale notes, the names are in the order of increased pitch levels; second (2), third (3), fourth (4), fifth (5), sixth (6), seventh (7) and octave (8). There are also larger intervals, called *compound*, such as ninth (9), tenth (10), eleventh (11), twelfth (12), thirteenth (13), fourteenth (14) and fifteenth (15), which are characteristic in jazz music harmony for advanced chords and mood formation. If the interval pitch differs from the root scale notes (major scale), there can be alterations to the micro-quality of the interval pitches, i.e. minor (narrowed), diminished (narrowed), augmented (extended). If the interval is rooted to the scale, it is one of the following; unison (1), major (2,3,6,7) or perfect (4,5). (Gotham, Gullings, Hamm, Hughes, Jarvis, Lavengood & Peterson, 2022.)

General tensions of intervals are determined as available and unavailable forms (The Jazz Piano Site, 2023). When referring to available tensions, tones are compared to the root chord, with specific chord tones (1,3,5,7) and tensions (9,11,13) or alterations based on these available tension tones (Available Tensions). Unavailable tensions are theoretically in conflict with root chord tones, either in sound or feel. However, in practice it can be observed that in many jazz-based harmonies and solos, musicians are applying both available and unavailable tension notes intentionally, to create certain levels of tensions. (Levine, 1989; Crook, 1991.) In case of unavailable tension tones, e.g. in jazz solo, the solo lines (musical phrases during improvisation) may contain several "out-lines", which in various incidents create extra strong tensions with smooth release tones to the original root chord at the end of solo line or phrase (Sting, 1986; Corea, 1989). This type of extra tension creation is very typical to modern jazz or progressive jazz genre. It is not a new innovation, since there were musicians already during 1950s and 1960s with strong expressive improvisations where unavailable tones were used (Davis, 1959; Davis, 1969).

Another approach to tensions is to focus on chords that contain very high-density tension featuring elements. These chords are specifically identified to dominant chords, which contain very strong and informative intervals of third (3) and seventh (7). Both intervals are guide tones and they have a natural tendency to be released due to high tension sound. Thus, tones that are very near to third and seventh are theoretically unavailable, since there is a high risk of collision if these harmonically important notes are disturbed. Instead, alterations can be easily made with unison (1) and fifth (5) tones, to create available tensions – to be still easily accepted by ear, even if there is existing tension observed. (Myette, 2023.)

For dominant chord classifications, there are four base chords; major seventh (maj7), dominant seventh (7), minor seventh (m7) and minor-major seventh (mmaj7). Out of these the dominant seventh offers the most fruitful and naturally powerful tension-release feeling, when combined with the release chord. In addition, dominant chords can also be generated in diminished chord qualities. Typically, the tension-release chord pairs are marked as V-I, since these chords are in extreme differences with tension (V, dominant) and release (I, tonic). The dominant chord (V) has very high pressure to be released to tonic (I), which usually reflects the base harmony of songs. According to the western music system, songs usually end with the tonic (I) and very often start also with the tonic (I). In the following subtitles, the tensions in single-line notes are more deeply analyzed (3.2) and chord-harmony is presented in more detail as well (3.3). (Gotham et al., 2022.)

APPENDIX 2 SINGLE-LINE (NOTE) TENSION-RELEASE BUILDING IN JAZZ SOLOS

According to the existing music theory, the dominant chord (V) offers the broadest supply of options to increase and utilize the tension to be created, due to its natural state of loaded dissonance intervals expected to release, specifically third (3) and seventh (7) intervals. In addition, there are many possibilities also to alternate the available tension tones, which in the dominant chord are commonly fifth (5) and ninth (9) – both with #5/b5 (raised or lowered half-step) and #9/b9 (raised or lowered half-step). These alternations are briefly referred to as V7alt in jazz music, including the variations with fifth and ninth. For the unison (I) chord, which is peacefully non-tensed by nature, the release from dominant (V) to unison (I) chord in single-line solo improvisation offers very high potential for the listener/viewer to experience the full spectrum of the musical drama tension. First, there is high tension laid in dominant (V), requiring to be released, and then the tension is released in unison (I). Of course, there are different ways to do this with single-line phrases and in improvisation, this requires high-level professionalism from the improvisation performer to express and create this tension-release as a genuine experience for the listener. Next, three different examples of single note improvisations from V to I are described. These are based on increased tension-release principles, adopting the single-lines with modal approach (scale notes with low dissonance), alternative notes approach (varying fifth and ninth) and chromatic approach (using upper structures and chromatic encounter notes). (Levine, 1989.)

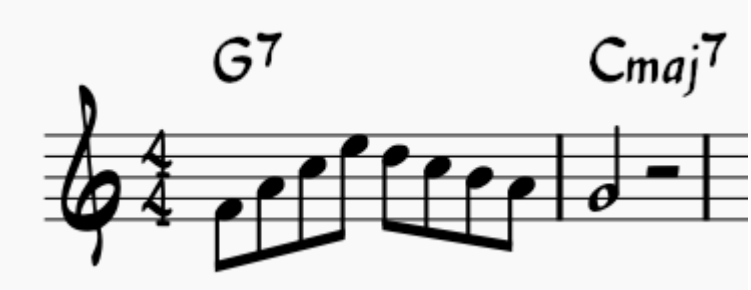

FIGURE 11 Single-line with conventionally balanced scale notes (low-tension)

The dominant (G7) functions as V chord and four first notes are intervals 7, 9, 11, and 13, providing decent tension and identified as available tension notes, as explained (Levine, 1989). The following four notes are directly from C-major scale, functioning as prepared release, which is arriving in a very peaceful destination in G tone, which is the fifth interval tone in with C. The tonic chord is Cmaj7, which is often used in jazz music to represent the I chord harmony. To

be exact, the most released landing chord (I) theoretically would be C6, which is left beyond this analysis. In this framework, Cmaj7 represents already a very high release mode for the harmony.

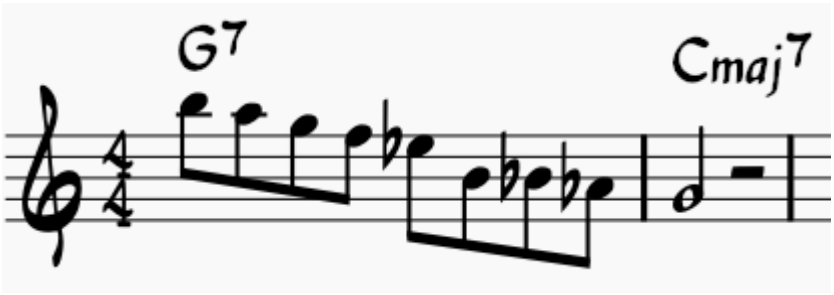

FIGURE 12 Single-line with V alternative (5,9) tones (medium tension)

With the same V-I chord progression, the starting notes follow conventionally balanced scale notes (3,9,1,7) with no alternative variations. However, in the proceeding four notes, alternations have been applied to fifth (5) and ninth (9), as follows; #5, 3, #9, b9. The tension is clearly observed with a differentiating mode compared to the scale notes in the previous example. Finally, the peaceful fifth (5) is representing the landing note without any tensions left, it is totally released and the listener should find it calm.

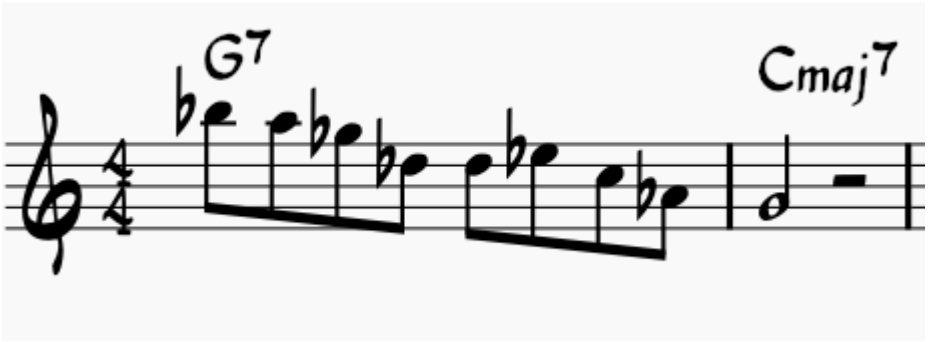

FIGURE 13 Single line with chromatic approach, unavailable tones (high tension)

Here, both chromatic approach and unavailable tension tones are presented. The first note is an encounter (or approach) note to the proceeding three notes, which form an upper structure, namely Gb minor chord tones (A, Gb, Db) in the played order. The upper structure is a principal system name for a triad chord, which is extended from the root chord key (Levine, 1989). The next four notes have a similar structure; there is a chromatic encounter (or approach) note to the proceeding three notes, forming another triad, namely Ab major chord (Eb, C, Ab) in the played order. The tension is really strong in the first eight notes in

dominant (V) due both available and unavailable tension tones and in addition to the applied upper structure. The phrase is released with the familiar fifth tone in C. For the listener being able to enjoy this type of intentional harmony formed outside of the original key, advanced musical ear or a professional musician background is most likely required. For some non-musicians, or for the non-trained musical ear, the single-line phrase in this third example might even be uncomfortable or non-pleasant, even anxiety oriented. The created or offered musical content cannot be assumed to be experienced in homogenous ways among different listeners due capabilities to understand and manage the information contained.

Here are some statements from masters of jazz, regarding the jazz improvisation.

> There are no wrong notes, some are just more right than others (Monk).
>
> There are no wrong notes, only wrong resolutions (Evans).
>
> It's not the note you play that's the wrong note – it's the note you play afterwards that makes it right or wrong (Davis)
>
> Do not fear mistakes - there are none (Davis)

(Walk That Bass, 2015.)

APPENDIX 3 MULTIPLE TONE TENSION-RELEASE BUILDING IN JAZZ HARMONY

In music harmony, the tension-oriented chords are mostly focused around dominant seven chords (V7), due to high need of harmonic release in third (3) and seventh (7) intervals. In addition, the dissonance is very high and needs to be released, to the commonly known and already familiar tonic (I), as also referred to earlier. (Benward & Saker, 2003.) However, especially in jazz harmony, it is common practice to color chords and harmony, even in released spots with dissonant tones, which would in certain cases or theoretically require resolving – but if intelligently formed and created, they can be simultaneously dissonant and released (Levine 1989, 1995). The following example is presenting a tonic (I) chord with simultaneous dissonance and release (resolving not required)

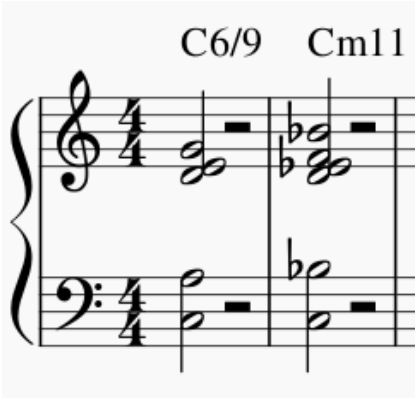

FIGURE 14 Simultaneous dissonance and release in tonic (I) chords

These chords have dissonant intervals, minor 2nd in the first chord and cluster of two minor 2nd intervals in the second chord. Both chords are in tonic (I) with different qualities, major 6/9 and minor 11. These chord progressions are carefully designed and well-established in the jazz genre, also found in multiple recordings of jazz throughout the years (Davis, 1964; Ritenour, 1988). The stability of dissonance may be explained by neutralizing intervals outside the dissonant interval(s). In the first chord, the upper interval of the dissonant one is minor third and the interval below is perfect fourth, which is a theoretically consonant interval. In the second chord the upper interval of the dissonant cluster is perfect fourth and the interval below is major third. From these chords it can be observed that dissonant and release modes can be existent simultaneously. Again, similarly to examples in single-line phrases, the listener/viewer's musical training or advanced ear levels may produce different outcomes of the experienced sound, but it is likely that released tonic chords even with

dissonant intervals are relaxed in the ear, due to intelligently collated tones according to established jazz theory and jazz practice. (Levine, 1989; Levine, 1995.)

Furthermore, other than the seventh (V7) dominant chord, there are also previously mentioned maj7 chord and minormajor7, which are typically tonic (I), and minor7. These have different moods by nature, as presented in table 13.

TABLE 11 Dominant chord qualities with feel and sound (adapted from The Jazz Piano Site, 2023)

Chord quality	**Feel/sound**
maj7	released, calm, happy
minormaj7	very dissonant, restless
7	tensioned, needs to be released*
minor7	melancholic, sorrowful

These feelings and sounds should be quite broadly recognized in western music. However, the star-marked dominant 7th chord needs an addendum for the previously described conventional tension-release path*. In blues-oriented jazz tunes, it is very common to treat dominant 7th chords as being stable tonic (I) chords. For instance, 12-bar jazz-blues structure contains mainly dominant 7th chords, which are treated solely as being equal to tonic chords. This approach is rooted to blues, and would require another deeper analysis, which is beyond the tension framework emphasized in this thesis. The dominant 7th chord has a very fruitful quality to be referred to as a good theoretical ground for a tension filled representative harmony (Levine, 1989, 1995; Crook, 1991; Bergonzi, 1994).

APPENDIX 4 RESEARCH SURVEY QUESTIONS, QUALITATIVE & QUANTITATIVE

All questions are identical regarding audio stimuli (10) for respondents.

1. Gender: M/F
2. Musicianship: Non-musician/musician
3. Email: provide your email address
4. Age group
5. Education

Improvised jazz solo (without instructions here)

6. Stimuli one to five, improvised jazz-solos
    a. Qualitative / Open question: describe how do you experience/feel the offered jazz solo, based on the introductory guidance above. Please apply at least 100 words and describe as versatile and honest way as possible.

Open answer, 100 words min.

    b. Quantitative / Likert scale: analyze the content of the solo, based on the experienced tension. 1=no tension, very relaxed feeling, 2=low tension, 3=some tension detected, 4=mostly tension, 5=very tensioned.

    c. Quantitative / Dichotomy: I am able to identify one or multiple identified starting time-points for the tensions: Yes/No.

    c2. If Yes to c then please identify two starting time-points for the tensions by specifying the time in minute and seconds, e.g. 1min 04sec (just the starting time-point).

Time point 1: *Time point 2:*

    d. Quantitative / Dichotomy: I am able to identify the separated length of tensions in different parts of the solo: Yes/No.

d2. If Yes to d then please identify two length spans for separated tension parts in minute and seconds for starting point and ending point, e.g. 1min 04sec – 1min 09sec.

Duration of the tension 1: *Duration of the tension 2:*

e. Quantitative / Dichotomy: During the improvised solo, the soloist is building up the tension in anticipating manner, which I am able to identify and there is certain expectation for the tension to be increased: Yes/No

e2. If Yes to e then please identify one length span in the solo, where expectation in forthcoming tension is being built, in minute and seconds for starting point and ending point, e.g. 1min 04sec – 1min 09sec.

Duration of the pre-tension building:

f. Solo contains tension, which is occasionally released and can be identified.

f2. If Yes to f then please identify one such released time point, as 1min 04. Alternatively, you can mark the length of the release time span in minute and seconds for starting point and ending point, e.g. 1min 04sec – 1min 09sec.

Time point for release: *or* *Time span/duration for release:*

Jazz harmony (without instructions here)

7. Stimuli six to ten, jazz harmony

    a. Qualitative / Open question: describe how do you experience/feel the offered jazz-harmony excerpt, based on the introductory guidance above. Please apply at least 100 words and describe as versatile and honest way as possible.

Open answer, 100 words min.

    b. Quantitative / Likert scale: analyze the tension level of provided harmony and performance, based on the experienced tension. 1=no tension, very relaxed feeling, 2=low tension, 3=some tension detected, 4=mostly tension, 5=very tensioned

    c. Qualitative / Multiple-choice question: Describe your feeling closest to offered options, when listening to the excerpted audio clip (you can choose one or more feelings)

    _ Joy

    _ Sadness

    _ Surprise

    _ Anger

    _ Inspired

    _ Annoyance

    _ Disgust

    _ Happiness

    _ Repellent

    _ Overwhelmed

    _ Appealing

    _ Distracting

    _ Breathtaking

    _ Confusing

_ Exciting

_ Empowering

_ Other, specify

Open answer