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The Effects of Tempo and Timbre on Felt Emotions

Chiu Yuet Alicia Sher
Durham University

ABSTRACT

The aim of this study was to investigate the effects of tempo and timbre on felt emotions. Thirty participants were allocated to a total of four experiments, with two tempo and two timbre conditions. Participants rated their felt emotions by using the Geneva Emotional Music Scale (GEMS-9) in each experiment. Results demonstrated that tempo did have an effect on listeners' felt emotions, in particular, a faster tempo induced more positive emotions. Contrary to the hypothesis, the slower excerpt did not induce more sad emotions quantitatively. It was predicted in the timbre conditions, that the richer and brighter the harmony created by instruments would create a stronger emotional response. This hypothesis was inconclusive since participants' total felt emotions were rated higher when listening to violin excerpts than the cello excerpts. This study demonstrated how differences in musical elements such as tempo and timbre could influence listeners' felt emotions, suggesting that music is a useful and effective tool for studying the influence of emotions in regards to therapeutic application.

1. INTRODUCTION

Music and emotions are intrinsically connected as many studies suggest that one of music's functions can be emotion regulation, it can act as a powerful form of communication for listeners to convey their emotions (Juslin & Laukka, 2004; Saarikallio & Erkkilä, 2007). Different musical elements such as tempo, timbre and rhythm, enable both composers and performers to evoke some specific emotions and moods to listeners. Listeners can also experience sensations through modifications of various musical components during the music listening process (Gabrielsson & Lindström, 1993; Juslin & Laukka, 2004). While tempo has been considered as the most significant and primary component in modulating effect since it has also been shown that the simplest emotions to be induced by tempo are happiness and sadness (Gagnon & Peretz, 2003; Hevner, 1937).

Previous research has examined the relationships between tempo and emotions, with some finding a positive correlation between these elements. Van Der Zwaag et al. (2011) investigated the effects of tempo, mode and percussiveness on emotions in the context of an office environment setting by conducting a repetitive typing task, with four types of background music provided, with differences in tempo and mode. Participants were randomly allocated into two groups, provided with pop and rock songs in either continuous or discontinuous condition, by using a 7- point likert scale to rate the emotion ratings in the aspects of arousal, valence (positive and negative feelings) and tension. The findings concluded that a faster tempo induced higher arousal ratings. Similarly, Gagnon and Peretz (2003) also examined how emotion is varied by tempo and mode. They particularly investigated the effects of tempo and mode on the happy-sad distinction by conducting two sets of experiments with four conditions each: Mode isolated, Tempo isolated, Convergent combined and Divergent combined condition, using the same music stimuli - equitone melodies. Participants in both experiments were randomly assigned into one of the four conditions and rated the melody which sounded happy or sad on a 10-point rating scale, with the only difference being that participants were doubly recruited in order to evaluate how gender varied in the aspect of identifying nonverbal cues. The result showed that a faster tempo and major mode convey happiness to melodies.

In regard to the effect of timbre, Bowman and Yamauchi (2016) discovered that timbre could influence listeners' perception of emotion. They conducted two experiments to examine whether timbre affects listeners' perceived emotion in instrumental sounds based on timbre and emotional judgement. The same music stimuli were used in all experiments and participants were divided randomly into two groups. The result demonstrated that the emotional ratings, particularly in the domain of sadness, aligned with the intended emotions of the music stimuli. Likewise, Eerola et al. (2012) also explored the role of timbre in the perception of broad affect dimensions in isolated musical sounds by conducting three experiments. Participants rated the perceived effects of monophonic instrument sounds with the same duration, pitch and dynamics by using a three-dimensional affect model, with the addition of an emotional dissimilarity task. The findings showed that timbre related

acoustic characteristics are crucial in impacting emotional perception and expressiveness. In addition, Lucassen (2006) has found that different musical instruments are strongly affecting listener's perceived emotions.

Lahdelma and Eerola (2014) also found that timbre did evoke emotional responses. By exploring how single chords convey emotional qualities to listeners, by dividing participants into four groups based on their music sophistication - musicians (low, high) and non-musicians (low, high), and were asked to rate the 5 positive and 5 negative adjectives in order to measure their affective mood. Also, participants had to rate chords played by piano and strings by using a 9-item scale. It was found that strings had higher mean ratings than piano in the aspects of nostalgia, sadness and tenderness based on the GEMS-9, while piano scored higher mean ratings in the aspect of happiness. This suggests that timbre was clearly affecting the emotional connotations of the chords, in which single chords did convey unique emotional feelings to both musicians and non-musicians.

Based on the above studies, two major research gaps were found. Firstly, these studies only considered the use of chords, scales, pop and rock songs as music stimuli, neglecting timbre and chord subtleties to musical genres, identifying a research gap that emphasises the significance of a thorough understanding of how these components function within various forms of music (e.g. Gagnon & Peretz, 2003; Lahdelma & Eerola, 2014; Van Der Zwaag et al., 2011). Therefore, this present study has applied the use of Classical music for music stimuli since most of them are instrumental music which is without any lyrics, allowing to put the focus solely on the impact of musical elements without the impact of verbal context in order to explore whether using different genres of music would more effectively affect listeners' felt emotions. Secondly, all the previous research only focused on the relationship between perceived emotions and music rather than felt emotions. According to Gabrielsson (2001), there are two types of emotions that can be presented during a music listening process which are perceived and felt emotions. However, it is challenging to differentiate between these emotions (Juslin & Sloboda, 2010; Kivy, 1990). Perceived emotions are emotions that are expressed through music, and recognised by the listener, without necessarily feeling an emotion oneself (Juslin & Sloboda, 2010). While felt emotions are emotions that are 'relatively brief, intense' that trigger an emotional response (Juslin, 2011). Since there is a lack of research investigating the effect of musical components on felt emotions instead of perceived emotions so this study decided to concentrate on how musical elements affect the felt emotions of listeners since felt emotions focus more on the listener's emotional response to music in which emotions tend to bring a more powerful, intense and long-lasting experience to listeners (Frijda, 1993).

This study's research question is "Do tempo and timbre affect listeners' felt emotions?", which aims to explore the relationship between tempo, timbre and listeners' felt emotions. Based on the previous research, two hypotheses were established. The first hypothesis to be examined regarding the tempo condition is that a faster tempo would elicit positive and energetic emotions, while a slower tempo would evoke more tenderness and sad emotions (Gagnon & Peretz, 2003; Van Der Zwaag et al., 2011). For the timbre condition, this study is based on an exploratory purpose and aims to compare the impacts of various timbres on felt emotions since there was a lack of research in this domain and literature on the topic of timbre and felt emotions. Therefore, the second hypothesis would just predict that the richer and brighter the harmony created by instruments would create a stronger emotional response (Lucassen, 2006). However, no specific emotion will be predicted.

2. METHOD

Design. This study used a causal and within-participants design to investigate the effects of tempo and timbre on participants' felt emotions. Using a quantitative method with an anonymous online questionnaire created by Qualtrics. The independent variables of this study were a total of four music excerpts: one music excerpt with two tempo conditions (slow/fast), and another music excerpt with two timbre conditions (violin/cello). While the dependent variable was the felt emotions of the participants, the emotion ratings were measured by the Geneva Emotional Music Scale (Zentner et al., 2008).

Participants. There were a total of 30 participants recruited for this experiment (19 females, 9 males and 2 others), with ages ranging from 20 to 56 (M = 23.2, SD = 6.65). They were recruited mostly through convenience sampling through social media and emails. According to cultural background, the majority were from the UK (n=17), and the remaining were non-Western (n=13). According to the Ollen-MSI scale which tests music expertise (Ollen, 2006), four participants were classified as professional musicians. Ten of them

(33%) were proficient in musical instruments, with the most common instrument being the piano, followed by the cello and violin, and lastly the trombone.

Materials/Stimuli. This experiment was conducted by using a Qualtrics online survey, which took around ten minutes to complete. For the musical stimuli of this study, two different versions (slow/fast) of Prelude in C Major, BWV 846 for solo piano by Johann Sebastian Bach, performed by two different musicians were used in tempo condition. Similarly, two different versions (violin/cello) of "Humoresque" Op. 101, No. 7 by Antonín Dvořák were used in timbre condition. The duration of the two music stimuli were manipulated to be one minute. Other musical elements were controlled by using different versions of the same piece of music, ensuring that the effects of tempo and timbre could be examined independently of other factors. In addition, participants' level of musical expertise was assessed by asking one question by using the Ollen Musical Sophistication Index (Ollen-MSI) (Ollen, 2006). Furthermore, in each music excerpt under each condition, a GEMS-9 version of the Geneva Emotional Music Scale (1 = Not at all, 5 = Very much) (Zentner et al., 2008) was used as the major measurement of listeners' felt emotions. Its 45 emotions were assigned to 9 musical emotion categories: Wonder, Transcendence, Power, Tenderness, Nostalgia, Peacefulness, Joyful Activation, Tension and Sadness.

Procedure. Participants took the questionnaire in Qualtrics, at first reading an overview of the study, then giving their consent to take part and indicating all of them were over the age of 18. To take into consideration background variables, participants were asked to provide demographic information, including age, gender, cultural background and musicianship. Participants were randomly allocated to four conditions in which they listened to the music excerpt and were asked to rate their felt emotions towards the piece on the same page by using the GEMS-9 emotional ratings on a 5-point likert scale, while there was no hint of the name of music was given to them. The page with each music excerpt contained a timer with no more than 2 minutes, enabling an accurate quality control since participants were only allowed access to the next section when they finished listening to the whole music excerpt. This process was repeated until participants had been exposed to each version of the excerpt out of four in a random order. The last section of the survey required participants to rate some close-ended questions, such as 'Have you heard this piece of music before?,' with 2 options: yes or no. Also, 'Do you recognise this piece of music?' would appear if the previous question was answered as yes.

3. RESULTS

Felt emotions (GEMS-9) between the two excerpts in tempo condition. In order to investigate the primary research aim which is whether and how listeners' felt emotions are influenced by tempo. The mean ratings of 9 felt emotions were first calculated across the fast and slow versions of the music excerpt in tempo condition. It was found that Transcendence, Tenderness, Nostalgia, Peacefulness, Tension and Sadness in the fast excerpt showed a higher mean than in the slow excerpt (see Table 1). Since the means of the 9 felt emotions were calculated and found out some of the emotions were higher in the fast excerpt than the slow one, separate paired t-tests were conducted. The results of t-tests showed statistical significance in Transcendence ($t(29) = 2.43$, $p = .02$), which is less than .05. In addition, the statistical significance of Nostalgia and Peacefulness was shown by their exact p values were ($t(29) = 2.10$, $p = .05$) and ($t(29) = 2.04$, $p = .05$) respectively (see Figure 1).

Table 1. Means and *SD* of the 9 musical emotions of two excerpts in tempo condition

Musical emotions	**Fast excerpt**	**Slow excerpt**
	Mean / SD	Mean / SD
Wonder	2.53 (*SD* = 0.86)	2.77 (*SD* = 1.22)
Transcendence	3.17 (*SD* = 1.53)	2.57 (*SD* = 1.28)
Tenderness	2.9 (*SD* = 1.21)	2.63 (*SD* = 1.27)
Nostalgia	3.63 (*SD* = 1.35)	3.2 (*SD* = 1.35)
Peacefulness	3.77 (*SD* = 1.28)	3.23 (*SD* = 1.07)
Power	2 (*SD* = 1.2)	2.17 (*SD* = 1.37)
Joyful Activation	2.33 (*SD* = 1.42)	2.73 (*SD* = 1.28)
Tension	1.77 (*SD* = 1.14)	1.53 (*SD* = 0.97)
Sadness	2.27 (*SD* = 1.2)	1.8 (*SD* = 1.1)

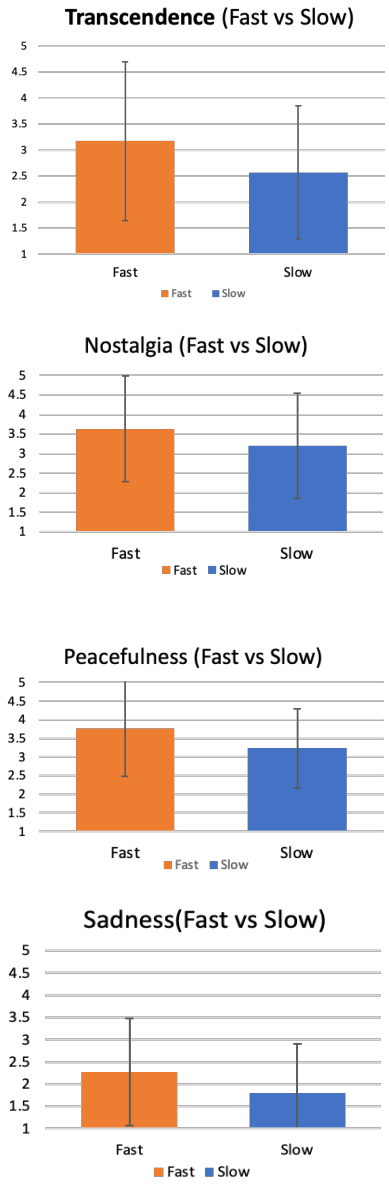

Figure 1. Mean ratings of Transcendence, Nostalgia, Peacefulness and Sadness in two versions of music excerpt in tempo condition

Total number of felt emotions in timbre condition. Regarding the second hypothesis which is to test the effect of timbre on listeners' felt emotions, it was shown that the violin excerpt elicited a greater and higher total number of felt emotions rated by participants than the cello excerpt in timbre condition, which suggested that the violin induced greater and more intense emotions to participants than the cello excerpt.

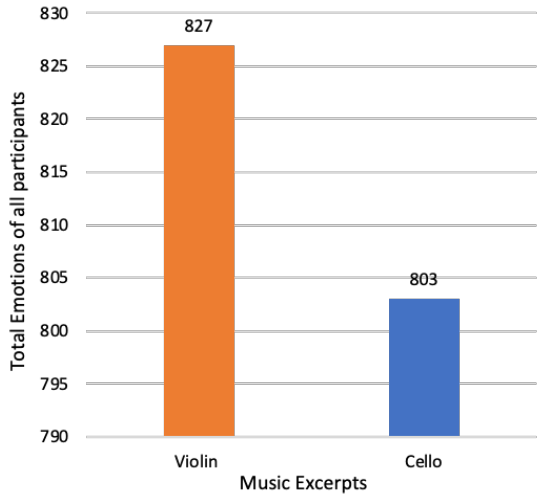

Figure 2. Bar graph showing the total number of emotion ratings for violin and cello excerpts in timbre condition

Felt emotions (GEMS-9) between the two excerpts in timbre condition. The mean musical emotions of the violin excerpt were all higher than the cello excerpts except in terms of Peacefulness, Tension and Sadness (see Table 2). Therefore, in order to examine whether the differences in total felt emotions were statistically significant and compare the mean musical emotions between violin and cello excerpts, a pair t-test was conducted. Nevertheless, none of the 9 musical emotions between the violin and cello excerpts in the t-test findings revealed a statistically significant result with high p-value ($p > .05$), even though the closest one is Nostalgia ($t(29) = -1.72$, $p = 0.1$) (see Table 3), which contradicts to the second hypothesis.

Table 2. Means and *SD* of the 9 musical emotions of two excerpts in timbre condition

Musical emotions	**Violin excerpt**	**Cello excerpt**
Wonder	3.47 (*SD* = 1.04)	3.23 (*SD* = 1.19)
Transcendence	3.3 (*SD* = 1.15)	3.17 (*SD* = 1.12)
Tenderness	3.87 (*SD* = 1.07)	3.47 (*SD* = 1.22)
Nostalgia	3.97 (*SD* = 1.13)	3.57 (*SD* = 1.1)
Peacefulness	3.53 (*SD* = 0.94)	3.77 (*SD* = 1.22)
Power	2.5 (*SD* = 1.14)	2.37 (*SD* = 1.0)
Joyful Activation	3.37 (*SD* = 1.22)	3.33 (*SD* = 1.35)
Tension	1.6 (*SD* = 1.13)	1.73 (*SD* = 1.01)
Sadness	1.97 (*SD* = 1.27)	2.13 (*SD* = 1.31)

Table 3. T-tests results of the 9 musical emotions of two excerpts in timbre condition

Musical emotions	**T-test Results**
Wonder	t(29) = -1.19, p = 0.24
Transcendence	t(29) = -0.55, p = 0.59
Tenderness	t(29) = -1.59, p = 0.12
Nostalgia	t(29) = -1.72, p = 0.1
Peacefulness	t(29) = 0.88, p = 0.39
Power	t(29) = -0.63, p = 0.54
Joyful Activation	t(29) = -0.1, p = 0.92
Tension	t(29) = 0.64, p = 0.53
Sadness	t(29) = 0.68, p = 0.5

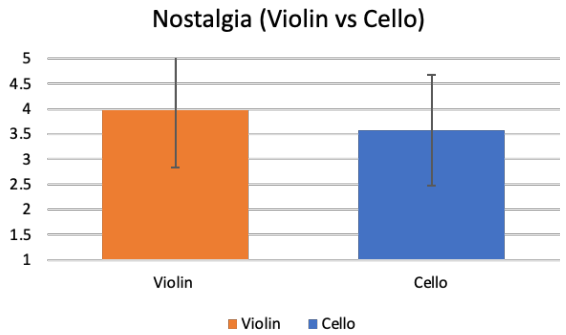

Figure 3. Mean ratings of Nostalgia in two versions of music excerpt in timbre condition

4. DISCUSSION

This experiment explored whether tempo and timbre affect listeners' felt emotions. The results of this study supported the first hypothesis on tempo condition, which aligned with Van Der Zwaag et al.'s (2011) and Gagnon and Peretz's (2003) results, which it was found that tempo could affect the felt emotions of listeners, with faster tempo evoked more positive and energetic emotions. Results from t-tests showed that the fast version of the music excerpt, especially in terms of Transcendence, Nostalgia and Peacefulness, showed a statistical significance. Interestingly, transcendence has a connection to a fast tempo instead of a slow tempo. A possible explanation might be that transcendence is a complex and deep but positive emotion. When people meditate, they can see feelings of transcendence since it involves a heightened sense of meaning and connectedness with others and with the world (Frankl, 1966). They can enter a state of flow characterised by deep concentration and focus on the techniques that stimulate cognitive effects, allowing them to experience a sense of satisfaction and contribute to the intense positive emotions and well-being, like gratitude and joy. Therefore, positive emotions and transcendence are intrinsically connected in which it is unexpected that transcendence has a linkage with fast tempo. However, this result did not show that slow tempo evoke more negative emotions than fast tempo music excerpt which contradicted half of the hypothesis and previous research (Gagnon & Peretz, 2003; Van Der Zwaag et al., 2011). Although the mean ratings demonstrated that more Sadness was induced in fast tempo music excerpts than in slow tempo excerpts unexpectedly, it showed a non-statistically significant result ($p > .05$). Thus, future research could investigate the effects and connections between various musical elements such

as the melodic complexity with higher note density, instead of only concentrating on the effects of single musical components on felt emotions since the combination of several elements might have significant results in impacting listeners' felt emotions.

While the second hypothesis predicted that timbre would affect listeners' felt emotions, in which a stronger emotional response will be evoked by the richer and brighter harmony created by instruments. However, the results of this study did not support this hypothesis. Despite the total emotions for the violin excerpt rated by participants were higher than in the cello's excerpt, but from the t-test, all results were not statistically significant, conflicted with the findings of Lucassen (2006). Despite none of the emotions demonstrating statistical significance difference, results did show that the highest mean rating experienced by the participants was Nostalgia among all the 9 emotions, similar to the result that string scored significantly higher on Nostalgia/Longing by Eerola & Ladelma (2014). Furthermore, the fact that they rated higher for total emotions in the violin excerpt could indicate that listeners more easily evoke intense emotions by lighter and more vibrant tones. This might be attributed to the idea that the violin sounded very similar to the human voice. According to the super-expressive voice theory by Juslin (2011), the violin has expressive acoustical patterns that are equivalent to the sounds of emotional speech with extra unique characteristics, which these voice-like aspects of music are very effective at expressing emotions to listeners in a way to lead the listener to imitate the emotion internally (Juslin & Västfjäll, 2008). As a result, when participants listened to the two music excerpts played by both violin and cello, their brain's reactions were stimulated and tended to react more rapidly to the sound that consisted of human-powered instruments, resembling the emotional content and empathy of the music, resulting that they are able to experience the emotions directly from the music and thus violin induced the highest and most powerful and strongest intensity of emotions.

While this study has given some evidence for the relationship between tempo and timbre on the effect of listeners' felt emotions, it has several limitations. Firstly, due to the small sample size which resulted in a limited number of professional musicians, the results were not accurate enough and leading to high p-values. Therefore, a larger sample size in the future would help to improve the statistical power in order to get an accurate result and a smaller p-value. Secondly, in the tempo condition, because of the small and limited variations of the tempo difference between two versions of the same music excerpt, it created a difficulty for listeners to differentiate the tempo differences and therefore they were hard to rate the 9 emotions on GEM-9, which resulted in vague and non-significant results. As a result, by selecting a piece of music which tempo varies significantly between versions or by widening the range of tempo difference it, would allow exploring the intensity of felt emotions easier and more effective to analyse and get a significant result. Thirdly, the duration of both music stimuli was relatively short which was ineffective in examining the felt emotions on listeners. As suggested by Eeola and Vuoskoski (2013), using a longer stimuli allows listeners to take a longer period to elicit emotions in themselves, so that a more specific emotional response to the music could be evoked, and thus, future research could employ the use of music stimuli lasting longer than 1 minute. Moreover, since this study took place in controlled experimental settings, resulting in a limitation in the use of musical stimuli. Having a live setting so that participants are allowed to choose their own preferred music in future research would enhance their interests, musical familiarity and engagement in the study, leading to a more authentic and convincing response, as shown by Van Der Zwaag et al., (2011). Lastly, only quantitative methodology was used in which the data and results were mainly based on the likert scale and rating of the 9 emotional terms from GEMS-9, leading to the low ecological validity of the data when compared to qualitative methods. Therefore, future research could be improved by conducting experiments using a mixed method which includes both qualitative and quantitative methods, using an open-ended response such as holding interviews since each of the participants has different listening habits and music background, so that they can be more objective in describing and correlating their actual emotions without being bound by the emotional terms selected by researchers.

To conclude, this study explored the effect of tempo and timbre on listeners' felt emotions in which the results support the first hypothesis that tempo can affect listeners' felt emotions. The fast excerpt indicated a statistically significant result in Transcendence, Nostalgia and Peacefulness, while it was unexpected and uncommon for listeners to experience and feel a higher intensity of Sadness in fast excerpts. However, the results contradicted the second hypothesis about the timbre condition, which predicted that the richer and brighter the harmony created by instruments would create a stronger emotional response. It did reveal tendencies that are similar to previous research which suggests that timbre did have an impact on listeners' felt emotions, with the bright and cheerful sound of the violin invoking more happy feelings. Yet, the results are not statistically significant in which the effect of timbre on the listeners' felt emotions was undetermined due to the similar timbral features and the lack of linkage between other musical variables. Despite some of the limitations,

this study contributes to the research into the relationship between music and emotion, in particular, that the findings explicitly demonstrated that tempo and timbre are essential in inducing the felt emotions of listeners, suggesting the implication that listeners are more likely to have greater emotional reactions to music featuring fast tempo and a voice-like instrument.

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