The Effects of Tempo and Tonality on Emotion: A Musicological Approach to Mass Communication Research on Music Effects

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Dedication

I dedicate this thesis to my family. To all my cousins who are scattered around the globe, working and building lives in different countries. To my aunts and uncles who continue to work hard for a better future for their kids. To my grandmother, who I miss dearly, and to my parents and sister, who believe in me more than I ever have. I think of you often, and no matter the distance, I always feel your love and support. I can’t wait for a future in which we can all be together again.

Abstract

The present study's goal was to test the effects of the tempo and tonality of a video's music score on emotions. Emotions were selected from three theoretical frameworks: Posner's two-dimensional model, Balkwill and Thompson's music-oriented basic emotion model, and Zentner et al.'s Geneva Emotion Music Scale (GEMS). By designing this study based on musicology research, this study can speak to music-related research in the mass communication field. It was hypothesized that tempo would have effects on arousal, tonality on valence, and that there would be clearer effects on GEMS than on basic emotions. A 2 (tonality: minor, major) x 2 (tempo: slow, fast) between-subjects experimental design was used, with 470 participants randomly assigned to one of the four conditions. A film music score was transposed for piano and four versions were recorded: Fast in minor key, fast in major key, slow in minor key, and slow in major key. Participants watched a neutrally-valenced video superimposed with the music from their respective condition, followed by a questionnaire addressing their emotions and possible confounding variables. Results indicated that tempo had an effect on arousal and the GEMS emotion of peace, while tonality had an effect on valence, the basic emotion of happiness, and the GEMS emotions of joy, transcendence, nostalgia, and peace, thereby supporting the hypotheses. Finally, individuals with musical proficiency experienced stronger levels of induced emotions, however, music proficiency did not affect tempo and tonality effects. Implications for the mass communication field are discussed further.

Keywords: music, tempo, tonality, dimensional emotions, discrete emotions

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The effects of music have captivated audiences and researchers throughout the centuries. In fact, the study of music effects can be traced back as far as Ancient Greece, where philosophers would often consider the moral and aesthetic implications of music (Mathiesen, 2002). In the modern day, researchers in psychology, marketing, mass communications, public health, and other fields, have tested the effects of music on variables relevant to their fields. For example, researchers in marketing and advertising have strived to understand music's effect on consumer behavior, such as purchase intent (Alpert & Alpert, 1990), and message recall (Fraser, 2013; Shen & Chen, 2006). Researchers in psychology have often focused on how individuals interact with music for desired effects, such as mood repair (Chen et al., 2007) and influencing performances of specific tasks, such as exercise (Sanchez et al., 2014) and work efficiency (Shih et al., 2012). Each field is interested in their respective outcome effects, however, across fields, research on music is conducted because of a belief in one fundamental idea: music has an effect on those who listen to it.

There is one field that is solely dedicated to the study of music and its effects: musicology. The field has officially existed since the late 19th century (Kursell, 2015), although interest in music research has existed for much longer. Musicology draws from various fields including sociology, acoustics, history, mathematics, and in particular, psychology. Consequently, research in musicology has the ability to cover an array of topics. For example, musicology has focused on the role of music in film/television (Cohen, 2015; Kupfer, 2017; Mera & Stumpf, 2014; Wallengren & Strukelj, 2015), the effects of visual and musical congruence (Boltz et al., 2009; Ireland, 2017), and in particular, the effect of music on emotion (Eerola & Vuoskoski, 2011; Makomaska, 2011; Tan et al., 2007; Tesoriero & Rickard, 2012; Västfjäll, 2002). However, what truly separates musicology from other fields that conduct music research, is an in-depth understanding of music itself.

Researchers in fields such as mass communication have not typically incorporated musicological knowledge, such as structural aspects of music, into their research. Instead, mass communication researchers often focus on either the sole presence and/or lack of music in a message (Costabile & Terman, 2013; Hahn & Hwang, 1993; Morris & Boone, 1998; Park & Young, 1986; Sharma, 2011) or on external associations of the music (Ashok et al., 2009; Chen et al., 2007; Hung, 2001; Jacob et al., 2009; Krishen & Sirgy, 2016; Lantos & Craton, 2012; North et al., 2016; Park & Young, 1986; Wagner, 2008; Zhu & Meyers-Levy, 2005). External associations are labels (such as music genre and cultural origin) that individuals assign to music depending on the music's structural qualities (such as modes, instrumentation, tempo, and melodic structure). For example, the Western Classical music genre is often characterized by the use of acoustic western instrumentation and established musical forms (such as sonata form), whereas Eastern Asian music is often associated with the pentatonic scale and the use of east asian instruments, such as the erhu. What makes these associations "external" is that they are dependent on how the listener contextualizes the music's structural qualities, meaning that these labels depend more on the listener's background and less on the qualities of the music itself. That is, these associations are external to the music itself. For example, individuals from Latin America may recognize bossa nova and cumbia as different genres, while someone unfamiliar with this music may simply label both of them as 'Latin' or 'World' music.

By treating music as a dichotomy in experimental research (i.e., there is or there is not music), researchers implicitly hypothesize that any music, even within a specific genre, leads to the same effects, which seems highly unlikely. In addition, by using solely external associations, the researcher is assuming that the reader shares the same understanding of these associations as they do. This is often not the case, as, for example, different cultures perceive genres and cultural associations differently (Mathur et al., 2015). External associations regarding music in mass communication research are often done without in-depth analysis or explanation of how they are selected or achieved. For example, Shen and Chen (2006) conducted a study focused on cultural congruency between music and messages. Although a pilot study was conducted in order to identify the musical pieces with the highest cultural congruity, the study authors did not address the structural qualities of the music they chose and how this could have influenced results. By choosing music purely through uninformed external associations, mass communication researchers are overlooking a rich body of research in musicology that could potentially inform their approach to music effects.

Mass communication research on music has often examined emotion, perhaps in part because music is generally accepted to be evocative. Emotion is considered a primary response to message stimuli. Consistent with this, theories of media effects often treat message-induced emotions as mediators of message effects on other variables such as attitude, purchase intent, recall, and persuasion. For this reason, his study tests the effects of music in a video message on emotions.

Music Research

Musicology research has found that even singular music structural qualities can have observable and significant effects on individuals. Some of these structural qualities include tonality, modality, rhythm, texture, dynamic, and tempo, to name a few. This study focuses on the emotional effects of two of such structural qualities of music: Tonality and tempo.

Tonality (or modality, which is a form of note organization understood to be the predecessor of tonality) has often been perceived as an indicator of emotional valence in music (Costa et al., 2004; Gabrielsson & Lindström, 2010; Hevner, 1935; Mead & Ball, 2007; Parncutt, 2013; 2014; Radford & Heritage, 2015). Based on the western classical tradition, tonality has to do with the practice of composing around a single note, named the tonic. Tonalities are based on the distances between the rest of the tones used in the composition in relationship to the tonic. Importantly, specific tonalities have been used when composing for specific events and occasions based on the idea that particular tonalities match the emotional valence of such events (such as funerals, love songs, or masses). Major tonality has more often been associated with events and emotions that are positive, while minor tonalities have more often been associated with events and emotions that are negative. It is possible for this to be flipped (a sad piece in a major tonality), but this tends to be uncommon.

Tempo is another structural quality of music that has received much attention in musicology research (but much less so if at all outside of musicology research). Tempo is measured through the number of beats per minute (BPM), which indicates the speed a piece is played at. This can be affected by time signatures: If the downbeat is significantly stronger than the upbeats, the music feels slower, and if the upbeats and downbeats are equal, the music feels faster (for example, 6/8 and 3/4 both contain six eighth notes per measures, however the downbeats in 6/8 create the feeling of two larger beats containing three eighth notes each, while 3/4 creates the feeling of 3 larger beats containing two eighth notes each. Essentially, 6/8 often feels slower than 3/4, even if they contain the same number of notes per measure). Previous research that tested the effects of tempo has found that the same music, played at different tempi, can elicit varying emotional responses from subjects (Mote, 2011; Rigg, 1940). Specifically, faster music is perceived to be more positive than slower music.

Emotions Research

Both mass communication and musicology draw, in part, from psychology to inform their theoretical frameworks, particularly in the area of emotions research. This study draws from two psychological emotions frameworks used in musicology: the two-dimensional model and the discrete model of emotion.

The two-dimensional model of emotion (Posner et al., 2005; Russell, 1980) has gained popularity both within mass communication (Fortunati & Taipale, 2012; Mattila & Wirtz, 2000) and musicology emotions research (Schubert, 1999; Witvliet & Vrana, 2006; Zentner et al., 2008). The two-dimensional theory of emotion builds upon the concept that expressed emotions stem from primitive reactions which helped individuals and species survive (Lang et al, 1998). These reactions stem from two basic types of responses to stimulation: appetitive and aversive. Specifically, reflexes responding to external stimuli can either be aversive (running away from predators) or attractive (finding food; Dickinson & Dearing, 1979). This was based on Konorski’s (1967) model which included the same dichotomy, although alternatively labeled as preservative and protective. Researchers have built upon these basic approach and avoidance reactions in order to explain the role of complex emotions (e.g., Gomez & Danuser, 2004; Lang et al, 1998; Thayer, 1989). For example, Posner et al.'s (2005) two-dimensional model proposes that all emotional states reflect some combination of two dimensions, which themselves stem from the approach and avoidance neurophysiological systems: valence (unpleasant - pleasant/negative - positive) and arousal (deactivation - activation). Valence indicates which system (approach or avoidance) will activate; positive valence is argued to induce an approach response while negative valence is argued to induce an avoidance response. Arousal indicates the likelihood that these mechanisms (approach or avoidance) will be acted upon. Specific emotions thus can be seen as a combination of valence and arousal, or as coordinates in the two-dimensional valence-arousal plane (Posner et al., 2005). For example, fear is a combination of negative/unpleasant valence and strong arousal and nervousness is a combination of negative valence but weak arousal. Thus, whereas both fear and nervous have negative valence, fear is more likely to be acted upon than nervousness because fear is felt with strong arousal and nervousness is felt with weak arousal. Consequently, applied to the present research, the two-dimensional model of emotion can tell us whether music that varies in tempo and tonality induces positive or negative emotions and whether these emotions are likely to be consequential, that is, acted upon.

Whereas dimensional emotion models describe emotions in terms of only two characteristics (i.e., arousal and valence), discrete emotion models view emotions as all having unique qualities, that is, emotions are discrete. Discrete emotion models have also been widely used in both mass communication (Kranzbühler et al., 2020; Villegas & Morton, 2020) and musicology (Balkwill & Thompson, 1999; Gabrielsson & Juslin, 1996). In contrast with the two-dimensional model, which maps emotions through two neurophysiological systems, discrete emotion models argue that emotions arise from activation within independent and unique neural pathways of the central nervous system, meaning each emotion maps onto one neural system (Ekman, 1992; Posner et al., 2005). For example, Ekman's discrete model of emotion, also known as the basic emotion model (1992; 1999), proposes five basic emotions: happiness, fear, anger, disgust, and sadness. Discrete emotion models have been used extensively in mass communication emotions research as a theoretical framework through which perceived and induced emotions can be measured as a response to stimuli such as a visual message or ad (Villegas & Morton, 2020).

A number of musicology researchers have argued that Ekman's model does not properly address the diverse spectrum of emotional effects caused by music (Balkwill & Thompson, 1999; Gabrielsson & Juslin, 1996; Zentner et al., 2008). This has led to the creation of music-specific discrete emotion models. For example, Zentner et al. (2008) introduced the domain-specific Geneva Emotion Music Scale (GEMS). Zentner argued that this model was necessary given that the basic discrete emotions function as survival responses to external stimuli, therefore making them high-intensity and the cause of physiological responses. Meanwhile, music is not meant to engage with an individual's evolutionary responses (such as fight or flight), and is not usually followed by goal-oriented responses (such as finding food) (Krumhansl, 1997). It is because of these fundamental differences in emotion-inducing conditions that Zentner used rating sessions among participants to find which emotions were induced by music, and what words would best convey these emotions. The resulting GEMS scale proposes nine discrete music-specific emotions: wonder, transcendence, tenderness, nostalgia, peacefulness, power, joyful activation, tension and sadness. In contrast to a two-dimensional valence-arousal view, these discrete emotions are argued to each be a unique emotional experience. Thus, for example, feeling nostalgic and feeling tenderness are uniquely different experiences even though they are the same in terms of valence and arousal. Applied to the present research, then, discrete emotions models can tell us which unique emotional experiences are induced by music that varies in tempo and tonality.

In conclusion, the two-dimensional models and discrete emotion models propose different views of emotion, and we can view these differences as offering answers to complementary questions. The two-dimensional model can address the question whether music induces positive or negative emotions, and whether these emotions will have consequences (will be acted upon). The discrete model, in contrast, accounts for unique emotional experiences regardless of whether they share similar valence-arousal coordinates in the two-dimensional emotion plane. By using approaches to emotion measurement from these two models, we are able to comprehensively address the goal of this study: to test whether tempo and tonality have actionable approach or avoidance effects (as measured by valence and arousal), and which unique emotions tempo and tonality induce (as measured by discrete emotions). Only a small section of the literature addresses emotions through both models, and consequently, it is only through a combined model that both of these questions can be addressed.

Specifically, this study makes use of the two-dimensional model of emotion (Posner et al., 2005; Russell, 1980), a music-specific version of the basic discrete emotions model (Balkwill & Thompson, 1999), which includes happiness, sadness, tenderness, anger, and fear (Eerola & Vuoskoski, 2011; Juslin, 2000; Kallinen, 2005; Krumhansl, 1997), and the GEMS model (Zentner et al., 2008). The basic discrete emotions model and the GEMS model were both included to understand the extent to which tempo and tonality induce generic emotions and the extent to which tempo and tonality induce music-related emotions.

Putting it all Together: Where Musicology Meets Emotion

Emotions research in musicology is unique in comparison to other fields not only because of its music specific models, but because of its music centered methodology. Musicology understands the importance of every single structural quality of music. Performers, producers, and composers often strive to induce specific emotions in their audiences through the use of specific musical decisions, a majority of which are centered around musical structural qualities. This has resulted in both musical performance practice traditions specific to producing music that will induce specific emotions, and research within musicology, including music theory, that strives to understand these relationships.

According to previous research, tonality and tempo may both have effects on emotion. As stated before, tonality is more generally understood to be an indicator of valence within the western classical tradition. Although there is no consensus in the musicology field regarding why exactly this is, there are various theories surrounding the topic. For example, in his study, Parncutt (2014) explains the seven most popular musical connotation theories, such as dissonance (minor modes have more dissonances, causing acoustic roughness), alterity (major modes and positive emotions are the norm), uncertainty (minor modes have more structural ambiguity), and cultural learning (we associate these modes with specific events and music that have emotional connotations). The present study makes use of the cultural learning theory, which states that the emotional connotations of major and minor tonalities developed as the tonal system was emerging, with composers establishing an emotional vocabulary based on associations. This theory is supported by two musicology bodies of research. One looks at how different cultures have their own understanding of musical emotional valence depending on the emotional vocabulary and modes their musical tradition has developed throughout history (Mathur et al., 2015), and the other looks at how young children are unable to assign emotional valence to musical modes, a skill which they learn later in their childhood (Dalla Bella et al., 2001). This study assumes the relationship between major and minor tonalities with positive and negative valence respectively because the western tonal tradition is essentially built upon this relationship, both from the audience and from the composer's viewpoints.

Whereas tonality has been argued to influence valence, tempo is often understood to be an indicator of arousal (Bramley et al., 2016; Droit-Volet et al., 2013; Husain et al., 2002; Kellaris & Kent, 1994; Ramos, 2011; Zwaag et al., 2011). Tempo has been theorized to have effects on arousal for many reasons. Perhaps the most prominent theory regards tempo recognition as an evolutionary skill. Tempo has been found to be applicable to many different life contexts and experiences (such as being lulled by a rocking sensation, or understanding that fast steps means something is approaching), and the ability to process tempo has been found to be acquired early on in life (Dalla Bella, et al., 2001). This theory consequently explains why tempo has strong physiological effects on humans, such as increased heart and breathing rates in faster tempos (Lundin, 1985), and the increase in cognitive load that can result from increased tempo (Oakes, 2003). In conclusion, the effects of tempo have foundations within human evolution and cognition, meaning that a faster tempo results in heightened reactions at both the physiological and psychological levels, in other words, arousal.

Note, however, that tempo has also been found to influence emotional valence, with faster tempo being associated with positively valenced emotions and slow tempo with negatively valenced emotions (Hevner, 1937; Mote, 2011; Rigg, 1940). These effects do not readily fit within the evolutionary purposes of tempo recognition. We can speculate, however, the relevance of Zuckerman's sensation seeking theory (1978). Sensation seeking theory proposes that all people need some level of stimulation - or arousal. Whereas people differ from each other in how much arousal they find pleasant, everyone needs some level of arousal, satisfying their need for arousal through a variety of experiences, including music. For example, Morgan and colleagues (2003) found that high sensation seekers prefer fast-paced music. It therefore is possible that faster tempo, and therefore higher arousal, is related to more positive valence. I will test this possibility in the present research.

The combined structural qualities of tempo and tonality have been researched in a variety of contexts. Specifically, a portion of the literature focuses on how tempo and tonality mediate the effects of emotions on a variety of independent variables. For example, Droit-Volet et al. (2013) conducted a study aimed at understanding how tempo and tonality affected time perception through valence and arousal. The study found that tempo and tonality were both indicators of time perception, as listening to music that induced positive valence and high arousal leads to shorter time estimates. Another example is the study by Husain et al. (2002) which focused on how spatial ability is influenced by the valence and arousal induced by tonality and tempo respectively. The study found that spatial ability is improved when valence is positive and arousal is high, meaning that participants did best when listening to fast music in a major tonality. These example studies used tonality as an indicator for valence and tempo as an indicator for arousal in order to induce specific effects on independent variables, such as time perception, spatial ability, and purchase intent (Knoferle et al., 2012).

In contrast, another portion of the literature has focused on the relationship between tempo and tonality, and in some cases other structural qualities as well, and how their combined use affects perceived and induced emotions, both at the psychological and physiological levels (Dalla Bella et al., 2001; Gagnon & Peretz, 2010; Peretz et al., 1998; van der Zwaag e al., 2011; Webster & Weir, 2005). In regards to valence and arousal, all of these studies concur that tonality and tempo affect valence and arousal respectively. However, their results do not concur regarding the relationship between the two. For example, Peretz et al. conducted a study that measured emotional responses to tempo and tonality in patients with brain damage (1998). Their results indicated that whereas brain damage had little to no effect on participant’s abilities to perceive valence and arousal in music, both mode and tempo were indicators of valence, yet mode was a stronger indicator than tempo. In contrast, a study by Gagnon and Peretz that focused on the effects of tempo and mode specifically found that tempo was a stronger indicator of valence than tonality (2010). These findings indicate the continued need to test the effects of tempo and tonality on valence and arousal in order to understand and explain the hierarchy of effects regarding specific musical structural qualities.

The present study builds on the literature supporting tonality as a stronger indicator of valence than tempo. This decision is based on the cultural learning theory, given that the classical western tradition tends to prioritize tonality as an indicator of valence over tempo, and as a result, composers tend to write and perform music with this intention in mind. The result is a repertoire where a vast majority of pieces use tonality as a main indicator of their valence, and an audience's ear is cultivated to understand this relationship.

In conclusion, this study builds upon the tempo and tonality research to construct the following hypotheses regarding valence and arousal:

H1a: Music in a major tonality and in a fast tempo will induce more positively valenced and higher arousal emotions than music in minor tonalities and/or with slow tempo.

H1b: Music in a minor tonality and a slow tempo will induce more negatively valenced and lower arousal emotions than music in major tonalities and/or with faster tempo.

H1c: Music in a major tonality and a slow tempo will induce more positively valenced emotions than music in minor tonalities, but will induce lower arousal than music in a fast tempo.

H1d: Music in a minor tonality and a fast tempo will induce more negatively valenced emotions than music in major tonalities, but will induce higher arousal emotions than music in slow tempo.

Regarding discrete emotions, previous literature in musicology has found that different modalities and tempos, both independently and in combination, can induce specific discrete perceived emotions (Ramos, 2011; Trochindis & Bigand, 2013). For example, Ramos found that major tonalities (specifically, the Ionian mode) are associated with discrete emotions such as happiness, while minor tonalities (specifically the Dorian and Aeolian modes) are associated with sadness (2011). Additionally, the study conducted by Trochidis and Bigand (2013) found that major tonalities with fast tempo were often associated with happiness, major tonalities with slow tempo associated with serenity, minor tonalities with fast tempo associated with anger, and minor tonalities with slow tempo associated with sadness. However, although there is research that tested the effects of tonality and tempo on some discrete emotions, to the best of my knowledge there has not been research that looks at how tonality and tempo affect both arousal and valence (i.e., the actionable approach or avoidance effects) as well as music-specific discrete emotions (i.e., the unique emotions that tempo and tonality induce). It is therefore the goal of this study to address the effects of tonality and tempo in both emotional frameworks.

Given that, to the extent of my knowledge, no previous research has dealt with the basic and GEMS emotions in terms of tonality and tempo, I will therefore ask the following research question:

R1: How do tempo and tonality affect basic and GEMS emotions?

It stands to reason that emotions that have been identified as specific to music may be more likely to be affected by tempo and tonality than basic emotions. I thus expect:

H2: Tempo and tonality will have clearer effects on GEMS emotions than on basic emotions.

Accounting for Confounding Variables

I have argued for why tempo and tonality should affect emotions. However, in the context of music research, these effects may be contingent on a number of variables. One possible variable is musical proficiency. Musical proficiency can be defined as the level of western classical tradition musical education an individual has received. This can include learning instruments and studying music theory and/or history. Musically trained individuals are often able to identify musical qualities such as the tonality of a piece or melody. Given that major tonalities have often been associated with positively valenced emotions and vice versa for minor tonalities, it is possible that musically trained individuals will ignore tempo, identify a tonality, and assign an emotional valence to it, therefore becoming influenced by the emotion they believe they should be experiencing. The second variable is liking. Liking can be defined as the degree that an individual likes an object/behavior. Although film music was chosen to reduce the level of liking and familiarity influences, the study included liking towards the music/video in order to ensure that emotional valence was not influenced by liking, as previous research has found them to be separate constructs (Schubert, 2007). Attitude towards the video's content was included as a third variable in order to understand if a video induces more positive emotions if people like the video, i.e., have a positive attitude towards the video content. The final variable included was mood. In the context of this study, mood was defined as the participant's current affective state (Knobloch, 2003). This study was conducted during the 2020 COVID-19 pandemic, during which many individuals suffered from physical and mental health related issues and conditions. As such, it is possible that at least some participants' mood was subdued, and because mood is relevant for emotions that people feel in response to external stimuli, I examined participants' mood.

Overall, the previous variables were incorporated to ensure any possible confounding variables were accounted for, leading to the following research questions:

R2: Do musically trained individuals experience different induced emotions than non-musically trained individuals when listening to the same music?

R3: Do liking and emotional valence function as separate constructs, as found by previous research?

R4: Is there a relationship between attitude and emotional valence?

R5: Is there a relationship between mood and emotional valence?

Method

Design

A 2 (tonality: minor, major) x 2 (tempo: slow = <120bpm, fast = >180bpm) between-subjects experimental design was implemented, resulting in four conditions: major tonality in fast tempo, major tonality in slow tempo, minor tonality in fast tempo, and minor tonality in slow tempo. The four tonality x tempo sets were superimposed on the same video (see stimulus material for a detailed description of the video). Dependent variables included discrete and dimensional emotions, and covariates included musical proficiency, attitude, liking, and mood.

Participants

Five hundred participants from MTurk participated in the study in exchange for 1.25 USD. Responses from 24 participants were excluded because they failed an audio-check, suggesting they would not be able to listen to the music. The final sample included 470 participants (229 female, 235 male, 3 non-binary/genderqueer, and 3 who did not specify), with a mean age of 33.1 years (SD = 10.66). MTurk hosts studies under the label "Human Intelligence Task" (HIT). The present study was posted on May 12, 2020 and excluded individuals under the age of 18 and non-English speakers. Eligible workers had to demonstrate a 98% approval rating and between 100 and 500 approved HITs. These restrictions were placed in order to exclude professional survey takers and participants who would not pay attention to the tasks.

Procedure

MTurk participants who chose to participate in the study were redirected from MTurk to a Qualtrics survey on the device of their choice. Participants began the study after reading a brief introduction and signing a digital consent form, after which they were asked basic demographic questions. Participants were then asked to put on earphones and complete an audio-fidelity check in order to ensure volume levels were appropriate, after which they were randomly assigned to one of the four conditions. Participants then observed the video with their assigned music. Next, they were asked to complete a questionnaire regarding the emotions induced by the video. After completing the questionnaire, participants were compensated 1.25 USD for their time. Data was collected through the use of Qualtrics.

The questionnaire began with two items addressing the discrete (wonder, transcendence, tenderness, nostalgia, peacefulness, power, joyful activation, tension and sadness) and dimensional (arousal and valence) emotions the participants experienced after observing the video. The following nine items addressed the participant's liking towards the videos and music in the video. This section measured participant's attitudes towards the activities portrayed in the video, as well as the participant's liking towards the music. The following four items focused on measuring the participant's level of musical expertise, as well as their familiarity with the music used in the video. Finally, the last two items were included as mood checks in order to measure the participant's emotional state before the video.

Stimuli

Visuals

The visuals in the constructed video were purposely neutrally-valenced. The royalty-free clips used included no facial expressions and/or objects that could induce emotional valence. The videos chosen included a close up of a hand painting a door white with a brush, a close up of two hands cutting through paper with an exacto knife, two hands cutting an apple with a knife, a close up of a bike wheel turning, and a close up of a hand painting a bench with a roller. The resulting video was one minute long and remained the same across all four conditions.

Music

There is no consensus among musicology researchers regarding what music to use as stimuli for research. A majority of previous studies used recognizable Western classical music pieces (Alpert & Alpert, 1990; Costa et al., 2005; Dalla Bella et al., 2001; Gomez & Danuser, 2004; Husain & Thompson, 2002; Jeong et al., 2011; Khalfa, 2008; Krumhansl, 1997; Kupfer, 2017; Mitterschiffthaler et al., 2007; Tamir & Robinson; 2007; Ziv et al., 2011), while a number of other previous studies used pop songs/commercial music (Boltz et al., 2009; Chen et al., 2007; Fraser & Bradford, 2013; Park & Young, 1986), film music (Costabile & Terman, 2013; Eerola & Vuoskoski, 2011; Ireland, 2015), and cultural-specific music (Spanish, Brazilian, etc.) (Balkwill & Thompson; Lalwani et al., 2009). According to Eerola and Vuoskoski (2011), non-recognizable film music often lacks preference and familiarity influences from individuals, making it a relatively ‘neutral’ stimulus material. For example, individuals may have pre-existing attitudes towards specific music genres or cultures. However, film music tends to remain relatively neutral across individuals, as long as it is not recognizable (eg. the Star Wars film score).

The music used for this study was a short piece composed using the transcribed melody of “Journey to Peru” from the film *Paddington* (2014). The music was also purposely lyric-less to avoid verbal emotional cues. The film music was transcribed onto a short composition on the piano in order to create matching instrumentation across all four conditions. This avoids unintended influence of differences in instrumentation. The piece is in F major and 3/4 (meaning three quarter notes per measure), with a bpm of 114 for each quarter note. Although 114 bpm may be considered to be a fast tempo, the melody of this piece treats the first beat as a down beat and the second and third beats as upbeats, meaning that the piece feels slower because the listener identifies one strong beat per measure instead of three. Consequently, the piece can be considered to be in 38 bpm, however, for the sake of performance practice, the annotated bpm was kept at 114.

After transcribing the melody and composing the short piece, it was recorded on an acoustic piano at 225 bpm (fast) and 114 bpm (slow). It was then transcribed into its parallel minor (F minor) and recorded in the same tempi on the same instrument. The result was four recordings: major tonality in fast tempo, major tonality in slow tempo, minor tonality in fast tempo, and minor tonality in slow tempo. In order for the slow tracks to match the length of the fast tracks, the initial section of the piece was repeated in the fast tracks in order to increase its time length without creating additional material.

Measures

Video-Induced Valence and Arousal

Valence and arousal were measured with two items each using seven point semantic differential scales. Following the stem "Viewing this video made me feel…", two valence items used Positive/Negative and Pleased/Displeased anchors ($r = 0.692$), while two arousal items used Calm/Excited and Relaxed/Tense anchors ($r = 0.712$). The two valence items were averaged to create a valence scale, and the two arousal items were averaged to create an arousal scale.

Discrete Emotions

Both the Basic Emotions and the GEMS emotions were measured through seven point Likert scales (1 = Not at All, 7 = Extremely). The Basic emotions were measured by prompting the participants: "Viewing the video made me feel: Happy, Sad, Tender, Fearful, Angry". The GEMS scale was measured in a similar manner: "Viewing the video made me feel: Wonder , Transcendence, Nostalgia, Peacefulness, Power, Joyful, Tension”. Because I am interested in effects on specific discrete emotions, these items were not scaled but analyzed as individual (but possibly correlated) items.

Video Liking

Three items measured liking towards the video using seven point Likert scales (1 = disagree, 7 = agree). The items included the statements “I liked the video.”, “The video was beautiful.”, and “I would watch this video again.” All three items were correlated (Liked and Beautiful $r = 0.664$; Liked and Rewatch 0.678; Beautiful and Rewatch 0.600) and had high reliability (Cronbach’s $\alpha = 0.835$). The three liking items were combined to create a general video liking scale.

Attitude

Attitude was measured through seven point Likert scales (1 = disagree, 7 = agree). Two items were included, with the first item asking how positive participants felt towards the activities in the video, and then how negative.

Music Liking

Liking towards music was measured through two items using seven point Likert scales with anchors of Not at All/Extremely and addressed the extent to which participants thought the music was appropriate for the video, how engaging they believed the music was, and how much they liked the music.

Music Perceived Valence and Arousal

Music’s perceived emotional valence was measured through a seven point semantic differential scale with anchors including Extremely Sad/Extremely Happy. The music’s perceived arousal was measured through seven point semantic differential scales with anchors including Extremely Relaxing/Extremely Exciting and Extremely Calm/Extremely Tense ($r = 0.679$). The two arousal items were averaged to create a single perceived arousal scale. An additional item measuring the music's perceived speed, measured through a seven point Likert scale with anchors of Slow/Fast, was used to understand the relationship between arousal and perceived music speed.

Musical Proficiency

Musical proficiency was measured through a single multiple choice item which asked for participants to self-report their previous musical education/experience. Options included applied instrumental education at an early age (continued or discontinued), music theory and/or history education beyond the highschool level, and ear training beyond the highschool level, as well as two options including "None of the above" and "Other:". Musical proficiency was computed into a single indicator variable: 1 = those with musical proficiency and 2 = those without (which included "Applied instrumental education at an early age: discontinued", "None of the above", and select instances of "Other").

Mood

A mood check was included at the end of the questionnaire in order to assess the participant's emotional state before observing the video. Four items measured through semantic differential scales addressed the participant's emotional state according to anchors of calm/stressed, negative/positive, at loss/in control, and unmotivated/motivated to express how they generally felt the week before participating in the study and immediately before the study. Given the strong correlations between respective items at the weekly and day level (calm/stressed $r = 0.611$, negative/positive $r = 0.674$, at loss/in control $r = 0.668$, unmotivated/motivated $r = 0.677$) mood items with identical anchors were combined to create four overall mood items.

Analysis Plan

In order to test whether tonality and tempo affect emotions, I will run two sets of analysis of variance (using General Linear Model, or GLM procedures). In both sets of GLM analyses, tempo and tonality will be independent variables. In a first set, valence and arousal will be dependent variables. In a second set, the basic discrete and GEMS discrete emotions will be dependent variables. Given that two of the discrete emotions included in the GEMS model are also part of the basic emotions model (tenderness and sadness), they were excluded from the GEMS items to avoid repetition and will be analyzed as part of the basic emotions before being discussed in the context of both models. Univariate GLMs will be used if the dependent variables are not correlated with each other. If the dependent variables are correlated, then I will use multivariate GLMs to control for the family-wise Type I error rate.

Individual chi-square tests will be run to test the relationship between the items of music/video liking and valence to ensure independence between the two constructs. Multivariate GLM analysis will also be used to test whether emotions (both discrete and dimensional) systematically vary by musical liking, musical proficiency, musical familiarity and moods (all individually). This will be done across conditions in order to understand the relationships between these items and reported induced emotions.

Results

Descriptive Statistics

Reported Emotions

Table 1 presents means, standard deviations and correlations between the study's key variables across all four conditions. Regarding dimensional emotions, emotional valence tended to lean towards more positive valence, *M* = 5.53 on a 7-point scale and *SD* = 1.22, while emotional arousal tended to lean towards lower arousal, *M* = 2.80 on a 7-point scale and *SD* = 1.76. Valence and arousal were moderately correlated (r = -0.21).

Table 1
Key Variables: Means, standard deviations, and correlations.

Correlations

Measure	M	SD	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Valence	5.53	1.22	-0.206	0.557	-0.039	0.325	0.022	0.009	0.363	0.387	0.291	0.566	0.32	0.453	-0.087
2. Arousal	2.80	1.76		0.168	0.65	0.165	0.737	0.736	0.27	0.294	0.277	-0.25	0.492	0.231	0.716
3. Happy	4.75	1.534			0.201	0.471	0.305	0.279	0.571	0.608	0.442	0.511	0.606	0.714	0.217
4. Sad	2.19	1.702				0.363	0.801	0.788	0.373	0.378	0.378	-0.026	0.45	0.236	0.721
5. Tender	4.08	1.775					0.33	0.304	0.468	0.451	0.489	0.388	0.389	0.396	0.271
6. Fear	1.99	1.731						0.89	0.413	0.454	0.384	0.012	0.572	0.332	0.815
7. Anger	1.86	1.644							0.371	0.44	0.345	0.009	0.55	0.316	0.79
8. Wonder	4.14	1.819								0.61	0.58	0.355	0.592	0.595	0.362
9. Transcendence	3.87	1.755									0.49	0.374	0.636	0.612	0.374
10. Nostalgia	4.33	1.717										0.364	0.46	0.486	0.346
11. Peace	5.46	1.419											0.251	0.444	-0.128
12. Power	3.10	1.928												0.638	0.502
13. Joy	4.30	1.716													0.248
14. Tension	2.24	1.794													

Regarding discrete basic emotions, happy and tender were reported around scale midpoints, whereas sadness, fear, and anger were low. The GEMS emotions of wonder, transcendence, nostalgia, and joy generally resided around scale midpoints, while power and tension were generally lower, and peace was higher. Overall, a majority of the emotions variables were either moderately or highly correlated to each other. Valence was found to be highly correlated to happiness (r = 0.577) and peace (r = 0.566), and similarly valenced emotions were often highly correlated, such as happiness with wonder (r = 0.571) and joy (r = 0.714), and sadness with fear (r = 0.801), anger (r = 0.788), and tension (r = 0.721).

Table 2
Perceived Musical Valence/Arousal: Means, standard deviations, and correlations.

Measure	M	SD	2	3	4	5
			Correlations			
1. Valence	5.53	1.221	-0.206	0.400	-0.114	0.082
2. Arousal	2.80	1.758		0.159	0.724	0.518
3.Music was Sad/Happy	4.96	1.372			0.250	0.132
4. Music was Slow/Fast	3.70	1.338				0.580
5. Music Arousal Low/High	2.81	1.692				

Liking

Table 3 presents means, standard deviations and correlations between the study's liking variables across all four conditions. Overall, participants tended to have positive liking towards the video, *M* = 5.19 on a 7-point scale and *SD* = 1.216, and positive attitudes towards the activities demonstrated in the video, *M* = 5.58 and *SD* = 1.122. Liking and positive attitude were highly correlated (r = 0.557). Additionally, participants thought the music across all four conditions was engaging, *M* = 5.01 and *SD* = 1.242. Finally, the

Table 3
Liking Variables: Means, standard deviations, and correlations.

Measure	M	SD	2	3	4	5	6
			Correlations				
1. Liking	5.19	1.216	0.705	-0.078	0.478	0.498	0.602
2. Positive Attitude	5.58	1.122		-0.284	0.4	0.434	0.478
3. Negative Attitude	2.20	1.680			0.057	-0.129	-0.079
4. Music is Unengaging/Engaging	5.01	1.242				0.329	0.477
5. Music is Appropriate	5.77	1.316					0.543
6. Liked Music	5.63	1.263					

music was deemed appropriate for the video, *M* = 5.77 and *SD* = 1.316, and generally liked across all four conditions, *M* = 5.63 and *SD* = 1.263. Music appropriateness and liking were correlated with each other (r = 0.543), as well as music liking and video liking (r = 0.602).

Musical Proficiency

From the 170 participants, 52.6% reported having little to no musical proficiency, while 47.4% indicating having specified musical training indicating their musical proficiency (Table 4).

Table 4
Musical Proficiency: Frequencies and percentages.

Musical Proficiency	Frequency (N = 470)	Percentage
Musically Proficient	223	47.4
Not Musically Proficient	247	52.6

Mood

Table 5 presents means, standard deviations and correlations between participant's reported moods across all four conditions. At the weekly level, participants reported feeling at the midway of a 7-point scale for all four items. At the pre-study level, participants reported being slightly calmer (*M* = 3.77 and *SD* = 1.736), more positive (*M* = 4.74 and *SD* = 1.468), more in control (*M* = 4.78 and *SD* = 1.445), and more motivated (*M* = 4.54 and *SD* = 1.579) across all four conditions, indicating slightly more positive moods at the pre-study level. In conclusion, participants reported generally moderately positive mood, indicating that no extreme mood was present before the study was taken that could potentially skew reported emotions.

Table 5
Mood Variables: Means, standard deviations, and correlations.

			Correlations						
Measure	M	SD	2	3	4	5	6	7	8
1. Week's Mood is Calm/Stressed	4.18	1.823	-0.482	-0.435	-0.351	0.611	-0.338	-0.313	-0.25
2. Week's Mood is Negative/Positive	4.45	1.617		0.749	0.699	-0.229	0.674	0.567	0.582
3. Week's Mood is At Lost/In Control	4.40	1.622			0.68	-0.212	0.597	0.668	0.573
4. Week's Mood is Unmotivated/Motivated	4.41	1.779				-0.124	0.537	0.501	0.677
5. Day's Mood is Calm/Stressed	3.77	1.736					-0.399	-0.308	-0.212
6. Day's Mood is Negative/Positive	4.74	1.468						0.695	0.662
7. Day's Mood is At Lost/In Control	4.78	1.445							0.666
8. Day's Mood is Unmotivated/Motivated	4.54	1.579							

Familiarity

A total of 152 participants (32.3%) found the music from the video familiar, but none were able to identify it.

Hypothesis Tests

Hypothesis 1. Tonality and tempo as indicators of valence and arousal.

Because of the correlations between the emotion items, I used a multivariate GLM procedure to test for the effects of Tempo and Tonality on the three different emotions models across the four conditions (Table 6). Tonality had a statistically significant multivariate effect on Arousal and Valence (F (2, 465) = 4.895, p = 0.008; Wilk's Λ = 0.979, partial $\eta 2$ = 0.021), as did Tempo (F (2, 465) = 3.275, p = 0.039; Wilk's Λ = 0.986, partial $\eta 2$ = 0.014). There was no multivariate interaction effect. Univariate effects demonstrated that tempo had a strong effect on arousal, with fast tempos inducing stronger arousal (M = 3.006) than slow tempo (M = 2.596, p = 0.011). There was no tempo effect on valence. Tonality had a strong effect on valence; major tonality induced more positive valence (M = 5.701) than minor tonality (M = 5.354, p =

0.002). There was no tonality effect on arousal. In conclusion, tonality had strong effects on valence and tempo on arousal, consequently supporting Hypotheses 1.1-1.4.

Tonality had a significant multivariate effect on the basic emotions (F (5, 462) = 5.898, p < 0.001; Wilk's Λ = 0.940, partial $\eta 2$ = 0.060). Tempo had no multivariate effect (F (5, 462) = 0.762, p = 0.577; Wilk's Λ = 0.992, partial $\eta 2$ = 0.008), nor was there an interaction effect (F (5, 462) = 1.151, p = 0.332; Wilk's Λ = 0.988, partial $\eta 2$ = 0.012). At the univariate level, Tonality had an effect on Happiness (F = 16.037); participants in the major tonality condition reported feeling happier (M = 5.031) than participants in the minor tonality condition (M = 4.473, p < 0.001). Tonality had no effects on Sadness, Tenderness, Fear and Anger. In conclusion, tonality only had effects on one of the basic emotions: happiness (Table 7).

Hypothesis 2. Tempo and tonality will have clearer effects on GEMS emotions than on basic emotions.

Regarding the GEMS emotions, both Tonality (F (7, 460) = 3.475, p = 0.001; Wilk's Λ = 0.950, partial $\eta 2$ = 0.050) and Tempo (F (7, 460) = 2.346, p = 0.023; Wilk's Λ = 0.966, partial $\eta 2$ = 0.034) had statistically significant multivariate effects (Table 9). However, there was no interaction effect (F (7, 460) = 0.876, p = 0.525; Wilk's Λ = 0.987, partial $\eta 2$ = 0.013). At the univariate level, Tonality had effects on peace (F = 11.661), with music in major tonalities inducing more peace (M = 5.678) than minor (M = 5.238, p = 0.001), joy (F = 11.142), with major tonalities inducing more joy (M = 4.558) than minor (M = 4.035, p = 0.001), transcendence (F = 4.296), with major tonalities inducing more transcendence (M = 4.033) than minor (M = 3.698, p = 0.039)

Table 6
Multivariate analysis of variance summary for message condition effects on valence and arousal.

Multivariate Effect					Univariate Effects								
	F	*df*	*p*	η_p^2		*F*	*df*	*p*	η_p^2	Means			
Tonality	4.895	2, 465	0.008	0.021						Major	Minor	Fast	Slow
					Valence	9.650	1.000	0.002	0.020	5.701	5.354		
					Arousal	0.057	1.000	0.811	<0.001	2.782	2.820		
Tempo	3.275	2, 465	0.039	0.014									
					Valence	0.718	1.000	0.397	0.002			5.481	5.575
					Arousal	6.450	1.000	0.011	0.014			3.006	2.596
Tonality x Tempo	0.224	2, 465	0.800	0.001						Major	Minor		
					Valence	0.355	1.000	0.552	0.001	5.621	5.340	Fast	
										5.782	5.368	Slow	
					Arousal	0.176	1.000	0.675	<0.001	3.021	2.992	Fast	
										2.543	2.649	Slow	

Table 7
Multivariate analysis of variance summary for message condition effects on basic emotions.

	Multivariate Effect				Univariate Effects								
	F	*df*	*p*	η_p^2		*F*	*df*	*p*	η_p^2	Means			
Tonality	5.898	5, 462	<0.001	0.060						Major	Minor	Fast	Slow
					Happy	16.037	1.00	<0.001	0.033	5.031	4.473		
					Sad	1.756	1.00	0.186	0.004	2.082	2.290		
					Tender	0.339	1.00	0.339	0.002	4.159	4.002		
					Fear	0.720	1.00	0.720	<0.001	2.020	1.962		
					Angry	0.263	1.00	0.263	0.003	1.947	1.777		
Tempo	0.762	5, 462	0.577	0.008									
					Happy	1.440	1.00	0.231	0.003			4.668	4.836
					Sad	0.207	1.00	0.650	<0.001			2.222	2.150
					Tender	0.032	1.00	0.858	<0.001			4.066	4.095
					Fear	0.278	1.00	0.599	0.001			2.033	1.949
					Angry	0.960	1.00	0.328	0.002			1.936	1.788
Tonality x Tempo	1.151	5, 462	0.332	0.012						Major	Minor		
					Happy	0.315	1.00	0.575	0.001	4.908	4.429	Fast	
										5.154	4.518	Slow	
					Sad	3.218	1.00	0.073	0.007	2.258	2.185	Fast	
										1.906	2.395	Slow	

		Tender	1.402	1.00	0.237	0.003	4.242	3.891	Fast
							4.077	4.114	Slow
		Fear	0.999	1.00	0.318	0.002	2.142	1.924	Fast
							1.897	2.000	Slow
		Angry	1.579	1.00	0.210	0.003	2.117	1.756	Fast
							1.778	1.798	Slow

Table 8
Multivariate analysis of variance summary for message condition effects on the GEMS scale emotions.

Multivariate Effect					Univariate Effects								
	F	*df*	*p*	η_p^2		*F*	*df*	*p*	η_p^2	Means			
Tonality	3.475	7, 460	0.001	0.050						Major	Minor	Fast	Slow
					Wonder	0.056	1.000	0.814	<0.001	4.157	4.117		
					Transcendence	4.296	1.000	0.039	0.009	4.033	3.698		
					Nostalgia	3.317	1.000	0.069	0.007	4.472	4.184		
					Peace	11.661	1.000	0.001	0.024	5.678	5.238		
					Power	1.974	1.000	0.161	0.004	3.226	2.977		
					Joy	11.142	1.000	0.001	0.023	4.558	4.035		
					Tension	1.022	1.000	0.312	0.002	2.155	2.323		
Tempo	2.346	7, 460	0.023	0.034									
					Wonder	0.514	1.000	0.474	0.001			4.197	4.076

					Transcendence	0.971	1.000	0.325	0.002			3.945	3.786
					Nostalgia	0.201	1.000	0.654	<0.001			4.363	4.293
					Peace	6.995	1.000	0.008	0.015			5.288	5.628
					Power	1.232	1.000	0.268	0.003			3.200	3.003
					Joy	0.484	1.000	0.487	0.001			4.351	4.242
					Tension	0.021	1.000	0.884	<0.001			2.251	2.227
Tonality x Tempo	0.876	7, 460	0.525	0.013						Major	Minor		
					Wonder	1.192	1.000	0.275	0.003	4.125	4.188	Fast	
										4.269	3.965	Slow	
					Transcendence	0.003	1.000	0.956	<0.001	4.117	3.949	Fast	
										3.773	3.623	Slow	
					Nostalgia	<0.001	1.000	0.992	<0.001	4.508	4.436	Fast	
									<0.00	4.218	4.149	Slow	
					Peace	0.806	1.000	0.370	0.002	5.450	5.906	Fast	
										5.126	5.351	Slow	
					Power	0.008	1.000	0.927	<0.001	3.333	3.120	Fast	
										3.067	2.886	Slow	
					Joy	2.053	1.000	0.153	0.004	4.500	4.615	Fast	
										4.202	3.868	Slow	
					Tension	0.484	1.000	0.487	0.001	2.225	2.085	Fast	
										2.227	2.368	Slow	

and nostalgia (*F* = 3.317), with major tonalities inducing more nostalgia (*M* = 4.472) than minor (*M* = 4.184, *p* = 0.069).

In contrast, tempo only had an effect on Peace (*F* = 6.995), with slow tempo inducing more peace (*M* = 5.628) than fast tempo (*M* = 5.288, *p* = 0.008). No other effects were observed, including the emotions of sadness and tenderness shared with the basic emotions model (Table 8). In conclusion, there were effects on four out of the seven discrete GEMS scale emotions, two of which are related to positive valence (peace and joy), and two that are more ambiguous (nostalgia and transcendence). The results indicate that four of the nine emotions in the GEMS scale were used in reporting induced emotions, resulting in clearer effects on the GEMS rather than the basic emotions, therefore supporting Hypothesis 2.

Research Question 2. The effects of musical proficiency on reported emotions.

In order to analyze the relationship between musical proficiency and reported emotions, distribution of musically-proficient and non-proficient participants in each condition was first conducted to ensure even distribution (Table 9). After ensuring even distribution, a MANOVA was run to test the effect of musical proficiency on reported emotions. The results demonstrated a multivariate effect on all emotions, dimensional and discrete, except for peace (*F* = 1.372). In particular arousal (*F* = 29.068) with a mean difference of 0.85, happiness (*F* = 23.758) with a mean difference of 0.675, fear (*F* = 50.762) with a mean difference of 0.981, anger (*F* = 34.785) with a mean difference of 0.865, transcendence (*F* = 24.879) with a mean difference of 0.789, power (*F* = 33.444) with a mean difference of 0.996, and tension (*F*= 32.948) with a mean difference of 0.97.

Table 9 Musical Proficiency: Frequencies and percentages.			
Condition	Musical Proficiency	Frequency (N = 470)	Percentage
Major - Fast	Has Musical Proficiency	64	13.62
	No Musical Proficiency	61	12.98
Major - Slow	Has Musical Proficiency	56	11.91
	No Musical Proficiency	59	12.55
Minor - Fast	Has Musical Proficiency	46	9.79
	No Musical Proficiency	65	13.83
Minor - Slow	Has Musical Proficiency	57	12.13
	No Musical Proficiency	62	13.19

Overall, musically proficient participants reported higher levels of each emotion, dimensional and discrete, than their non-proficient counterparts (Table 10).

Research Question 3. Are liking and reported valence different constructs?

Liking was included to test whether liking and valence are correlated, as previous research has found them to be separate constructs (Schubert, 2007). In this study, these variables were highly correlated (r = 0.653, $p < 0.001$), but not so high as to suggest that they reflect the same concept (Table 11).

Table 11
Valence and Liking: Means, standard deviations, and correlations.

			Bivariate Correlations	
			2. Liking	
Measure	M	SD	r	*p*
1. Valence	5.53	1.221	0.653**	<0.001
2. Liking	5.19	1.216		

** Correlation is significant at the 0.01 level (2-tailed).

Table 10
Multivariate analysis of variance summary for musical proficiency effects on reported emotions.

Multivariate Effect					Univariate Effects						
	F	*df*	*p*	η_p^2		*F*	*df*	*p*	η_p^2	Means	
Musical Proficiency	4.173	14, 455	<0.001	0.114						Proficient	Non-Prof
					Arousal	29.068	1	<0.001	0.058	3.251	2.401
					Valence	7.565	1	0.006	0.016	5.691	5.383
					Happy	23.758	1	<0.001	0.048	5.108	4.433
					Sad	25.505	1	<0.001	0.052	2.592	1.818
					Tender	8.943	1	0.003	0.019	4.336	3.850
					Fear	40.762	1	<0.001	0.080	2.507	1.526
					Angry	34.785	1	<0.001	0.016	2.318	1.453
					Wonder	17.139	1	<0.001	0.035	4.498	3.814
					Transcendence	24.879	1	<0.001	0.050	4.283	3.494
					Nostalgia	12.323	1	<0.001	0.026	4.619	4.069
					Peace	1.372	1	0.242	0.003	5.538	5.385
					Power	33.444	1	<0.001	0.067	3.628	2.632
					Joy	15.093	1	<0.001	0.031	4.619	4.012
					Tension	32.948	1	<0.001	0.066	2.722	1.802

Research Question 4. Effect of attitude on reported valence.

Positive attitude was found to have a strong correlation with valence (r = 0.621, *p* <0.001), while negative attitude has a slight negative correlation (r = -0.142, *p* = 0.002). The results indicate that attitude does have an effect on valence, specifically, positive attitude will result in higher reported valence and negative attitude will result in a lower reported valence (Table 12).

Table 12
Valence and Attitude: Means, standard deviations, and correlations.

			Bivariate Correlations			
			2. Positive Attitude		3. Negative Attitude	
Measure	M	SD	r	*p*	r	*p*
1. Valence	5.53	1.221	0.621**	<0.001	-0.142**	0.002
2. Positive Attitude	5.19	1.122			-0.284**	<0.001
3. Negative Attitude	2.20	1.680				

** Correlation is significant at the 0.01 level (2-tailed).

Table 13
Valence, Arousal and Moods: Means, standard deviations, and correlations.

			Bivariate Correlation									
Measure	M	SD	2		3		4		5		6	
			r	*p*	r	*p*	r	*p*	r	*p*	r	*p*
1. Valence	5.53	1.221	-0.206	<0.001	0.071	0.124	0.168	<0.001	0.077	0.095	0.096*	0.038
2. Arousal	2.804	1.757			0.220**	<0.001	0.303**	<0.001	0.282**	<0.001	0.375**	<0.001
3. Calm/Stress	3.978	1.597					-0.442**	<0.001	-0.389**	<0.001	-0.287**	<0.001
4. Negative/Positive	4.595	1.411							0.782**	<0.001	0.741**	<0.001
5. At Loss/In Control	4.590	1.401									0.724**	<0.001
6. Unmotivated/Motivated	4.476	1.537										

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Research Question 5. Effect of mood on reported emotion.

Table 13 includes means, standard deviations, and correlations between valence and arousal and the four mood items. Although valence and the four mood items were not correlated (r = 0.071, 0.168, 0.077, and 0.096 respectively), arousal and the four mood items were moderately correlated (0.220, 0.303, 0.282, and 0.375 respectively). In conclusion, mood did not hold a strong effect on reported arousal and valence, therefore suggesting that the data was not skewed by participant's mood previous to the study.

Discussion

The principal goal of the present study was to understand the effects of tonality and tempo on both dimensional and discrete emotions. Regarding dimensional emotions, the findings of this study support the hypothesis that tempo has direct effects on arousal, while tonality has direct effects on valence. These results are consistent with previous literature (Gagnon & Peretz, 2010; Hevner, 1937; Peretz et al., 1998; van der Zwaag e al., 2011; Webster & Weir, 2005), which posits tempo recognition as an evolutionary skill (Dalla Bella, et al., 2001) and the learned relationship between tonality and emotion as a result of cultural learning (Parncutt, 2014).

The findings do not support some previous literature stating tempo as an indicator of valence (Gagnon & Peretz, 2010; Rigg 1964). Previous research supporting the effects of tempo on valence has often focused on tempo while controlling for other structural qualities. For example, Gagnon and Peretz (2010) focused on the effects of three modes (major, minor, and whole-tone) and three different tempi (slow, moderate, and fast) on equitone melodies, meaning melodies with the exact same melodic structure, while Rigg's study (1964) took five phrases, two sad and three happy, and played them at six different tempi. However, these attempts to control for specific structural qualities do not account for the fact that said structural qualities have effects of their own that cannot be disregarded simply because they are present in all conditions. For example, the results of

Rigg's study do indicate that tempo has an effect on valence, however, there is a clear relationship between the phrases' initial valence (happy or sad) and the perceived valence, regardless of tempo, indicating that there were structural qualities at work influencing initial valence.

A similar concept can be observed in Gagnon and Peretz' study, where the mode condition, which uses the same tempo between all three modes, demonstrates the clear effect of mode on valence. Gagnon and Peretz interpreted their results as indicating that tempo is a stronger determinant of valence. However, the difference between the mode condition and tempo conditions seems to indicate that tempo and mode are additive, meaning that tempo contributed to the intensity of the valence by working in combination with mode, and not the direction of the valence itself. In the present study, there were no effects of tempo on valence, and no multivariate interaction effect. Although the ability to recognize tempo is developed at a much earlier age as an evolutionary skill, the musical cultural learning theory indicates that as individuals in a culture listen to music, they develop the ability to recognize emotional connotations of specific tonalities as developed by both the tonal system and composers' emotional vocabulary (Parncutt, 2014). Given that all participants in this study were 18 or older, they had already progressed through various years of musical cultural learning where tonality is regarded as a more important indicator of valence than tempo, hence the lack of effect of tempo on valence. In conclusion, it is possible that tempo, in combination with other structural qualities, may have effects on valence, however, it is worth accounting for these additional structural qualities, as tempo does not exist in a void within music and therefore should not be treated as such.

Regarding the basic emotions, although numerous studies have found tempo and tonality to have effects on arousal and valence, only two studies, to the best of my knowledge, have looked at the effects of the structural qualities of tempo and tonality on discrete emotions (Ramos, 2011; Trochindis & Bigand, 2013). Both of these studies used four basic discrete emotions in order to measure the effects of mode and tempo: happiness, sadness, serenity, and anger. The results for both Ramos' (2011) and Trochindis and Bigand's (2013) studies indicate that the more tonal and less atonal a piece is, the more likely it will be related to happiness and serenity rather than sadness and anger, with tempo moderating these effects through arousal (high arousal = anger and happiness, low arousal = sadness and serenity). It is worth noting, however, that these four discrete emotions can be considered anchor coordinates in the two-dimensional valence-arousal plane (Posner et al., 2005), meaning that the use of these basic emotions do not give a significantly more in-depth understanding of specific emotions in contrast to the dimensional emotions. The present study uses both basic and GEMS emotions to understand the unique emotions affected by tempo and tonality. The results indicate that tempo and tonality were found to induce clearer effects on the GEMS emotions than on the basic emotions. More specifically, tonality affected more music-relevant emotions as opposed to basic emotions (which only includes the music-relevant emotion of tenderness). It is worth noting that the basic emotions include five discrete emotions, while the GEMS scale includes nine. However, only one of the five basic emotions (or 20%) was influenced by tonality, while four of the nine GEMS emotions (or 55.6%) were influenced by tonality and one by tempo. In addition to the sheer number of emotions, we should consider the relevance of each discrete emotion to music. Given the clear effects of music on the GEMS scale in contrast with the basic emotions, the results suggest that it is worth considering the use of music-specific discrete emotions when researching the emotional effects of music, as there is a considerate difference in result between music-specific and non-music-specific models. This has clear implications for both communication researchers who are interested in testing music effects and musicologists, as most previous work in both fields has turned to basic emotions instead of music-relevant emotions.

Additional Findings

A number of possible confounding variables were included in this study in order to ensure that induced emotions were a direct cause of the stimulus music. One of these variables was musical proficiency. Previous researchers in musicology have at times excluded participants with musical proficiency in order to ensure results that weren't tainted by those who might recognize the use of specific structural qualities in the stimulus materials (Dalla Bella et al., 2000; Gagnon & Peretz, 2010; Kellaris & Kent, 1994; Khalfa et al., 2008; Trochindis & Bigand, 2013). The present study considered that understanding the effects of music on everyone, including those with musical proficiency, is important and therefore should be included. Results found that those participants with musical proficiency found music to be more evocative than those with no musical proficiency. This may be because participants who received musical training of some sort beyond the high-school level tend to be immersed into the tonal system of their culture, therefore better understand the relationship between specific emotions and specific structural qualities. As a result, musically proficient participants reported the results of both their induced emotions and the expectations stemming from their musical training, resulting in stronger induced emotions. However, given that the only difference between proficient and non-proficient was the intensity of each emotion, and given that participants from each group were evenly distributed across all four conditions, the findings do not support the need to control for musical proficiency and the hypotheses results remain the same. In conclusion, given the differences between musically proficient and non-proficient participants, I suggest that future researchers keep in mind when conducting music-related research by ensuring an even distribution of both groups within their experiment's conditions.

Schubert (2007) indicated that liking and emotional valence function as separate constructs. The results of this study indicate that liking towards the music video and reported valence were in fact highly correlated, indicating that liking and emotional valence were not separate constructs. However, given the overall positively valenced reported emotions across all four conditions, it is not surprising that valence and liking are correlated in the present study. This may have been caused by the fact that the stimulus music was in major and minor, which still continue to be recognizable modes within the tonal system. If the stimulus music had used atonal music, it is possible that more negatively valenced reported emotions would have been induced (Ramos et al., 2011). Therefore, it is safe to assume that the current study does not have the reported emotional distribution to test these variables as separate constructs.

Additionally, the relationship between attitude and valence was also addressed, finding a strong positive correlation between valence and positive attitude, as well as a strong negative correlation between valence and negative attitude. These results indicated that when participants found the music to have positive valence, they also developed a positive attitude towards the video's content, rather than negative attitude, demonstrating a relationship between the two. The final possible confounding variable was mood. Overall, correlation between the dimensional emotions and reported mood were small to non-existent. In addition, all of the reported mood items were fairly central across the 7-point scales used to measure them. In conclusion, despite the COVID-19 crisis occurring during the time of data collection, participants' mood did not have an effect on reported emotions.

Implications for Mass Communication Research

Mass communication as a field has had consistent shortcomings in regards to music-related research, such as the use of musical stimuli informed by external associations, the lack of proper musical analysis and understanding of the literature which leads to a misunderstanding of the possible effects of music, and the generalization of results achieved through the use of said music and analysis. The present study demonstrated how consequential these shortcomings can be.

The first shortcoming that should be addressed is the use of musical stimuli informed by external associations. The results of this study indicate that change in tonality and tempo can have significant effects on both dimensional and discrete emotions. When music is chosen for a study based solely on external associations, such as genre, the researcher is overlooking a number of structural qualities that may be at play. For example, the differences in effects between classic rock and western classical music may seem obvious to most listeners, however, given the effects of specific structural qualities, it is possible to induce similar effects with songs from both genres if they were to share similar tonality, modulations, tempo, dynamics, and texture. These effects would not be dependent on the genre of music, but rather the combination of individual structural qualities. Even if researchers were to do pre-tests to ensure that the musical pieces of specific genres achieve specific emotions, this would only be true for the specific piece they choose and would not be generalizable to the genre they chose from. Consequently, the results of these studies are not only ungeneralizable, but also impractical when informing practical skills in advertisement, as most advertisers understand that all the songs of a genre do not elicit the same emotional response. Another detail that should be considered is that external associations often bring with them individual preferences that are difficult to control for, such as whether or not one prefers one genre or musician above others. These preferences can be beneficial and interesting for future research, but should be approached with thorough musicological research in order to use them in an informed manner.

The second shortcoming that should be addressed is the use of musicological research to inform mass communication's music-related research. There is a rich and vast body of research in musicology that has addressed the history and effects of music in diverse ways. Other fields, such as psychology, have also dedicated extensive research to understand the effects of music, both emotional and cognitive, in a variety of contexts. Researchers who strive to understand the effects of music in mass communication would benefit from using the knowledge available for them to make informed decisions in their research. For example, if a communication scholar were to try and understand how music in an advertisement affects purchase intent as mediated by emotion, it is critical for them to understand which emotions are being induced by which musical qualities and how. By assuming that any upbeat electronic music may have the same effects on emotion and therefore purchase intent would be incorrect and damaging to those who may try and use the results of that study to inform their own research or their practical skills.

In conclusion, by informing itself through musicology, mass communication research can better understand how music affects individuals in a variety of scenarios, including but not limited to: advertisements, health messages, political campaign messages, and entertainment media such as movies, shows, and videogames. Music is ever present in communication, as it is in life, and to understand how individuals and society interacts with music is fundamental to understanding communication itself.

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