Spring 2016

Do You Chill When I Chill? Exploring Strong Emotional Responses to Unfamiliar Musical Traditions

Eleonora Judith Beier
Bard College

Do You Chill When I Chill?

Exploring Strong Emotional Responses to Unfamiliar Musical Traditions

Senior Project Submitted to

The Division of Science, Mathematics, and Computing

of Bard College

by

Eleonora Judith Beier

Annandale-on-Hudson, New York

May 2016

Acknowledgments

This research was supported by the Bard Psychology Department as part of a senior project. I would like to thank my senior project adviser, Dr. Justin Hulbert, for his tremendous support in all aspects of this experiment, as well as Dr. Amy Winecoff and the members of the senior project board, Dr. John Halle and Dr. Stuart Levine, for their valuable input. Many thanks also go to: Dr. Zdravko Blazekovic for his guidance in contacting the Chinese music expert; Dr. Mariagrazia Carlone, Paul Beier and Yun Fan for their recommendations in the selection of pieces and the creation of the musical knowledge survey; Dr. Dan Ellis for his response to my questions regarding his scrambling script; Andrew Feyer for the acoustical manipulations of the pieces; and Malkie Scarf and Adolfo Coyotl for their unconditional help and moral support.

Table of Contents

Abstract

While research suggests that listeners from diverse cultural backgrounds can infer what mood is expressed in a piece from a different culture, no study to date has assessed whether peak emotional responses can also be induced cross-culturally. The chill response in particular has been defined as a sudden increase in emotional arousal elicited by a passage in music. This study addressed the question of whether listeners could experience chills for traditional Chinese music – with which they were either familiar or unfamiliar – as well as for Western classical music – with which all participants were familiar. Chills were measured through self-report and skin conductance while participants listened to pieces selected from each style. In accordance with the hypothesis, there was no significant difference in the number of chills felt in response to both styles of music, regardless of whether participants were familiar or unfamiliar with traditional Chinese music. However, both groups of participants showed significantly fewer chills when listening to scrambled versions of the same pieces, which acted as a control. Scrambled music was also rated as less likable and harder to pay attention to across groups. Overall, pieces that had received higher liking and attention ratings were found to elicit more chills. Thus, even under limited exposure, listeners can experience strong emotional responses to music from an unfamiliar culture as much as listeners familiar with that music. This contrasts with the view that all musical meaning is generated within a culture and suggests instead that there are cross-cultural cues capable of eliciting powerful emotions in people of all backgrounds.

Introduction

Music is recognized as a fundamental human trait playing an important role in all human societies (Nettl, 2000; Patel, 2008). Its ubiquity raises the question of whether there is a human capacity for making and understanding music that could have evolved similarly to the human capacity for language. While all languages can be traced to a single Universal Grammar (Berwick & Chomsky, forthcoming), it is challenging to reduce the variety of musical styles from different times and places to a single, common set of characteristics. Part of this challenge derives from the difficulty in defining what music is (Patel, 2008).

Ethnomusicologist Judith Becker (1986) argues that musical styles from different cultures are simply incommensurable because of fundamental differences in function and meaning that cannot be decontextualized. Nonetheless, research on musical universals points to striking similarities in the structure of music around the world, such as octave equivalence (a frequency and its double are recognized as the same pitch), the importance of the fifth in most tonal systems, and the existence of scales—which can be traced to psychoacoustic properties of sound (Patel, 2008). Regardless of these structural similarities, it is argued that the incommensurability of musical styles is primarily true for musical meaning (Becker 1986). This leads to the question of what aspects of music are responsible for conveying meaning.

The view that all musical significance derives from cultural context contrasts with the idea that music presents a structure capable of generating meaning unrelated to the external world. The latter is referred to as “intramusical” meaning, as opposed to “extramusical” meaning, which is informed by contextual aspects (Patel, 2008). Studies of intramusical meaning have mainly focused on the way music expresses emotion, although it should be noted that emotion might just be one of several forms of musical meaning (Becker, 1986; Patel, 2008). Nonetheless, music has been shown to be emotionally expressive across cultures (Patel, 2008).

An early account for how musical structure generates emotion is based on Meyer's (1967) insight into the role of expectations. Internalized patterns of musical structure lead listeners to generate expectations for what patterns will follow next and a sense of whether a pattern is complete or needs completion. In their generative theory of tonal music, Lerdahl and Jackendoff (1983) expand on this view by analyzing musical structure through trees of tension and relaxation: the incompleteness of a pattern or deviance from expectation leads to tension, while a pattern's completeness leads to relaxation. The interplay of tension and relaxation is, in their view, what ultimately gives rise to changes in arousal and emotion.

While this theory is primarily based on Western classical music, similar accounts suggest that expectations might be generated both by culture-specific patterns and by universal, general principles of perceptual organization such as Gestalt principles of grouping (Narmour, 1990). This claim was tested in an experiment where American and Chinese listeners heard excerpts from British and Chinese folk songs and rated how much different tones, presented as possible continuations of the excerpt, matched their expectations (Krumhansl, 1995). The two groups did not differ significantly in their ratings, suggesting that expectations were formed even for music from a different culture. In addition, when only considering the British excerpts, expectations did not differ significantly for Western musicians and non-musicians, indicating that explicit knowledge of music theory is not required for the formation of musical expectations. These findings have been interpreted as indicating that musical expectations, and therefore emotion, are generated through both culture-specific and shared psychological principles (Krumhansl, 2002).

This view is further supported by cross-cultural studies on the interpretation of the mood expressed by music. Balkwill and Thompson (1999) had two performers of classical Hindustani music record ragas (a type of melodic piece) to express four kinds of emotion: joy, sadness, anger and peacefulness. Western listeners unfamiliar with Hindustani music were then asked to choose the dominant emotion expressed by each raga and to rate the raga along four psychophysical dimensions: tempo, rhythmic complexity, melodic complexity and pitch range. When compared to the ratings made by four experts of Hindustani music, the Western listeners were able to correctly differentiate the ragas on the basis of intended emotion when the emotion was joy, sadness or anger, and to a lesser extent for peacefulness. It was also found that certain psychophysical dimensions were related to the perceived emotion: faster tempos were positively correlated with perceived joy and negatively correlated with sadness and peacefulness; rhythmic and melodic complexity were positively correlated with perceived sadness and negatively correlated with joy and peacefulness. The authors concluded that, when unable to rely on cultural conventions, listeners make their judgments based on psychophysical aspects of the music, which can be therefore be seen as universal cues of emotion.

These results were replicated and expanded in a study by Laukka et al. (2013). The researchers asked professional performers from four different musical traditions (Swedish folk music, Hindustani classical music, Japanese traditional music, and Western classical music) to perform short pieces from their tradition in order to convey 11 different emotions: happiness, sadness, anger, fear, affection, peacefulness, humor, longing, solemnity, spirituality and neutral. Secondly, the researchers had participants from each of these cultures (Sweden, India and Japan) listen to each recorded excerpt and choose from the list of emotions the term that best described what they heard. Western classical music was used as a control with the assumption that participants would be familiar with it across cultures, while they would know little or nothing about the other specific traditions (which was confirmed through familiarity ratings). It was found that for some emotions, members of one culture were better at decoding the mood intended by the performer from their own culture than those intended by performers from a different culture. This was particularly true for sadness, solemnity, anger, longing and fear. However, with the exception of spirituality, most expressions of emotion were recognized with accuracy above chance for both familiar and unfamiliar music; cross-cultural recognition rates varied for different emotions and were higher for anger, fear, happiness, humor, peacefulness and sadness. The researchers were also interested in whether certain cues were consistently used by performers to encode an emotion, and by listeners to decode it, across cultures. Several correlations were found. For example, high sound level was associated with anger and low sound level with affection and peacefulness. Similarly, a clear pulse and a rough timber corresponded to anger, happiness and humor, whereas an ambiguous pulse and a smoother timber corresponded to longing, peacefulness and sadness. However, there was a better match between the cues used by performers and those used by listeners within one culture than across cultures.

Laukka et al.'s study further validates Balkwill and Thompson's (1999) findings in supporting the idea that, in addition to culture-specific cues of emotion based on learned cultural conventions, there are also cross-cultural cues based on psychophysical properties of sound that affect all humans. This view is in accordance with Narmour's theory that the musical structure giving rise to expectations, and therefore emotion, is partly based on shared Gestalt principles.

Felt versus Recognized Emotion

While these studies assessed the accuracy and reliability with which musical emotion was recognized by listeners, it has been argued that this does not necessarily imply that the music induced actual felt emotion in the listeners (Juslin & Laukka, 2004). While listeners might correctly judge the intended mood of a piece to be sadness, this does not guarantee that they feel sad after hearing the piece. In support of this idea, Salimpoor et al. (2009) found that, when asked to rate the arousal and valence expressed by various excerpts, there were significant differences between what participants thought the piece was trying to convey and what they reported to actually feel.

According to Juslin and Laukka (2004), while self-report is the simplest way to measure felt emotion, it lacks objectiveness and is subject to demand bias. However, more objective measures of emotion, such as neural and physiological correlates, tend to rely on a categorical view whereby distinct mechanisms lead to different, “discrete” emotional responses (e.g., anger or happiness as natural kinds). This view is controversial, as it has been proposed that emotion might be better described as an emergent phenomenon resulting from the categorization of an underlying core affect (Barrett, 2006). There are also other reasons for why it may be hard to measure felt discrete emotions in music. Especially when it comes to cross-cultural research, it has been acknowledged that a possible confound is presented by the fact that the words used to categorize a piece’s mood (e.g., “sadness,” “peacefulness,” “solemnity” etc.) are drawn from a Western categorization of emotions and might therefore not reflect the emotion categories that people from a different culture would choose to label a piece of music (Laukka et al., 2013). Another approach would be to ask participants to rate emotions for valence (positive/negative) and arousal (high/low). However, it can be hard to differentiate emotions that fall similarly along these two continuums (e.g., anger and fear, both high in arousal and with negative valence) but that result in completely different behavior and that are represented in very different ways in music (Juslin & Laukka, 2004). These observations point to the idea that it is difficult to assess with certainty what discrete emotion is felt by a listener in response to music, either through self-report or though physiological measures.

A way that some of these problems might be addressed is through the study of peak emotional responses, which are not valenced but which present clearly measurable peaks in arousal. In particular, a promising measure of felt emotion has been identified in the "chill" response, also referred to as "thrills" and "frissons" (Grewe & Kopiez, 2009; Harrison & Loui, 2014). Chills are sudden increases in arousal that correspond to strong self-reported emotion (Grewe & Kopiez, 2009) and that can be objectively measured as increases in skin conductance (Craig, 2005; Grewe et al., 2007).

Chills are a particularly interesting kind of musical emotion as they can only be reported if felt; in other words, a participant would not be able to classify a piece of music as "chill-inducing" based on simple emotion recognition, which means that a reported chill is indicative of the fact that music has induced felt emotion. Accordingly, chill-inducing excerpts receive higher ratings of perceived pleasure and show higher physiological arousal than less pleasurable or neutral excerpts (Salimpoor et al., 2009). Neurological studies of chills indicate that they are associated with activity in reward and motivation areas of the brain, which also respond to stimuli such as food and sex (Blood & Zatorre, 2001). Importantly, activity in these areas was correlated with chill intensity but not with mildly pleasant emotion induced by consonance. This suggests that chills in particular might arise from aspects of music that are capable of triggering reward mechanisms associated with biologically relevant stimuli.

What Causes Chills?

Preliminary investigations found that self-reported instances of chills seemed to coincide with new or unexpected harmonic changes (Sloboda, 1991). This finding was interpreted as suggesting that chills are induced by culture-specific aspects of the music. However, later studies showed that chills were also correlated with other types of unexpected changes, such as a sudden dynamic leap (a peak in loudness) and the entry of a new voice (which can also be instrumental; Grewe et al., 2007; Panksepp, 1995). This seems to suggest that chills are caused by unexpected shifts in the piece, which can be related to both overall structure (e.g., harmony) and psychophysical aspects (e.g., loudness). This fits with Lerdahl and Jackendoff's theory that emotion is the result of a pattern of tension and relaxation resulting from the breaking and fulfillment of expectations. A sudden change in the music would constitute a breaking of expectation, which in turn leads to a peak in arousal that is experienced in the form of a chill. However, it should be noted that while chills tend to coincide with unexpected events, not all unexpected events induce chills in all participants in a trigger-like fashion, explaining the low predictability of these responses at any particular section of a piece, across participants (Grewe et al., 2007).

The fact that expectations can be broken both by seemingly culture-specific events and by general psychoacoustic events opens the possibility that a listener might experience chills even in response to music from an unfamiliar tradition, contrary to what had been previously proposed (Sloboda, 1991). However, no study to date has tried to assess whether this is the case. If chills can be induced by unfamiliar music, then it can be inferred that music presents cross-cultural elements capable of inducing peak emotional responses beyond mood recognition.

The Present Study

This study assessed whether listeners experienced chills in traditional Chinese music, with which they were either familiar or unfamiliar, and in Western classical music, with which all participants were familiar. The reason for not including a group unfamiliar with Western classical music was that, due to its pervasiveness (Laukka et al., 2013), it would have been difficult to find such group within the Bard population. I hypothesized that if there are cross-cultural chill-inducing elements common to Western classical music and traditional Chinese music, then the two groups of participants would report chills to both styles. In order to more objectively identify peaks in arousal, a measure of skin conductance was used in conjunction with self-report.

As a control measure, participants also listened to stimuli created by separately scrambling the other pieces used in the study. Scrambled music has been previously used as a non-musical control presenting similar acoustic features to music but no distinguishable structure. In particular, studies have shown different brain activation patterns to scrambled compared to non-scrambled music (Abrams et al., 2013; Fedorenko et al., 2012; Janata et al., 2002; Jiang et al., 2013; Levitin & Menon, 2005; Menon & Levitin, 2005). Some of these studies found that music, as compared to scrambled music, engages areas of the brain involved with linguistic structure (e.g., Brodmann Area 47, Levitin & Menon, 2005) as well as areas involved in reward processing (e.g., nucleus accumbens and ventral tegmental area, Menon & Levitin, 2005). This matches behavioral results showing that scrambled pieces are rated as more incoherent and as less aesthetically pleasing than non-scrambled music (Latitte & Bigand, 2006), which is consistent with the idea that structure is necessary for emotional communication in music. The results of these studies led me to hypothesize that the scrambled pieces would either elicit no chills at all or significantly fewer chills than the original pieces.

A final set of hypotheses regarded the extent to which participants reported to have liked and having been able to pay attention to each of the pieces. Panksepp (1995) found a correlation between self-reported liking of music and number of chills. Similarly, Salimpoor et al. (2009)

found a correlation between physiological arousal and perceived pleasure in music. Thus I hypothesized that self-reported liking for the pieces would predict the number of chills. As Nusbaum et al. (2014) found that people reported significantly more chills when listening to music closely, I also hypothesized that attention paid to each piece would predict the number of chills.

Method

The method described in this section has been approved by the Bard College Institutional Review Board (see Appendix A**).**

Participants

Participants were recruited through an initial screening survey offered to the wider Bard community. Information about the study, along with a link to the online survey was emailed to relevant Bard listservs (e.g., music classes and student groups, with permission of the relevant administrators) and posted on relevant Facebook groups. Additionally, the survey was advertised through fliers on the Bard campus (see Appendix B). A total of 139 people took the initial survey (70 female, mean age: 21.22y). Since the percentage of participants who have been found to experience chills in music from their own culture but unknown to them varies from 56% (Grewe & Kopiez, 2009) to 75% (Craig, 2005), and about a fourth of the population does not experience chills at all (Nusbaum et al., 2014), one of the screening criteria for participation in the study (fully described in the “Screening Survey” section below) was having experienced chills in Western classical and/or traditional Chinese music in the past. Thus, of all survey responders, 28 were deemed eligible for the Western-only group and 16 for the Western+Chinese group. After being contacted, 8 people in the Western-only group agreed to participate (4 female, mean age:

21y) as well as 8 people in the Western+Chinese group (6 female, mean age: 20.37y). In addition, 3 similarly selected participants took part in an official pilot study (2 Western-only, 1 Western+Chinese, all male, mean age: 20.33y). More statistics related to the measures from the screening survey can be found in Table 1.

Table 1

Comparisons of screening survey responses across groups

	Western-only		Western+Chinese			
	M	*SD*	*M*	*SD*	t^1	*df*
Age	21	2.56	20.37	1.3	0.615	10.38
Liking of music (1-5)	4.75	0.46	5	0	-1.528	7
Liking of Western classical music (1-5)	4.37	0.52	4.75	0.46	-1.528	13.83
Liking of traditional Chinese music (1-5)	3.12	0.35	4.75	0.46	-7.891*	13

Note. * = $p < 0.001$. There were no significant differences across groups except for reported liking of traditional Chinese music (higher scores indicate higher liking). This likely reflects the fact that the screening survey instructed participants to select a rating of “3” if unfamiliar with the style of music.

Compensation

Participants who completed the online survey were entered in a raffle for a $25 Amazon gift card. Participants who were selected and who agreed to participate in the main experiment or the pilot study were also entered in a raffle for a $50 Amazon gift card, while also being compensated with candy after the experiment.

[1] As equal variances could not be assumed for some t-tests, all t-test statistics reported in this paper do not assume equal variances. The tests would have led to the same conclusions had equal variances been assumed. Additionally, all t-tests are two-tailed.

Screening Survey

The screening survey (found in Appendix C) asked participants about their musical experience and preferences. Questions on musical experience were adapted from a study on the relationship between musical training and late-life cognition (Gooding et al., 2014). The questions on musical preferences asked for favorite genres, how much participants enjoy music, and whether they have had strong emotional responses to music in general, and to Western classical music or traditional Chinese music in particular. Finally, the survey asked participants whether they wanted to be contacted for a future experiment on people’s emotional reactions to music. Depending on their responses, some participants were selected for the main experiment. Specifically, for a participant to qualify for the Western-only group, their enjoyment of music in general and of Western classical music in particular had to be rated as 4 or 5 on a 1 to 5 scale and they had to report having felt chill-like emotions (defined as “shivers down the spine or goosebumps”) in music in general and in Western classical music in particular. For a participant to qualify for the Western+Chinese group, they had to report similar high ratings for both Western classical music and traditional Chinese music, as well as for music in general.

Main Experiment

Stimuli. *Pieces*. Musical selections from two musical traditions: Western classical and traditional Chinese. Western classical music was defined as “European art music from 1000 AD to the early 1900s” while traditional Chinese music as “the folk, art, and court music of China from the 12th century BCE to present” based on correspondence with experts of both styles (Paul Beier, personal communication, December 10th, 2015; Yun Fan, personal communication, November 17th, 2015). Also based on this correspondence, two pieces were selected from each style according to the following criteria: 1) Highly emotional; 2) Instrumental (no voice/lyrics); 3) Between 3 and 10 minutes in length; 4) Relatively unknown. The reason for excluding very famous pieces was to reduce the potential for people's familiarity with particular works from confounding the effects of familiarity with the genre as a whole. Unfortunately, these criteria ruled out most pieces from the Western classical tradition that have been previously found to reliably elicit chills in studies that reported them, as these pieces were often either very famous or included voice. A preliminary selection of about 5 pieces from each tradition, acquired through previous studies and advice from experts, went through an unofficial pilot study where two friends of the experimenter listened to all pieces and reported how many chills (if any) they experienced in response to each. Based on their responses, the two pieces that elicited the most chills from each tradition (and that had not been recognized) were used for the experiment. The resulting Western classical pieces were the third movement (*Molto adagio*) of Beethoven's string quartet in A minor, op. 132, and the fourth movement (*Molto allegro e vivace*) of Mendelssohn's string quartet in E-flat major no.1, op.12. Both pieces were composed in the first half of the Nineteenth century in Austria and Germany, respectively, and can be considered to belong to the early Romantic period. The two traditional Chinese pieces selected through the unofficial pilot were *Chilly wind in spring*, an piece for erhu with yangqin accompaniment arranged by folk musician Hua Yanjun (stage name Abing) during the early Twentieth century; and *Riding to the flower festival*, a traditional piece for pipa. Because the two traditional Chinese pieces were shorter in length, I shortened the Western classical pieces to approximately match their length (about 6 min and 4 min, respectively), trying to cut them on an already present rest in the music and tapering off the end in order to give a sense of closure. In this way, the total time participants spent listening to traditional Chinese music and the total time they spent listening to Western classical music was roughly equal, so that participants would not have a higher chance of experiencing chills to one type of music compared to the other. This was confirmed through a t-test showing no significant differences in length between the two types of pieces. The pieces were then amplitude normalized through Logic Pro X software, so that they would all have the same volume. In the rest of the method section, the two types of pieces are referred to as Western pieces and Eastern pieces for consistency. *Scrambling procedure.* There is no standardized scrambling procedure in the literature, with segments varying in length from 250ms (Levitin & Menon, 2005) to 900ms (Jiang et al., 2013) and up to 15 seconds (Lalitte & Bigand, 2006). In this experiment, the selected musical pieces were scrambled using a time-domain scrambling of audio signals Matlab script developed by Ellis (2010). The script was edited in order to randomly re-order segments of 600ms over a window of 60 seconds. According to the developer, this script “can be used to create new versions of existing recordings that preserve the spectral content over longer time scales, but remove structure at shorter timescales” (Ellis, 2010). Thus, similarly to other studies that used scrambled music, the scrambled pieces used in this experiment resembled their non-scrambled counterparts in their overall length and in the preservation of some low-level acoustic features. *Relaxation sound*. Before the start of the experiment, participants listened to three minutes of a recording of waves crashing on a beach in order for them to relax and the for skin conductance apparatus to stabilize. This sound was also amplitude normalized to match the volume of the pieces.

Procedure and behavioral measures. Participants first signed an informed consent form (Appendix D). The task was explained to them thoroughly, and they were given a definition of what is meant by “experiencing a chill” reflecting the one used in the screening survey. This definition described a chill as a strongly emotional response to a point in music, experienced as a shiver down the spine or in the arms or goosebumps, and was modeled after Grewe et al.'s (2007) definition. Participants were then seated in a comfortable chair in front of a computer screen and asked to wear a headphone set (Sennheiser HD 428) connected to the computer. After the skin conductance electrodes were applied by the experimenter, participants listened to the three-minute-long relaxation sound (waves crashing on a beach) in order for the skin conductance measure to stabilize and for the participants to enter into a neutral, relaxed mood before listening to the pieces. A similar introductory relaxation phase was included by Craig (2005), who used Gregorian chant as a baseline for skin conductance during which no chills were measured; however, I decided to utilize natural sounds rather than music in order to not bias participants towards either Western classical or traditional Chinese music. The relaxation sound was also used to test for preferred volume. Starting with a pre-selected volume setting of 90 (on a Dell Optiplex 9020 desktop), participants were asked to specify whether they wanted this setting to be higher or lower in order to achieve a volume that was as high as possible without being uncomfortable. A t-test revealed there were no significant differences in volume chosen across groups.

After the relaxation sound, an automated computer script played the pieces in pseudo-random order. The pseudo-random order was generated through a script that randomized the order each time with the constraint that the first piece be a non-scrambled piece, and that the first four and the last four pieces be a Western non-scrambled piece (WN), a Western scrambled piece (WS), an Eastern non-scrambled piece (EN) and an Eastern scrambled piece (ES). Given that there were two versions of each type of piece, an example of a pseudo-random order generated through the script is EN1, WS2, WN2, ES1, WN1, EN2, WS1, ES2. Because the script generated a new pseudo-random order for each participant, there likely was not any systematic bias due to piece order. Before each piece started, there were 10 seconds of silence aimed at stabilizing the skin conductance. Participants received a three minute break after the presentation of the fourth piece.

Participants were instructed to rest their right hand on a keyboard and press spacebar every time they started feeling a chill, and to keep it pressed for the entire duration of the chill (a setup used by Grewe et al., 2007). In all participants, regardless of handedness, skin conductance was measured from the left hand while the right hand was used to report chills, because of the way the setup was positioned. After listening to each piece, participants manually answered a few post-piece questions presented by the computer. The questions were adapted and expanded from Panksepp (1995) and can be found in Appendix E. The questions asked participants how much they liked the piece, how familiar they were with it and how much they had been able to keep their attention focused on the music. Additional questions not included in the present analyses asked to rate the piece's level of emotional content and the extent to which the piece expressed happiness or sadness. After listening to all pieces, participants were asked to rate how much they had enjoyed the chills they had experienced (if any), a question also adapted from Panksepp (1995). All questions were answered on a 1 to 7 Likert scale anchored at 1 with "Not at all," 4 with "Somewhat," and 7 with "Very much."

Finally, participants completed a survey to test their knowledge of Western classical music and traditional Chinese music. The survey questions can be found in Appendix F and were suggested by experts in both styles of music (Dr. Mariagrazia Carlone, personal communication, November 4th, 2015; Yun Fan, personal communication, November 10th, 2015). Additionally, part of Gooding et al.'s (2014) questionnaire on musical experience was adapted to test for knowledge of Western notation and music theory. While previous studies show that this knowledge should not influence the prevalence or strength of chills (Grewe & Kopiez, 2009) and of musical expectations in general (Krumhansl, 1995), this measure was used to assure that there were no significant differences in participants' emotional reactions in regards to their experience. To this aim, it would have been optimal to also include questions based on music theory and notation of traditional Chinese music. However, consultation of an expert in this type of music revealed that there is no commonly accepted form of notation (Yun Fan, personal communication, November 11th, 2015). A few final questions in the survey assessed participants' level of familiarity with the particular sub-genres used in the study. At the end of the experiment, participants had a chance to ask the experimenter any questions and were given a debriefing statement (Appendix G).

Psychophysiological measures. Skin conductance (SC) was monitored as an objective measure of physiological arousal, since skin conductance responses (SCRs), or peaks in SC, have been linked to the chill response. Before the start of the experiment, participants were asked to wash their hands with water, after which two passive Nihon Kohden electrodes were placed on the volar (palmer) surface of the distill phalanges of the index and middle finger of the left hand with electrode paste, as suggested by Figner and Murphy (2011). The electrodes were thoroughly cleaned between uses. The skin conductance attachments were designed to be integrated with the BioSemi ActiveTwo system which digitizes and records the physiological responses synced to the presentation of the musical pieces. An additional two electrodes (CMS/DLR) were attached to the back of the left hand in order to provide a baseline. Participants were instructed to rest their left hand face down on a surface (with the tip of their fingers off the border of the surface so that pressure was not applied to the electrode sites) and to keep their left hand as still as possible for the duration of each piece. The maximum sample rate permitted by BioSemi was 64Hz, which was then up-sampled to 256Hz as this allowed for more accurate recording of the triggers indicating the start and end of pieces and reported chills. I applied the standard low-pass filter of 3Hz provided by BioSemi in order to reduce the noise in the raw data. No high-pass filter was used to separate tonic from phasic changes in the skin conductance (Figner & Murphy, 2011) since tonic changes (or changes in skin conductance level, SCL) were not analyzed at this time. However, it is possible to apply such filter at a later time in case these analyses will be conducted in the future. Skin conductance responses coinciding with button presses (resulting from reported experienced chills) were identified through Autonomate, a free Matlab toolbox which uses the derivative of the signal to find peaks in SC and measures their amplitude (Green et al., 2014). For these analyses, only chills that presented both a button press and a peak in SC were considered (as in Grewe at al., 2007).

Results

A total of 285 reported chills were collected (146 from Western-only participants, 139 from Western+Chinese participants). Of these, 163 corresponded to a measured peak in skin conductance, and were thus included in the analyses (83 from Western-only participants, 80 from Western+Chinese participants; see Figure 1 for a representative example of a peak in skin conductance following a chill reported through a button press). An independent samples t-tests showed that the average number of reported and measured chills did not vary significantly across groups. The percentage of reported chills that were also measured in the skin conductance was therefore 57%. This is numerically less than what has been previously found (e.g., 73% in Grewe et al., 2007). However, Grewe et al. found that most measured chills were in response to participant-selected pieces. As all pieces used in this experiment had been selected to be unfamiliar to the participants, it should be expected that they would elicit less chills than familiar pieces. One Western+Chinese and two Western-only participants did not report any chills. The number of participants who did experience chills (81%) is therefore actually numerically higher than that found in previous experiments (e.g., 55% in Grewe et al., 2007). This might be because all participants in the present study had been screened for having experienced chills in the past.

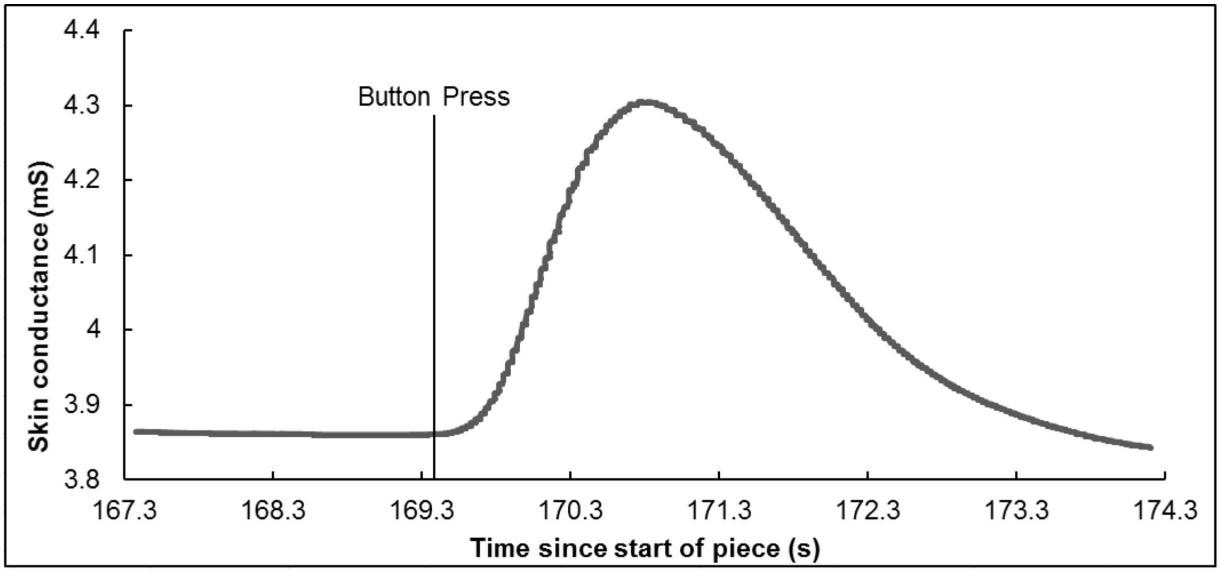


Figure 1. Change in skin conductance (measured in microSiemens) following a button press. This peak can be detected by Autonomate and would allow to classify this reported chill as measured.

Piece Type and Group Effects

Number of chills. A mixed-design repeated measures ANOVA was conducted on the number of measured chills (see Figure 2). The between-subject factor was participant group (Western-only; Western+Chinese). The within-subject factors were piece version (scrambled; non-scrambled) and piece style (Western classical; traditional Chinese). There were no main effects of group and style (both *F*'s<1). However, there was a significant main effect of version ($F(1, 14)=9.03$, $p=0.009$), with non-scrambled pieces eliciting significantly more chills ($M=4.09$, $SD=5.71$) than scrambled pieces ($M=1.00$, $SD=2.42$). There was no interaction between version and style, nor was there a three-way interaction including the additional group factor (both

F's<1). These results support the main hypotheses that both participants in the Western-only group and participants in the Western+Chinese groups can have chills to Western classical music and traditional Chinese music, and that they have more chills to the non-scrambled pieces than the scrambled pieces.

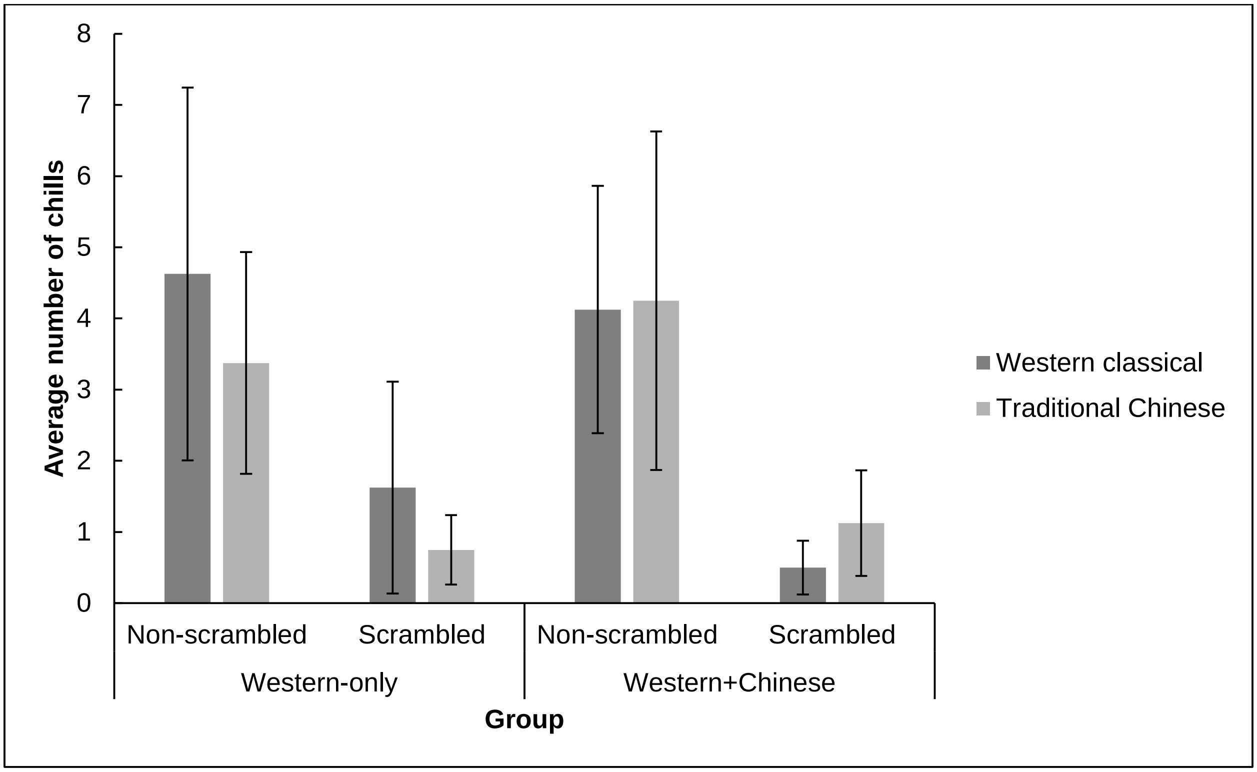


Figure 2. Effects of participant group, piece version and piece style on average number of chills. Only the main effect of piece version (scrambled; non-scrambled) was significant. Interestingly, Western-only participants show numerically fewer chills to the non-scrambled traditional Chinese pieces than the Western+Chinese participants, although this interaction was not significant. Error bars represent Standard Error of the Mean (SEM).

Behavioral measures. Two measures from the post-piece questionnaire were analyzed in an exploratory fashion: liking (how much participants liked the piece) and attention (how much participants had been able to focus on the piece), both collected on a 7-point scale where higher values indicated higher liking and attention. Two mixed-design repeated measure ANOVAs were conducted on these measures (see Figures 3 and 4). The between-subject factor was again participant group, and the within-subject factors were piece version and style. The analyses found that there were no main effects of group and piece style on attention ratings, but there was a main effect of piece version ($F(1, 14)=60.51$, $p<0.001$), with non-scrambled pieces receiving significantly higher attention ratings ($M=5.92$, $SD=0.92$) than scrambled pieces ($M=3.6$, $SD=1.54$). There were no interactions. Similarly, there was no main effect of group on liking ratings, but there was a main effect of piece version ($F(1, 14)=283.42$, $p<0.001$), with non-scrambled pieces receiving significantly higher liking ratings ($M=6.03$, $SD=0.9$) than scrambled pieces ($M=2.64$, $SD=1.36$). However, contrary to what was found for attention, there was also a significant main effect of style on liking ratings ($F(1, 14)=13.66$, $p=.002$), with traditional Chinese pieces receiving significantly higher liking ratings ($M=4.56$, $SD=1.92$) than Western classical pieces ($M=4.11$, $SD=2.17$). While no interactions were significant, there was a non-significant trend for an interaction between style and group ($F(1, 14)=2.74$, $p=.12$), which led to an exploratory analysis of whether this effect was mostly driven by any particular group or piece version. I expected that it would mostly be driven by the Western+Chinese participants, who showed overall numerically higher liking for the traditional Chinese pieces than for the Western classical ones. Indeed, t-tests showed that this difference was only significant between Western classical and traditional Chinese scrambled pieces for the Western+Chinese group ($t(29.48)=2.48$, $p=0.019$). This might be due to the fact that Western+Chinese participants had previous exposure to traditional Chinese music, contrary to the Western-only participants.

While no hypothesis was formulated a priori, these results are consistent with the present literature, which shows that non-scrambled music is rated as more aesthetically pleasing (Latitte & Bigand, 2006) and more strongly engages brain areas related to reward (Menon & Levitin,

2005) than scrambled music. Furthermore, these findings support the idea that familiarity with the musical style is not a requirement for enjoyment of the piece.

An ulterior exploratory analysis was conducted on familiarity ratings (how familiar participants were with the piece on a 7-point scale), using the same statistical model. No significant main effects and no interactions were found. As the pieces were selected with the intention of not being recognized by participants, it was expected that there would be no group or style differences. The finding that scrambled pieces were rated as equally familiar to the non-scrambled pieces might seem surprising, but it is likely due to the fact that participants were able to recognize the scrambled version of a piece that had been presented to them earlier in the experiment in its non-scrambled form. In fact, Bigand, Yannick and Molin (2009) found that people are able to recognize a piece that has been scrambled even when the segments are as short as 250ms.

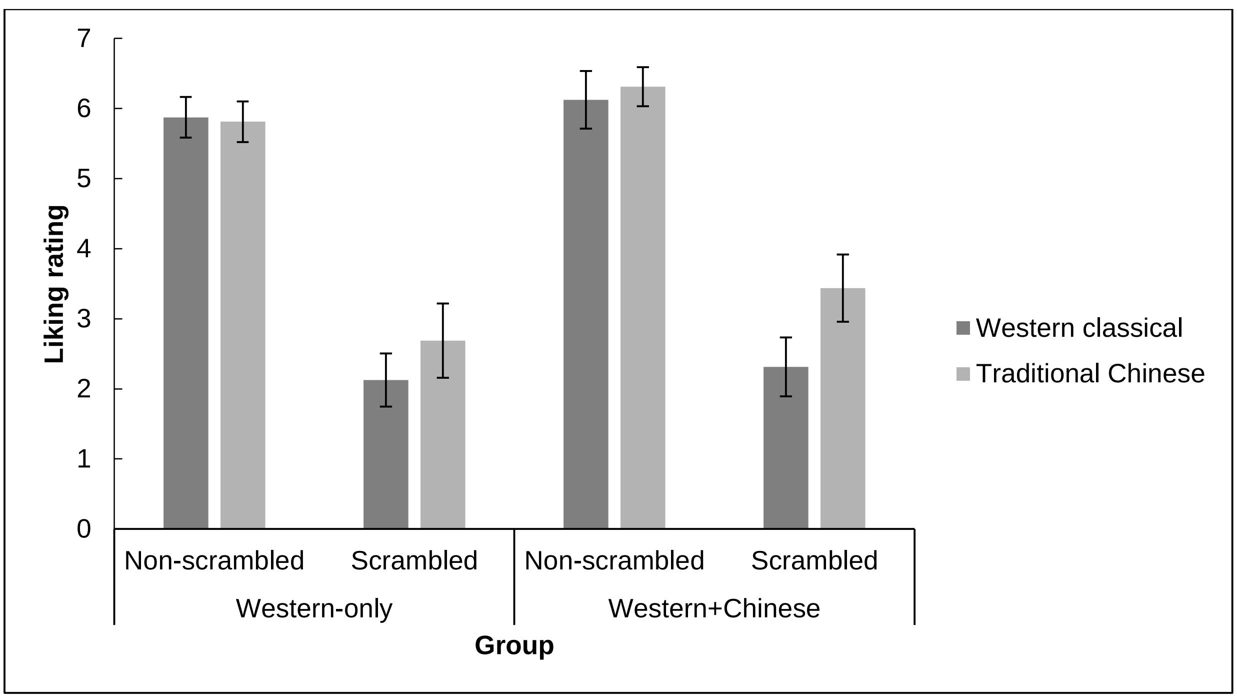


Figure 3. Effects of participant group, piece version and piece style on liking ratings (1-7; higher ratings indicate higher liking). Only the main effects of piece version (scrambled; non-scrambled) and style (Western classical; traditional Chinese) were significant. Error bars represent SEM.

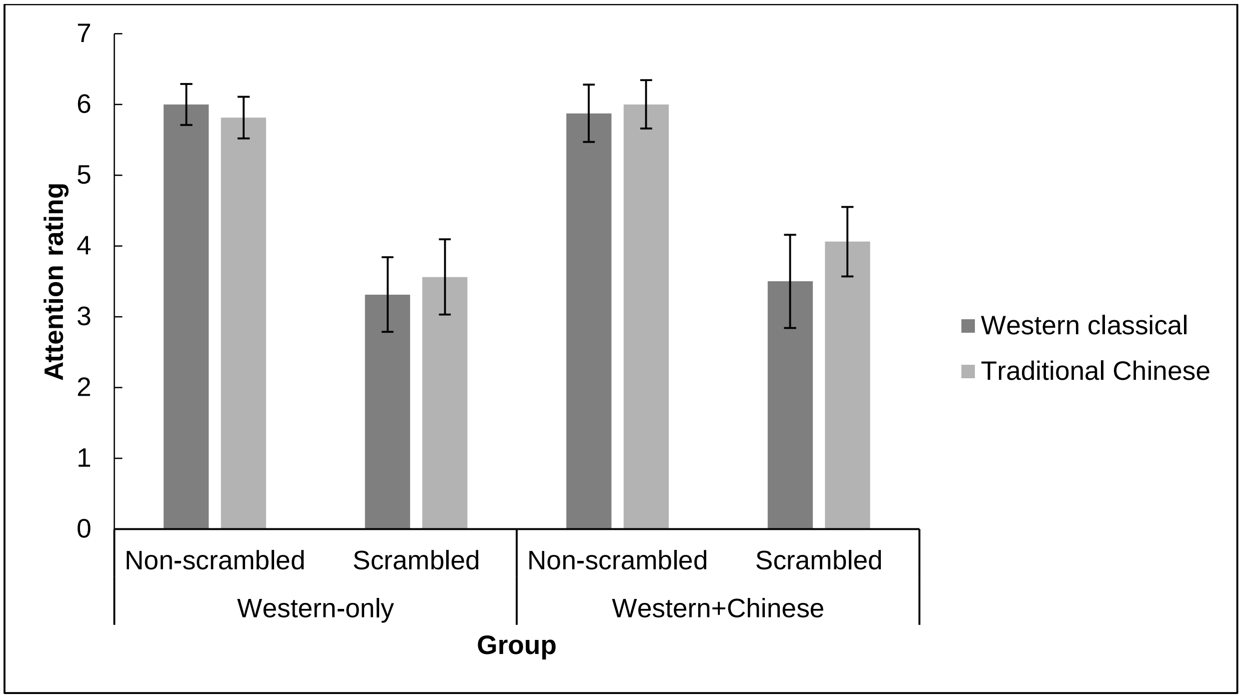


Figure 4. Effects of participant group, piece version and piece style on attention ratings (1-7; higher ratings indicate higher attention). Only the main effect of piece version (scrambled; non-scrambled) was significant. Error bars represent SEM.

Liking and Attention Effects

To check whether liking and attention ratings were related to the number of measured chills, all pieces for all participants were categorized as having received High Liking (score of 5 or more) or Low Liking (4 or less), and as High Attention (5 or more) or Low Attention (4 or less). Through this categorization, there was total of 64 High Liking pieces compared to a total of 64 Low Liking pieces, and a total of 78 High Attention pieces compared to a total of 50 Low Attention pieces. Two independent samples t-tests were then run on the number of measured chills, comparing High and Low Liking pieces and High and Low Attention pieces (see Figure 5). It was found that High Liking pieces elicited significantly more chills (M=2.2, SD=3.58) than Low Liking pieces (M=0.34, SD=1.45; $t(92.93) = -3.32$, $p<0.001$). Similarly, High Attention pieces elicited significantly more chills (M=2.02, SD=3.47) than Low Attention pieces (M=0.1, *SD*=0.46; *t*(81.23)= -4.83, *p*<0.001). This is in support of the hypothesis that higher liking and attention predict higher number of elicited chills. Moreover, Panksepp's (1995) finding of a correlation between liking and number of chills was replicated (*r*(128)=0.37, *p*<0.001) and also extended to a correlation between attention and number of chills (*r*(128)=0.35, *p*<0.001).

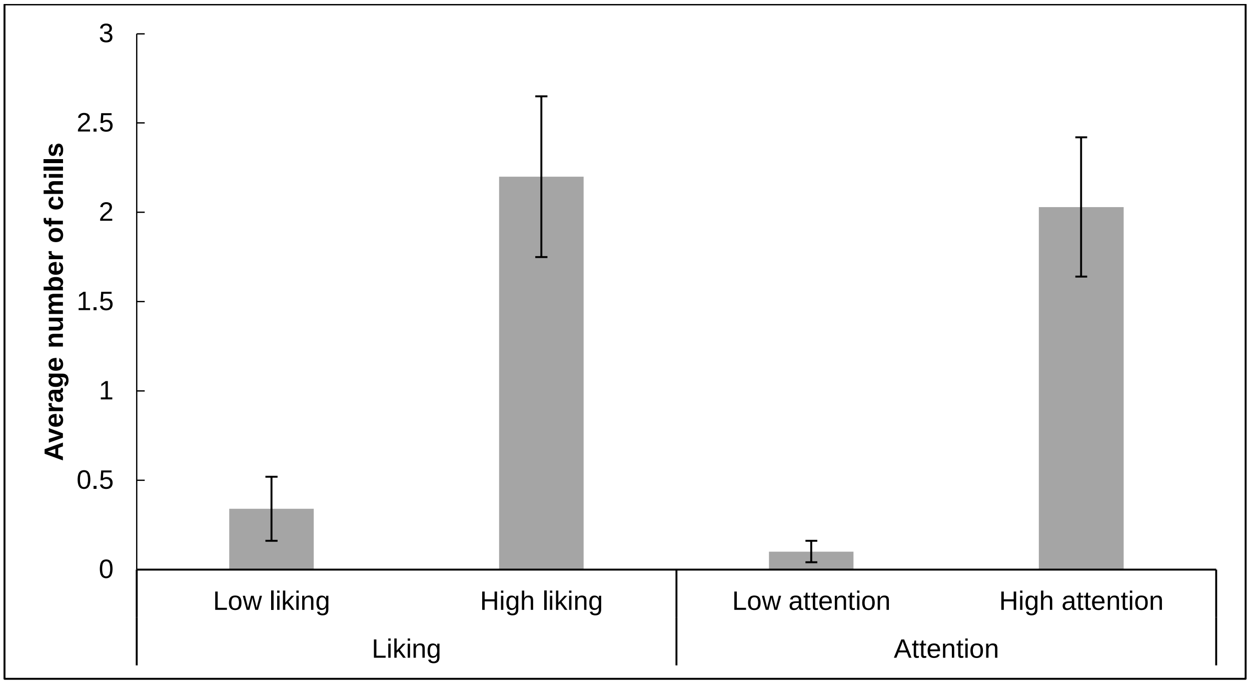


Figure 5. Effects of liking and attention on number of chills. Error bars represent SEM.

A subsequent, exploratory analysis further tested this relationship. All pieces for all participants were categorized as Chill if they had elicited one or more chills, and as No-chill if they had not elicited any chill. Two independent samples t-tests were run on liking and attention ratings, comparing Chill and No-chill pieces. It was found that Chill pieces received significantly higher liking scores (*M*=5.64, *SD*=1.33) than No-chill pieces (*M*=3.65, *SD*=2.04; *t*(120)= -6.6, *p*<0.001). Chill pieces also received significantly higher attention scores (*M*=5.77, *SD*=1.00) than No-chill pieces (*M*=4.24, *SD*=1.79; *t*(125.32)= -6.19, *p*<0.001). This suggests that not only high liking and attention for the pieces predicted number of chills, but also that whether a piece elicited any chills predicted how much participants liked and were able to pay attention to the piece. The results of all of these t-tests were still significant even after correcting for multiple comparisons.

Given the similar effects of liking and attention, an exploratory correlation was run between the two measures (see Figure 6). Liking and attention were significantly correlated ($r(128)=.8$, $p<0.001$). Follow-up analyses found that 15 out of 16 participants also showed a significant positive correlation between these two measures on the single-subject level. This indicates that pieces receiving high liking ratings also received high attention ratings, explaining the similar patterns of results associated with these two measures.

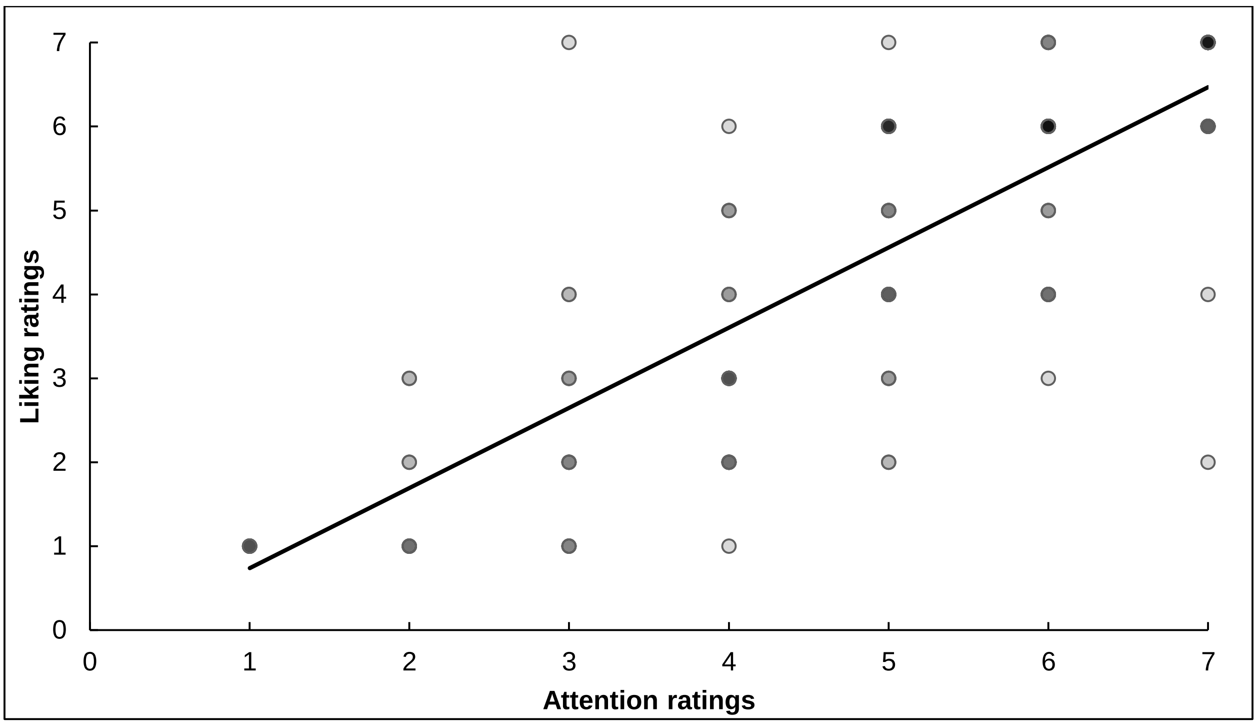


Figure 6. Significant correlation between liking and attention ratings. A total of 128 responses are plotted (responses to 8 pieces for 16 participants). Dot shading indicates the number of participants represented by each data point, with darker dots reflecting greater overlap.

Knowledge Tests

Comparisons were made across participant groups on the results of the musical knowledge survey. These were conducted to check whether the levels of knowledge of Western classical music, of Traditional Chinese music, and of music theory were different across groups. For each participant, the score for each type of knowledge was equal to the percentage of correct responses on the survey for that knowledge type. Because all participants reported being familiar with Western classical music, I predicted that there would be no differences in Western classical knowledge and music theory knowledge. However, since only the Western+Chinese group had reported being familiar with traditional Chinese music, I predicted that this group would show significantly higher traditional Chinese knowledge than the Western-only group. This prediction was supported by independent samples t-tests. While there were no significant group differences in Western classical knowledge and in music theory knowledge, Western+Chinese participants scored significantly higher in traditional Chinese knowledge (M=33.75%, SD=32.92) than Western-only participants (M=6.25%, SD=10.6; $t(8.44)= -2.25$, p=0.05). An exploratory analysis found that there were no reliable correlations between any of the different types of knowledge and total number of chills for each participant, showing that explicit musical knowledge was not necessary for the experience of chills (consistent with Grewe & Kopiez, 2009).

Discussion

The results of this study supported the main hypothesis that participants would not differ in the number of chills experienced while listening to Western classical music and traditional Chinese music, regardless of their familiarity with the latter style. The finding that participants in both the Western-only group and the Western+Chinese group had significantly more chills to non-scrambled music than to scrambled music suggests that a null effect of group and style on number of chills is not due to a failed experimental manipulation. On the contrary, this null finding can be interpreted as meaning that people can still experience strong emotional responses to music from a different culture with which they are unfamiliar (a conclusion similar to that of Craig, 2005 when comparing musicians and non-musicians with a similar sample size). Moreover, the results suggest that familiarity with a style is not necessary for liking and being able to pay attention to the music.

In accordance with Grewe et al. (2007), only chills that were both reported through a button press and that showed a peak in skin conductance were analyzed, even though other studies on chills have relied only on self-report (Nusbaum & Silva, 2010; Panksepp, 1995; Sloboda, 1991). The reason for this was that the main purpose of this study was to assess whether people could experience strong felt emotion even in music from a different culture. The skin conductance measure, reflecting sympathetic nervous system activation, was therefore an objective indicator of felt emotion. Nevertheless, when including all reported chills regardless of whether they had been measured, all statistical tests led to the same conclusions. Thus, while research on chills may rely just on self-report, including a measure of skin conductance is a further assurance of the validity of the results.

The second hypothesis of the study was that liking and attention ratings for each piece would predict the number of chills experienced. This hypothesis was also supported. However, since liking and attention were not pre-assigned independent variables, in that participants rated each piece on their own accord, a causal relationship cannot be determined. Furthermore, it was found that whether a piece elicited chills was also a predictor of how much the piece was liked and attended to. It is therefore equally possible that a piece was rated as more liked and attended to because of the experienced chills, or that the piece elicited more chills because it was liked and attended to. Either way, this relationship fits with the literature, which shows that chill-inducing excerpts are rated as more pleasurable than non-chill-inducing excerpts (Salimpoor et al., 2009), that there is a correlation between liking and reported chills (Panksepp, 1995), that people report increased mental alertness associated with chills (Craig, 2005), and that people report more chills when listening to music closely (Nusbaum et al., 2014). Additionally, attention and liking for the pieces were correlated.

Liking, Attention and Chills

While this study did not explore the direction of causality between liking, attention and number of chills, Brattico et al. (2013) provide an interesting framework for understanding their complex relationship. Drawing from neurological evidence, Brattico et al. theorize about the process leading from the perception of basic musical features to the generation of discrete emotions, aesthetic emotions, and conscious liking. At the first stage of musical understanding is feature analysis and integration, which allows for the perception of contour (the ups and downs of a melody), intervals, Gestalt sound patterns and beat. This is followed by the cognitive processing of rules and stylistic standards, including the detection of unexpected sounds violating these rules. Brattico et al. agree with Meyer (1967) that this stage plays a major role in the creation of aesthetic emotional responses. Simultaneous to feature analysis and cognitive processing are early emotional reactions to music. These include “core liking,” a pleasurable experience of which a listener is unaware, but which may subliminally determine later judgments. It is also described as a way in which pleasure centers of the brainstem are quickly activated, bypassing the mediation of higher-order brain structures. Additional aspects of this pre-attentive emotional reaction are arousal and valence. Through these, core liking is categorized into discrete emotions in music, similarly to how arousal and valence lead from basic core affect to the categorization of felt emotion (Barrett, 2006). Most relevant for this discussion, however, is the following step, which includes aesthetic judgments and aesthetic emotions. While aesthetic judgments are conscious evaluations of the beauty of the piece, aesthetic emotions include the experiences of awe, being moved, enjoyment, nostalgia and, most importantly, chills.

Brattico et al. posit that aesthetic emotions are distinct from discrete emotions (such as happiness or anger) in that they do not present goal relevance and arise in a context removed from any material effects on people's wellbeing. Importantly, they propose that while casual, or inattentive, listening to music mostly leads to basic emotions, listening with particular attention to aesthetic aspects of the music leads to these aesthetic emotions. Only after the experience of discrete emotions and aesthetic emotions, and the creation of aesthetic judgments, do listeners evaluate their conscious liking for the piece, which may become a long-lasting attitude.

This framework, therefore, sheds light on the way that liking, attention and chills are related. While it poses attention to the music as a prerequisite for aesthetic emotions, including chills, conscious liking is seen as a deliberate process involving the appraisal of discrete and aesthetic emotions, as well as aesthetic judgments and other aspects of the music, whose relevance for liking may vary from person to person and across cultures. Therefore, while the present study suggests that liking and attention are deeply related, Brattico et al.'s model indicates that their respective effects on number of chills may arise from different psychological processes. Namely, attention may directly prepare a listener for the experience of chills; on the other hand, conscious liking may rise because of the experienced chills. These speculative relationships should be further explored by future studies in order to better understand the causes and consequences of chills.

Origins of Chills

Brattico et al.’s (2013) theory is also interesting in that it describes chills not as reflex-like responses to basic aspects of the music but rather as more complex reactions that follow a series of higher-order processes, including cognitive processing of musical structure and assessment of the discrete emotions in the piece. This is consistent with the results of Grewe et al. (2007) in that while chills often coincide with unexpected events, not all unexpected events elicit chills in all participants. In reference to the present study, no statistical analysis has yet been conducted to assess whether chills tended to co-occur for particular musical events across participants. However, a visual representation of the occurrences of chills shows that while there was much variance across participants, a few points in the music seem to have elicited chills more than others.

This is particularly visible for the Beethoven piece (see Figure 7). Three general areas in the music, marked with boxes A, B and C, appear to have elicited chills across a number of participants, while other areas (e.g., between boxes B and C) did not elicit chills at all. A preliminary analysis by a music theory expert revealed that chills in the boxed areas tended to coincide with the repetition of themes in a new voice, the entrances of new melodies or themes, and sudden dynamic changes (Dr. John Halle, personal communication, May 2nd, 2016). For example, chills in box A corresponded to the entrances of new voices that recapitulated previous motives, as well as structural elements such as cadences. Several chills in box B occurred on the first note of a new musical theme, which was also a peak in loudness. Subsequent chills in this section also corresponded to repetitions of themes as well as sudden shifts from very loud to very quiet. Box C was marked both by peaks in loudness as well as by repetitions of themes in new voices. This is consistent with the literature, according to which sudden dynamic leaps and the entry of a new voice are often associated with chills (Grewe et al., 2007; Panksepp, 1995). While it may seem surprising that chills often arose when a theme was repeated rather than being introduced, Grewe et al. (2007) observed that in one of their pieces, the main theme tended to elicit chills throughout the entire piece, whenever it was repeated. Overall, a preliminary visualization of the data from this experiment seems to coincide with Grewe at al.'s (2007) and with Brattico et al.'s (2013) models for how chills are generated. Future analyses will test whether the patterns here described were statistically significant and whether they could be found for music of both styles and also for the scrambled music.

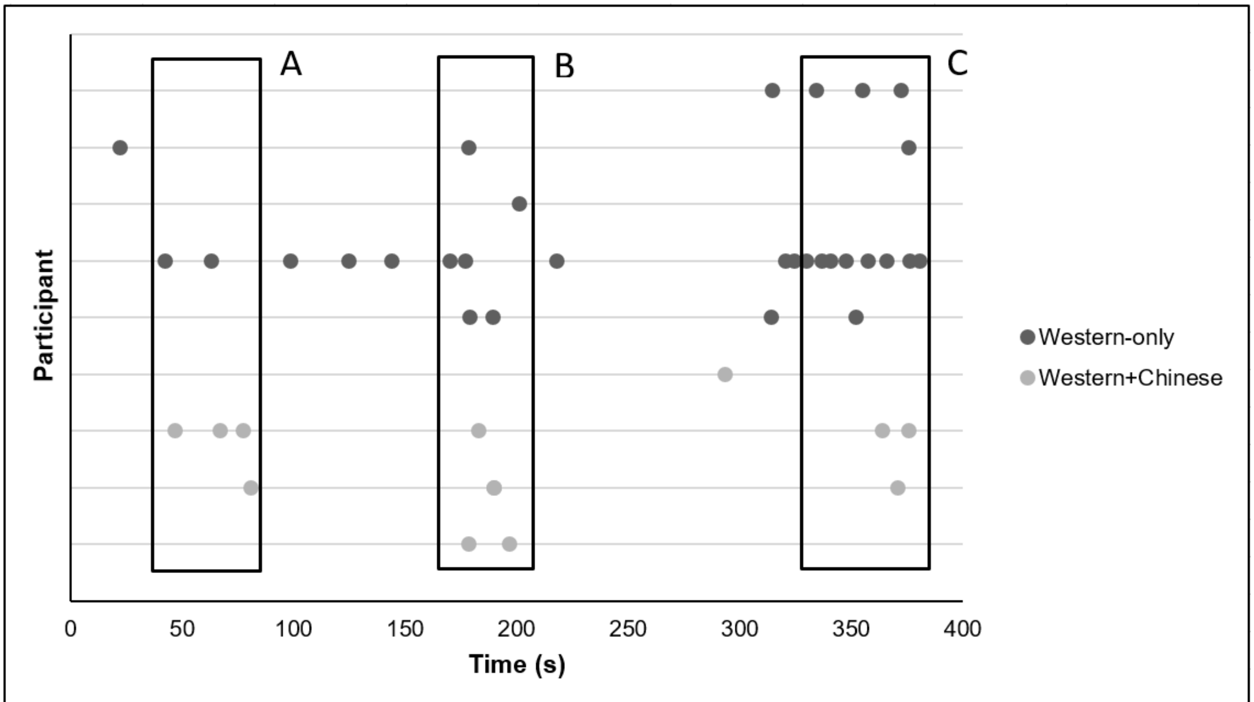


Figure 7. Visualization of the occurrence of measured chills in Western-only and in Western+Chinese participants in response to the third movement of Beethoven's String Quartet in A minor, op. 132. Each horizontal line corresponds to a participant who felt chills during this piece, and each dot corresponds to a measured chill. A total of 30 chills are plotted from Western-only participants, and a total of 13 chills from Western+Chinese participants. While responses vary greatly, some points in the music (marked with boxes) appear to have elicited chills in many participants.

Implications

Brattico et al.'s model suggests that people must have gone through the cognitive processing of musical structure and the categorization of discrete emotions before the experience of chills. This indicates that Western-only participants were able to perform these functions even for the traditional Chinese music. This is consistent with the previously reviewed literature, which showed that both American and Chinese participants are able to form structural expectations similarly for British and Chinese folk songs (Krumhansl, 1995) and that people can recognize the expressed discrete emotion of music from a different culture (Balkwill & Thompson, 1999; Laukka et al., 2013). While this experiment did not assess these two processes directly, it did include two questions in the post-piece questionnaire, adapted from Panksepp (1995), regarding the degree of perceived "happiness" and "sadness" in the pieces. While data from these two questions await analysis, it may help establish whether participants in the Western-only and in the Western+Chinese groups agreed on their perception of these two basic emotions. Future studies should also focus more directly on determining whether the understanding of musical structure and the extrapolation of expressed discrete emotions are in fact prior to the experience of chills.

Regardless of whether this is the case, the present study supports the idea that there are cross-cultural cues capable of eliciting strong felt emotion. If the processing of musical structure is found to occur before the experience of chills, then it may be possible that musical structure itself may present cross-cultural aspects, in accordance with Narmour (1990). While it is hard to come to this conclusion at present, assessing whether people can experience strong emotional reactions to music from an unfamiliar culture in the first place was a necessary step in this direction. Given that previous studies of chills did not take this into much consideration, this experiment opens up a new area of investigation into the causes of chills and into the cross-cultural aspects of musical communication.

One objection to this conclusion, however, is the fact that participants did report some chills to the scrambled pieces, albeit significantly fewer than to the non-scrambled ones. Standing to Brattico et al.'s model, this would imply that participants could process musical structure and infer discrete emotions even in the scrambled pieces to some degree. This is contrary to what would be expected, since the scrambling procedure should have removed most musical structure and disrupted musical cues of emotion. One possibility is that participants responded to the very local structural elements of the 600ms fragments. To test whether this is the case, future studies could use scrambled music divided into much shorter segments, such as 250ms, in order to more safely eliminate the effects of local structural features. It is also possible that the scrambled pieces retained some psychophysical cues of emotion, such as high sound level (associated with anger) or low sound level (associated with affection and peacefulness; Laukka et al., 2013), which led participants to be able to infer discrete emotions. Moreover, since participants heard the pieces in pseudo-random order, they could have recognized the scrambled pieces when they had previously heard their non-scrambled version (as the familiarity ratings suggest), thus recalling the emotions they had previously felt. Finally, it might be that the scrambled music induced a small number of chills thanks to unexpected acoustic events, such as peaks in loudness, which were preserved through the scrambling procedure. In fact, Grewe et al. (2007) posit that while most chills are not reflex-like and require a certain degree of processing to take place, some particularly salient acoustic events can bypass this process through a direct arousal of attention. These possible confounds should be addressed in future explorations of chills and of scrambled music, for example through the use of shorter segments or of other scrambling procedures that alter pitch as well as rhythmic structure (Fedorenko et al., 2012).

Also of importance for future directions is the recognition of the several limitations of this study. A first shortcoming is the small number of participants, which makes it harder to draw firm, generalizable conclusions from the data. This is especially true given the great variability in responses: a few participants did not report any chills, some reported just one, while others reported more than 50 throughout the experiment. Moreover, while the correlation between attention and liking was also significant at the participant level, the correlations between these measures and the number of chills only arose when considering data from all participants. This indicates that while some participants generally gave lower liking and attentions scores and felt fewer chills, others generally gave higher scores and felt more chills. Previous studies have found that individual differences influence the occurrence and number of chills. Chill responders in general tend to be more reward dependent and less sensation-seeking (Grewe et al., 2007). Within chill responders, the personality trait of openness to experience has been found to predict the number of chills reported (Nusbaum & Silva, 2010). In the future, I hope to replicate and expand my findings with a larger sample size while also further exploring the individual differences associated with different kinds of responders.

A second difficulty in this experiment was with the selection of musical pieces. As noted by Overy and Molnar-Szakacs (2009) among others, a scientific examination of music often presents the problem that controlled isolation of individual variables can lead to the reduction or even elimination of real-world musical experiences. In this case, to ensure that participants spent the same amount of time listening to each type of music, the Western classical pieces were shortened to match the length of the traditional Chinese pieces. This may have impacted the participants’ ratings of liking, as the pieces did not finish with their intended endings, presenting an ulterior difference between the Western and the Chinese pieces. Another criticism lies in the fact that while participants in both groups generally gave low familiarity ratings to the Western classical pieces, the selected pieces were written by extremely famous composers. Therefore, participants may have been familiar with the composers’ general style, which may also have changed their reactions as compared to the completely unfamiliar Chinese music.

Finally, it should be noted that it is possible that the concept of chills as intense aesthetic experiences might be a Western construct. As all participants were familiar with Western classical music, which poses aesthetic experience as one of its priorities (Becker, 1986), it was impossible to know whether people who have never been exposed to Western cultures would also have experienced chills, something that has never been studied before. As Brattico et al. (2013) suggest, aesthetic experiences tend to arise when listeners pay particular attention to aesthetic aspects of the music. Therefore, in a culture that does not emphasize these aspects, chills may not arise at all or may be expressed and experienced in different ways. Thus, while this study supports the idea that there are cross-cultural aspects of musical emotion, it does not deny the importance of cultural norms addressed by Becker (1986).

On a related note, it may also be that at least some of the cross-cultural cues of felt and recognized emotion found in music might be the result of today’s globalized world. A modern wave of ethnomusicologists argues that we cannot think of musical traditions as existing in a vacuum (Bendix, 1997). Rather, we should recognize the way that musical styles evolve and mix over time. Given the reach of Western music across the globe, it is possible that part of the cues of emotion now found in music from different cultures were at some point influenced by Western music, and vice versa.

This points to the importance of cross-cultural research and of the discourse between the fields of psychology and ethnomusicology. More studies, and further analyses of the presently collected data, should aim at addressing what specific aspects of music and of musical environments are responsible for chills across cultures. This, paired with an inquiry into the functions and history of the music involved, may lead to more concrete answers regarding the existence of musical universals.

The present study provides support for the idea that music can induce strong emotional responses in listeners of all backgrounds. This is at odds with the opinion that all musical meaning is generated by cultural norms, as well as with early studies of chills, which attributed these responses to culture-specific aspects of musical structure. On the other hand, the present results expand on the previous finding that people can infer the mood expressed by music from different cultures, by suggesting that cross-cultural cues may drive not only the recognition of discrete moods but also the subjective experience of intensely pleasurable emotions. Also in accordance with previous research, attention and liking for the pieces used in this study were strongly related to the number of chills elicited by them. As a first cross-cultural exploration of chills, this study opens new trajectories for investigating the origins of these peak responses. These pose consequences for how music as a whole expresses emotional meaning and the degree to which this expression is reducible to a commonly evolved human ability.

References

Abrams, D., Ryali, S., Chen, T., Chordia, P., Khouzam, A., Levitin, D., & Menon, V. (2013). Inter-subject synchronization of brain responses during natural music listening. *European Journal of Neuroscience, 37(9)*, 1458-1469.

Balkwill, L., & Thompson, W. (1999). A cross-cultural investigation of the perception of emotion in music: Psychophysical and cultural cues. *Music Perception: An Interdisciplinary Journal, 17(1)*, 43-64.

Barrett, L. F. (2006). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review, 10*, 20-46.

Becker, J. (1986). Is Western art music superior? *The Musical Quarterly, 72(3)*, 341-359.

Bendix, R. (1997). From fakelore to the politics of culture. *In Search of Authenticity: The Formation of Folklore Studies* (pp. 188-219). Madison: U of Wisconsin Press.

Berwick, R., & Chomsky, N. (forthcoming). The biolinguistic program: The current state of its evolution and development. In A-M. Di Sciullo & C. Aguero (Eds.), *Biolinguistic Investigations*. Cambridge MA: MIT Press.

Bigand, E., Yannick, G., & Molin, P. (2009). The contribution of local features to familiarity judgments in music. *Annals of the New York Academy of Sciences, 1169*, 234-244.

Blood, A., & Zatorre, R. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences of the United States of America, 98(20),* 11818-23.

Brattico, E., Bogert, B., & Jacobsen, T. (2013). Toward a neural chronometry for the aesthetic experience of music. *Frontiers in Psychology, 4*, 1-21.

Craig, D. (2005). An exploratory study of physiological changes during "chills" induced by music. *Musicae Scientiae, 9(2)*, 273-287.

Ellis, D. P. W. (2010). Time-domain scrambling of audio signals in Matlab [Software]. Available from: http://www.ee.columbia.edu/~dpwe/resources/matlab/scramble/

Fedorenko, E., McDermott, J., Norman-Haignere, S., & Kanwisher, N. (2012). Sensitivity to musical structure in the human brain. *Journal of Neurophysiology, 108*, 3289-3300.

Figner, B., & Murphy, R. O. (2011). Using skin conductance in judgment and decision making research. In M. Schulte-Mecklenbeck, A. Kuehberger, & R. Ranyard (Eds.), *A handbook of process tracing methods for decision research*. New York, NY: Psychology Press.

Gooding, L., Abner, E., Jicha, G., Kryscio, R., Schmitt, F. (2014). Musical training and late-life cognition. *American Journal of Alzheimer's Disease and Other Dementias, 29(4),* 333-343.

Green, S., Kregel, P., Fecteau, M., & LaBar, K. (2014). Development and validation of an unsupervised scoring system (Autonomate) for skin conductance response analysis. *International Journal of Psychophysiology*, 91(3), 186-193.

Grewe, O., Nagel, F., & Kopiez, R. (2007). Listening to music as a re-creative process: Physiological, psychological, and psychoacoustical correlates of chills and strong emotions. *Music Perception: An Interdisciplinary Journal, 24(3),* 297-314.

Grewe, O., & Kopiez, R. (2009). The chill parameter: Goosebumps and shivers as promising measures in emotion research. *Music Perception: An Interdisciplinary Journal, 27(1),* 61-74.

Harrison, L., & Loui, P. (2014). Thrills, chills, frissons, and skin orgasms: Toward an integrative model of transcendent psychophysiological experiences in music. *Frontiers in Psychology, 5,* 1-6.

Janata, P., Tillmann, B., & Bharucha, J. (2002). Listening to polyphonic music recruits domain-general attention and working memory circuits. *Cognitive, Affective, & Behavioral Neuroscience, 2(2),* 121-140.

Jiang, F., Stecker, G. C., & Fine, I. (2013). Functional localization of the auditory thalamus in individual human subjects. *Neuroimage, 78*, 295-304.

Juslin, P., & Laukka, P. (2004). Expression, perception, and induction of musical emotions: A review and a questionnaire study of everyday listening. *Journal of New Music Research, 33(3),* 217-238.

Krumhansl, C.L. (1995). Music psychology and music theory: Problems and prospects. *Music Theory Spectrum ,17,* 53-80

Krumhansl, C.L. (2002). Music: A link between cognition and emotion. *Current Directions in Psychological Science, 11(2)*, 45-50.

Lalitte, P., & Bigand, E. (2006). Music in the moment? Revisiting the effect of large scale structures. *Perceptual And Motor Skills*, *103*(3), 811-828.

Laukka, P., Thingujam, N., Eerola, T., Tamasaki, T., & Beller, G. (2013). Universal and culture-specific factors in the recognition and performance of musical affect expressions. *Emotion, 11*, 434-449.

Lerdahl, F., & Jackendoff, R. (1983). *A generative theory of tonal music.* Cambridge, MA: MIT Press.

Levitin, D., & Menon V. (2005). The neural locus of temporal structure and expectancies in music: Evidence from functional neuroimaging at 3 tesla. *Music Perception, 22(3),* 563-575.

Menon, V., & Levitin, D. (2005). The rewards of music listening: Response and physiological connectivity of the mesolimbic system. *Neuroimage, 28*, 175-184.

Meyer, L.B. (1967). *Music, the arts, and ideas.* Chicago: University of Chicago Press.

Narmour, E. (1990). *The analysis and cognition of basic melodic structures: The implication-realization model.* Chicago: University of Chicago Press.

Nettl, B. (2000). An ethnomusicologist contemplates universals in musical sound and musical culture. In N. L. Wallin, B. Merker, & S. Brown (Eds.), *The Origins of Music* (pp. 463-472). Cambridge, MA: MIT Press.

Nusbaum, E., & Silvia, P. (2010). Shivers and timbres: Personality and the experience of chills from music. *Social Psychological and Personality Science, 2*, 199-204.

Nusbaum, E., Silvia, P., Beaty, R., Burgin, C., Hodges, D., & Kwapil, T. (2014). Listening between the notes: Aesthetic chills in everyday music listening. *Psychology of Aesthetics, Creativity, and the Arts, 8(1),* 104-109.

Overy, K., & Molnar-Szakacs, I. (2009). Being together in time: Musical experience and the mirror neuron system. *Music Perception, 26(5),* 489-504.

Patel, A. (2008). *Music, Language and the Brain.* Oxford: Oxford UP.

Panksepp, J. (1995). The emotional sources of “chills” induced by music. *Music Perception: An Interdisciplinary Journal, 13(2),* 171-207.

Salimpoor, V., Benovoy, M., Longo, G., Cooperstock, J., & Zatorre, R. (2009) The rewarding aspects of music listening are related to degree of emotional arousal. *PLoS ONE, 4(10),* e7487.

Sloboda, J. (1991). Music structure and emotional response: Some empirical findings. *Psychology of Music*, *19,* 110-120.

Appendix A

IRB letter of approval and application.

Bard College Institutional Review Board

Date: October 23, 2015
To: Eleonora Beier
Cc: Justin Hulbert, Megan Karcher
From: Pavlina R. Tcherneva, IRB Chair
Re: October 2015 Proposal

DECISION: APPROVED

Dear Eleonora,

The Bard Institutional Review Board reviewed the revisions to your proposal. Your proposal is approved through October 23, 2016. Your case number is 2015OCT23-BEI.

Please notify the IRB if your methodology changes or unexpected events arise.

We wish you the best of luck with your research.

Pavlina R. Tcherneva
tchernev@bard.edu
IRB Chair

Eleonora Beier
IRB Proposal for Full Review

Title: The experience of chills in unfamiliar musical traditions

Research Question (250 words or less):

The chill response has been defined as a sudden increase in arousal in response to a passage in music. It has been measured as an increase in skin conductance response (SCR; Craig, 2005) and it has been associated with felt strong emotion and arousal (Grewe et al., 2009). While it has been proposed that chills are induced by culture-specific structural elements of music such as harmonic modulations (Sloboda, 1991), recent evidence indicates that there might be cross-cultural cues of emotion that allow listeners from diverse cultural backgrounds to infer what mood is being expressed in a piece from a different culture (Laukka et al., 2013). Could chills also be triggered by cross-cultural, shared cues, allowing people to experience chills in music from a different tradition? I will test whether participants with only knowledge of classical Western music and participants with the additional knowledge of traditional Chinese music show differential behavioral and/or skin conductance responses to pieces coming from either tradition. If the same number of chills will be observed in both groups for both the classical Western and the traditional Chinese pieces, but not to control scrambled pieces, I will infer that the Western-only group experienced chills in both the familiar and the unfamiliar music. In addition, this design will address the question of whether these hypothetical cross-cultural cues are related to acoustic features of the music that, even in the scrambled pieces, could produce a chill, or whether they depend on structure.

Briefly describe how you will recruit participants (e.g., Who will approach participants? What is the source of the participants?)

The existing literature suggests that an estimated 15 participants per group will be sufficient to achieve adequate power in order to test for differences in chills across individuals with Western-only or Western-plus-Chinese musical backgrounds. To populate these groups, an initial screening survey (described in detail in the next question) will be offered to the wider Bard community. Information about the study, along with a link to the online survey will be emailed to relevant Bard listservs (e.g., music classes and student groups, with permission of the relevant administrators). Additionally, I plan to advertise the study through fliers on campus. The survey itself will start with an informed consent screen informing recruits about the study, their rights (e.g., the ability to stop the survey at any time without penalty), and that by entering their information (full name and email) they will be automatically entered in a raffle for a $25 Amazon gift card. The survey will ask a number of questions assessing the recruits' level of experience with classical Western and/or traditional Chinese music, their music preferences, and their general experience with music. At the end of the survey, participants will be asked to provide their contact information (email and full name) to be entered in the survey raffle, which will take place at the end of the spring semester (the participants' names will be associated with randomly generated numbers, and then one of these numbers will be selected at random in order to assure fairness). Survey respondents will also be asked whether they would like to be contacted in the future to be part of the main experiment (described below). Interested parties will be told that if they are selected and choose to participate in the main experiment, they will be eligible to participate in a separate raffle for a $50 Amazon gift card. Of all the respondents who complete the survey and who showed interest in being part of the main experiment, I will later contact only those who demonstrated both knowledge and interest/enjoyment of either classical Western music alone or of both Western and Chinese music, and who reported normal hearing. These participants will be contacted through an email reminding them of their participation in the survey and asking them whether they would still like to be part of the main experiment. Should I not hear back from the recruit one way or another after five days, a second (and final) recruitment email will be sent. Recruits who indicate a continued desire to be part of the main experiment will be scheduled for individual testing. Upon arrival, recruits will go through an informed consent process. All participants will be offered candy (should they desire to partake) during their participation, in addition to being entered in the $50 gift card raffle as compensation for their participation.

Briefly describe the procedures you will be using to conduct your research. Include descriptions of what tasks your participants will be asked to do, and about how much time will be expected of each individual. NOTE: If you have supporting materials (recruitment posters, printed surveys, etc.) please email these documents separately as attachments to IRB@bard.edu. Name your attachments with your last name and a brief description (e.g., "WatsonConsentForm.doc").

1. Musical knowledge and preferences survey: A link to the survey will be sent to relevant members of the Bard community via electronic mailing lists, in addition to being advertised with fliers posted on campus. After an informed consent screen, participants will be asked questions of four main categories: musical experience; musical preferences; knowledge of classical Western music; knowledge of traditional Chinese music. Questions of musical experience will be adapted from a study on the relationship between musical training and late-life cognition (Gooding et al., 2014). Sample questions include: "If you currently play one or more instruments or sing, how many years total have you played? This includes years of training and years of just playing combined", "If you currently play one or more instruments or sing, how often do you usually play?", "If you currently play one or more instruments or sing, how proficient do you think you are?". Answers will be given on a 5-point Likert scale. The questions on musical preferences

will include items such as "What are your top 3 favorite styles of music?", "From a scale from 1 to 5, how much do you enjoy listening to traditional Chinese music?", "Approximately how much time do you spend per day listening to music?", "Approximately how many live concerts (of any genre) have you watched?". The questions on knowledge of classical Western and traditional Chinese music will be of two types: music theory and music history questions. An example music theory question could be to read notes in Western notation and in the numbered musical notation used for Chinese music. Music history items will be broad questions on composers and/or styles typical of both traditions. Finally, participants will fill out demographic information (age, gender, country of birth, country of residence), report their handedness and whether they have normal hearing. The survey should not take more than 15 minutes to complete.

2. Main Experiment:
    a. Stimuli. Musical selections from three categories: 1. classical Western; 2. traditional Chinese; 3. pieces generated by separately scrambling the pieces used in the previous two conditions. The third category will work as a control by presenting stimuli with many of the same acoustic features (e.g. average pitch and loudness) as the previous two, but without the necessary structure thought to convey emotion, in accordance with Lerdahl and Jackendoff's (1983) generative theory of tonal music. There will be two classical and two Chinese pieces, leading to four scrambled pieces. The pieces will be selected according to the following criteria: 1. Highly emotional; 2. Instrumental (no voice/lyrics); 3. Between 3 and 10 minutes in length; 4. Relatively unknown.
    b. Behavioral measures. Participants will first sign an informed consent form. The task will be explained to them thoroughly, and they will be given a definition of what is meant by "experiencing a chill". They will then be seated at a computer screen and asked to wear a headphone set connected to the computer. An automated computer script will play the pieces in random order. Participants will be instructed to rest their dominant hand on the response device and press a button every time they start feeling a chill, and to keep pressing it for its entire duration. After listening to each piece, participants will manually answer a few questions presented by the computer. The questions will be: "Have you heard this piece before?", "On a scale from 1 to 5, rate how familiar you are with this piece", "How much did you enjoy listening to this piece? (1-5)", "How intense was your experience of this piece? (1-5)".
    c. Psychophysiological measures. I hope to monitor participants' skin conductance as an objective measure of physiological arousal, since peaks in the Skin Conductance Response (SCRs) have been linked to the chill response. Before the start of the experiment, participants will be asked to wash their hands, after which two passive Nihon Kohden electrodes will be placed on the non-dominant hand with electrode paste. The purpose of the paste is to facilitate the transmission of

the signal, as part of the standard procedure for measuring skin conductance, and it is completely safe (Figner & Murphy, in press). The electrodes will be thoroughly cleaned between uses. The skin conductance attachments were designed to be integrated with the BioSemi ActiveTwo system that will digitize and record the physiological responses synced to the presentation of the musical pieces. SCRs will be identified through Autonomate, a free MATLAB toolbox (Green et al., 2014).

Approximately how many individuals do you expect to participate in your study?
Previous research (Craig, 2005) suggests that a sample size of approximately 30 individuals (15 per group) is sufficient to achieve reliable chill responses.

Please describe any risks and benefits your research may have for your participants. (For example, one study's risks might include minor emotional discomfort and eyestrain. The same study's benefits might include satisfaction from contributing to scientific knowledge and greater self-awareness.)

1. This study should involve minimal risk for all participants. Participants will be told in advance what will happen in the study and will be informed of their option to withdraw from participation at any time while still being entered in the raffle. The skin conductance electrodes involve no risk of electric shock. There is a very small risk that the electrodes will cause a mild skin irritation. This requires no treatment and will disappear within a few minutes, with no long-term damages. Wearing the headphones for a prolonged period of time might involve a slight discomfort in some participants. All participants will be allowed to remove the headphones for a short break halfway through the experiment, and will be encouraged at the beginning to let the experimenter know if they experience serious discomfort and would like to stop. Participants will be given a sample piece of music that will allow them to adjust and lock a comfortable volume setting that will be used across all pieces.
2. All participants in the main experiment will be compensated with candy. The winners of the survey and main raffle will also be compensated with the $25 and $50 Amazon gift cards, respectively. In addition, a possible benefit of the main experiment is to be exposed to traditional Chinese music, which will be a new and hopefully pleasurable experience for participants not previously exposed to it. Finally, participants might benefit from learning more about this topic through the debriefing, while also feeling satisfaction for having contributed to the advancement of knowledge in this area.

Please include here the verbal description of the consent process (how you will explain the consent form and the consent process to your participants):
Upon arrival, participants will be informed that the purpose of the experiment is to observe people’s emotional reactions to different kinds of music. They will be given a short overview of

what will happen in the study, specifically regarding what is meant by "chill response", as they will be asked to report any chills they feel throughout the experiment. They will be told that not everyone experiences chills in all types of music, therefore not to report any chills if they do not feel any. They will be given a copy of the consent form and be asked to read it carefully before signing it, and to ask any questions they may have. Before and after signing the consent form, they will be reminded of their ability to withdraw from participating at any time without penalty.

What procedures will you use to ensure that the information your participants provide will remain confidential?

The data from the survey will be automatically saved to a Google Drive spreadsheet under my account. In addition to the participants' responses, these data will contain the participants' names and email addresses for those who reported them. Google Drive documents are encrypted and can only be accessed through the password of the Google account, so there is no danger that the data will be publicized unless the account is hacked. Those participants who reported their interest in the main experiment will be assigned to a randomly generated participant number. The data collected in the main experiment will then only be associated with the participant number. Both the participant's name and the data associated with their number will only be shared by the experimenter and her senior project advisor and will be stored in a password-protected computer in a secure location. If data collected in this project were to be published, the data will be entirely stripped of any information capable of identifying the subjects.

Appendix B

Text of the recruitment email and flier.

Subject line: Like music? Fill out a short survey!

Do you like listening to music? Do you want a chance to win a $25 Amazon gift card?
Help me out in my psychology senior project by filling out a short survey on your experience and preferences in music!
The survey won't take more than 10 minutes. By completing the survey, you will be entered in a raffle for a $25 gift card!
To be eligible, you need to be at least 18 years old.
Here is the survey link: https://goo.gl/Yt8q1Z
(if the link doesn't work, copy and paste it into your web browser)
If you have any questions, contact Eleonora Beier at eb4385@bard.edu.

Thank you!!

Nora

Appendix C

Screening survey.

Music experience and preferences survey

* Required

INFORMED CONSENT AGREEMENT

Protocol number: 2015OCT23-BEI Expires: 5/20/2016
Music Experience Survey

Experimenter: Eleonora Beier (eb4385@bard.edu)
Supervisor: Dr. Justin Hulbert, Psychology Program (jhulbert@bard.edu)

You are being asked to fill out this survey as part of a Bard psychology senior project on musical experiences and preferences.

In this survey, you will be asked questions of two types: your musical experience (e.g. whether you play an instrument) and your musical preferences (e.g. your favorite kind of music).

The survey will take approximately 10 minutes.

If any of the questions cause you any discomfort, you are welcome to stop the survey at any time by simply closing the browser.

At the end, you will be asked to leave your name and email address if you would like to be included in a raffle for a $25 Amazon gift card. If you win the raffle, you will receive an email notification by the end of the spring semester.

At the end of the survey, you will also be asked if you would like to be contacted for an experiment on people's emotional reactions to different kinds of music. Should you be contacted for this experiment and choose to then participate, your name will also be entered in a separate $50 Amazon gift card raffle.

There are no risks and benefits associated with taking the survey. Your responses will be kept confidential and will only be shared by the experimenter and her senior project adviser.

Your participation in this survey is voluntary and you are free to quit it at any time.

If you have any questions or concerns, please contact Eleonora Beier at eb4385@bard.edu or Dr. Justin Hulbert, Psychology Program, Bard College, Annandale-on-Hudson, NY 12504, jhulbert@bard.edu. If you have questions about your rights as a research participant, please contact the Bard College Institutional Review Board at irb@bard.edu.

By checking the box below, you agree to participate and certify that you have read the information above and are at least 18 years old.

1. *

Check all that apply.

☐ I agree to participate in this survey and certify that I am at least 18 years old.

Musical experience

Please answer the following questions:

2. **1. Do you currently play an instrument or sing? For this survey, “currently” is defined as playing or singing that took place in the last year. If you answer no, skip to question 9.**

   Mark only one oval.

   - Yes
   - No

3. **2. Write all instruments that you currently play. If you sing, write “voice.”**

   ....

4. **3. If you currently play one or more instruments, what is your primary instrument? If you sing, write “voice.”**

   ....

5. **4. Have you ever been formally trained in your primary instrument (e.g. private lessons)?**

   Mark only one oval.

   - Yes
   - No

6. **5. If yes, at what age did you first start music lessons, classes, or training for your primary instrument? If you ever stopped and restarted, please give the age at which you started playing or singing for the first time**

   ....

7. **6. How many years total have you played (any instrument)? This includes years of training and years of just playing combined**

   ....

8. **7. How often do you usually play?**
Mark only one oval.

- Less than once a month
- Once or twice a month
- 1-3 times a week
- 4-6 times a week
- Daily

9. **8. How proficient do you think you are?**
Mark only one oval.

- Not proficient
- Slightly proficient
- Average
- Above average
- Highly proficient

10. **9. If you do not currently play or sing, did you play an instrument or sing in the past?**
If you currently play or sing or if you answer no to this question, please skip to question 13.
Mark only one oval.

- Yes
- No

11. **10. Write all instruments that you played in the past. If you sang, write "voice."**

12. **11. At what age did you stop playing or singing?**

13. **12. How many years total did you participate in music lessons, classes, or training?**

14. **13. If you currently play an instrument or sing or if you did so in the past, what broad categories of repertoire do you or did you mostly play? (e.g. Baroque, Romantic, Jazz, Pop, music from a different culture…)**

15. **14. Are you a student enrolled in the Bard Conservatory?**
Mark only one oval.

- Yes
- No

16. **15. What is your major?**

....

17. **16. Have you taken any music theory or ear training classes prior to Bard?**
Mark only one oval.

- Yes
- No

18. **17. Have you taken any music theory or ear training classes at Bard?**
Mark only one oval.

- Yes
- No

19. **18. If you have taken music theory classes, how proficient do you think you are in music theory?**
Mark only one oval.

- Not proficient
- Slightly proficient
- Average
- Above average
- Highly proficient

Musical preferences

These questions will ask you to describe your attitudes towards music in general and towards Western classical music and traditional Chinese music in particular. For this survey, Western classical music refers to European art music from 1000 AD to the early 1900s, while traditional Chinese music refers to the folk, art, and court music of China from the 12th century BCE to present.

Please respond to the required questions, since these are particularly important for learning about your preferences.

20. **1. What are your top 3 favorite styles of music? (e.g. Rock, classical…)**

....

21. **2. Approximately how many times during the week do you listen to music? (Do not count the times you play an instrument or sing)**
Mark only one oval.

- Less than once a week
- 1-3 times a week
- 4-6 times a week
- Once a day
- Multiple times per day

22. **3. Approximately how much time do you spend listening to music in a day? (Do not count the time you spend playing an instrument or singing)**
Mark only one oval.

- Less than an hour
- 1-2 hours
- 3-4 hours
- 5-6 hours
- More than 7 hours

23. **4. How much do you enjoy listening to music?** *
Mark only one oval.

	1	2	3	4	5	
Not at all						Very much

24. **5. Approximately how many live concerts (of any genre) have you watched in your lifetime?** *
Mark only one oval.

- None
- 1-4
- 5-10
- 11-20
- More than 20

25. **6. Do you ever listen to traditional Chinese music?** *
Mark only one oval.

- Yes
- No

26. **7. How much do you enjoy listening to traditional Chinese music?** *

If neutral or completely unfamiliar with this type of music, select "3"
Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

27. **8. Do you ever listen to Western classical music?** *

Mark only one oval.

- ◯ Yes
- ◯ No

28. **9. How much do you enjoy listening to Western classical music?** *

If neutral or completely unfamiliar with this type of music, select "3"
Mark only one oval.

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

29. **10. Approximately how many live concerts of traditional Chinese music have you watched?** *

Mark only one oval.

- ◯ None
- ◯ 1-4
- ◯ 5-10
- ◯ 11-20
- ◯ More than 20

30. **11. Approximately how many live concerts of Western classical music have you watched?** *

Mark only one oval.

- ◯ None
- ◯ 1-4
- ◯ 5-10
- ◯ 11-20
- ◯ More than 20

31. **12. Has music of any kind ever caused you to feel very emotional?** *
Mark only one oval.

- Yes
- No

32. **13. Have you ever felt a shiver down your spine or goosebumps while listening to any kind of music?** *
Mark only one oval.

- Yes
- No

33. **14. Has listening to Western classical music ever caused you to feel a shiver down your spine or goosebumps?** *
Mark only one oval.

- Yes
- No

34. **15. Has listening to traditional Chinese music ever caused you to feel a shiver down your spine or goosebumps?** *
Mark only one oval.

- Yes
- No

Demographic information

35. **1. What is your age?**

36. **2. What is your gender?**
Mark only one oval.

- Female
- Male
- Non-binary
- Other:

37. **3. What country do you live in?**

38. **4. In what country were you born?**

39. **5. Is English your first language?**
Mark only one oval.

- ( ) Yes
- ( ) No

40. **6. If English is not your first language, what is your first language?**

....

41. **7. List any other language you are fluent in other than English (if none, leave this blank).**

....

42. **8. Which is your dominant hand?**
Mark only one oval.

- ( ) Right
- ( ) Left
- ( ) Ambidextrious

Feedback

You are almost done with this survey. Before moving to the last page, is there any feedback you would like to give us about this survey? Mention anything you think should be revised, removed, or added, or if any question was confusing to you. Any comment is greatly appreciated!

43. **Enter your feedback here.**

....
....
....
....
....

Personal information

You have the opportunity to be entered in a raffle for a $25 Amazon gift card. If you win the raffle, you will receive an email notification by the end of the spring semester. To participate in the raffle, please enter your full name and email address below. Your information will be kept confidential as specified in the consent form.

If you are not interested in entering the raffle, you are free not to leave your name and email address.

44. **First name:**

....

45. **Last name:**

46. **Email address:**

Future experiment participation

I am currently running an experiment on people’s emotional reactions to different kinds of music. Participants come into a lab and listen to music while their skin conductance (a non-invasive measure of the hands’ natural sweat response) is measured. Participants in this experiment are entered in a raffle for a $50 Amazon gift card. Would you like to be contacted in order to participate in this experiment?

47. *

Mark only one oval.

- Yes
- No

48. **If you selected "Yes", please enter your phone number:**

This might be used to contact you for participating in the experiment.

If you selected “Yes”, please leave your contact information (name and email address) above, if you have not done so already. If you are selected to participate in the experiment, you will be contacted through email. Answering “Yes” does not make your decision final: you will be asked again through email whether you are still interested in participating, you will go through an informed consent process prior to the experiment, and you will be allowed to withdraw from the experiment at any time.

You have finished the survey. Please make sure the information on this last page is correct before hitting “Submit”, or we will be unable to enter you in the raffle or contact you for the future experiment.

Thank you very much for your participation!

If you have any questions or concerns, please contact Eleonora Beier at eb4385@bard.edu or Dr. Justin Hulbert, Psychology Program, Bard College, Annandale-on-Hudson, NY 12504, jhulbert@bard.edu.

Appendix D

Main experiment consent form.

INFORMED CONSENT AGREEMENT **Skin conductance**

Protocol number: 2015OCT23-BEI **Expires:** 5/20/2016
Study title: The experience of chills in unfamiliar musical traditions
Experimenter: Eleonora Beier (eb4385@bard.edu)
Supervisor: Dr. Justin Hulbert, Psychology Program (jhulbert@bard.edu)

Background: The purpose of this study is to observe people's emotional reactions to different kinds of music. In particular, I am interested in the "chill response". A *chill* is the feeling you get when, listening to music or to someone speak, you feel a shiver down the spine or in the arms, sometimes (but not necessarily) accompanied by goosebumps. Not everyone experiences chills, especially in music, so don't worry if that does not sound familiar. In this study you will listen to music and report every time you feel a chill. If you have any questions about chills, please ask the experimenter!

What will happen in the study: If you decide to participate, you will be asked to listen to several pieces of music through headphones. During each piece, you will rest your right hand on a computer response device. Every time you experience a chill, you will press a button, and keep it pressed for the entire duration of the chill. As not everyone experiences chills for all types of music, it is completely acceptable for you not to report any chills if you do not feel any. After listening to each piece, you will be asked a few questions regarding your familiarity and your enjoyment of the piece. The experiment will last about one hour.

During the study, I will record changes in your skin conductance, which reflects the variations in the hand's natural sweat response. With the use of a small amount of paste, two sterilized electrodes will be attached to your left hand for the entire duration of the experiment. The electrodes will be plugged into a set of electrically isolated amplifiers, meaning that there is no chance they could shock you. Participants are encouraged to keep the researcher informed of their continued comfort during the application of, removal of, and recording using the skin conductance electrodes.

Risks and benefits: There are no serious health risks associated with this study. There is a small risk that the electrodes will cause a mild skin irritation. This requires no treatment and will disappear within a few minutes, with no long-term damages. If wearing the headphones for a long period of time causes you discomfort, you are encouraged to let the experimenter know between pieces and take a short break. You are also welcome to withdraw from participation at any time during the experiment, should you feel uncomfortable in any way.

There is no direct benefit of participating, but the data collected in this study will help furthering the scientific understanding of the way music expresses emotion. Through this experiment, participants will also gain insight into the way experimental senior projects in psychology are conducted at Bard.

If you are a student at Bard College and find that any aspect of the experiment caused you distress, you are encouraged to contact the Bard Counseling Center at 845-758-7433 during normal business hours or at 845-758-7777 after hours or on weekends.

Compensation: You will be compensated at the end of the experiment in the form of candy. Your name will also be entered in a $50 gift card raffle that will take place once all participants have been run. If you win the raffle, you will receive a notification towards the end of the 2016 spring semester.

Participant's rights: Your participation in this experiment is voluntary and you have the right to withdraw at any time by letting the experimenter know. You will still receive compensation in the form of candy and your name will still be entered in the raffle regardless of whether you complete the experiment.

You will learn more about the study's hypotheses at the end of the session. If you would like to ask any additional questions about the experiment, you are welcome to contact Eleonora Beier at eb4385@bard.edu or Dr. Justin Hulbert, Psychology Program, Bard College, Annandale-on-Hudson, NY 12504, jhulbert@bard.edu. If you have questions about your rights as a research participant, please contact the Bard College Institutional Review Board at irb@bard.edu.

Anonymity: Your responses will be kept confidential. Your name will be assigned to a random participant number, and data collected from your session will only be associated with this number. Your name will be saved in a different location so that we may enter you in the raffle. Both your name and the data associated with your participant number will only be shared by the experimenter and her senior project advisor and will be stored securely in a password-protected computer.

STATEMENT OF CONSENT

"I have read this consent form and agree to participate in this study. I am aware of the purpose of the study, the risks and benefits involved, and the way I will be compensated. I have had an opportunity to ask any questions, and I have received satisfying answers. I understand that I may withdraw from this study at any time”

By signing below, you agree with the above statement of consent and certify that you are at least 18 years old:

Participant signature____________________________ Date______________

Participant printed name_____________________________

Experimenter signature__________________________

Appendix E

Post-piece questionnaire (adapted from Panksepp, 1995).

How much did you like this piece?
1 = Strongly disliked (I would not listen to this again)
4 = Neither liked nor disliked
7 = Strongly liked (I would look for this piece in the future)

How familiar are you with this piece?
1 = Not familiar (never heard it before)
4 = Somewhat familiar (music sounds familiar but can’t recognize it)
7 = Very familiar (I’ve heard this many times and can recognize its name/composer)

How much were you able to keep you attention focused on the piece?
1 = Not at all
4 = Somewhat
7 = Completely

How would you rate the level of emotional content in this piece?
1 = Not very emotional
4 = Somewhat emotional
7 = Strongly emotional

How would you rate the level of sadness/melancholy in this piece?
1 = low level of sadness/melancholy
4 = moderate level of sadness/melancholy
7 = high level of sadness/melancholy

How would you rate the level of happiness/excitement in this piece?
1 = low level of happiness/excitement
4 = moderate level of happiness/excitement
7 = high level of happiness/excitement

How much did this piece affect your mood and feelings?
1 = Not at all
4 = Moderately
7 = Very much

Appendix F

Musical knowledge survey.

Testing day survey

* Required

1. **Please ask the experimenter to insert your participant number.**

2. **Please ask the experimenter to insert your condition.**

The following questions will test your general level of knowledge of Western classical music and of traditional Chinese music. For the purpose of this survey, it is important that you do not refer to outside sources (e.g. internet) in order to answer correctly. Depending on your musical background, you might not know the answer to all of the questions. If you do not know the answer to a question, please select “I don’t know.” Your responses will be kept confidential as specified in the consent form. We appreciate your honesty and collaboration.

Western classical music questions

3. **1W. Which one of these operas is NOT by Verdi?** *
   Mark only one oval.
   - Aida
   - Nabucco
   - Traviata
   - Madame Butterfly
   - I don’t know

4. **2W. Gregorian chant is a style typical of:** *
   Mark only one oval.
   - ancient Rome
   - the Middle Ages
   - the 1700s
   - I don’t know

5. **3W. "Modulation" means:** *
Mark only one oval.

- singing from memory
- passing from one key to another in the same piece
- tuning a wind instrument
- I don't know

6. **4W. Which composer is most famous for his fugues?** *
Mark only one oval.

- Mozart
- Vivaldi
- Bach
- I don't know

7. **5W. A string quartet is formed by:** *
Mark only one oval.

- 2 violins, 1 viola and 1 cello
- 4 violins
- 1 violin, 1 viola, 1 cello and 1 bass
- I don't know

8. **6W. Polyphony is:** *
Mark only one oval.

- music for several wind instruments
- vocal music
- music for multiple voices
- I don't know

9. **7W. The Pathetique Sonata is by:** *
Mark only one oval.

- Haydn
- Beethoven
- Chopin
- I don't know

10. **8W. The lute has:** *
Mark only one oval.

- a mouth piece
- strings
- pedals
- I don’t know

11. **9W. The oboe has:** *
Mark only one oval.

- reeds
- piston valves
- strings
- I don’t know

Traditional Chinese music questions

12. **1E. Which one of the Chinese instruments below has two strings?** *
Mark only one oval.

- pipa (琵琶)
- sanxian (三弦)
- erhu (二胡)
- guzheng (古箏)
- I don’t know

13. **2E. Cantonese music is a form of:** *
Mark only one oval.

- instrumental music
- folk song
- Chinese opera
- religious music
- I don’t know

14. **3E. The pipa is a _______ instrument** *
Mark only one oval.

- percussion
- wind
- string
- keyboard
- I don’t know

15. **4E. Beijing opera (Peking opera) was formed in the:** *
Mark only one oval.

- 19th century
- 20th century
- 18th century
- 17th century
- I don't know

16. **5E. Which instrument is also referred to as a mouth organ?** *
Mark only one oval.

- guqin (古琴)
- sheng (笙)
- ruan (阮)
- luo (锣)
- I don't know

17. **6E. What best describes <Molihua> (Jasmine flower)?** *
Mark only one oval.

- ensemble piece
- opera music
- instrumental music
- folk song
- I don't know

18. **7E. How many strings does the guqin (古琴) have?** *
Mark only one oval.

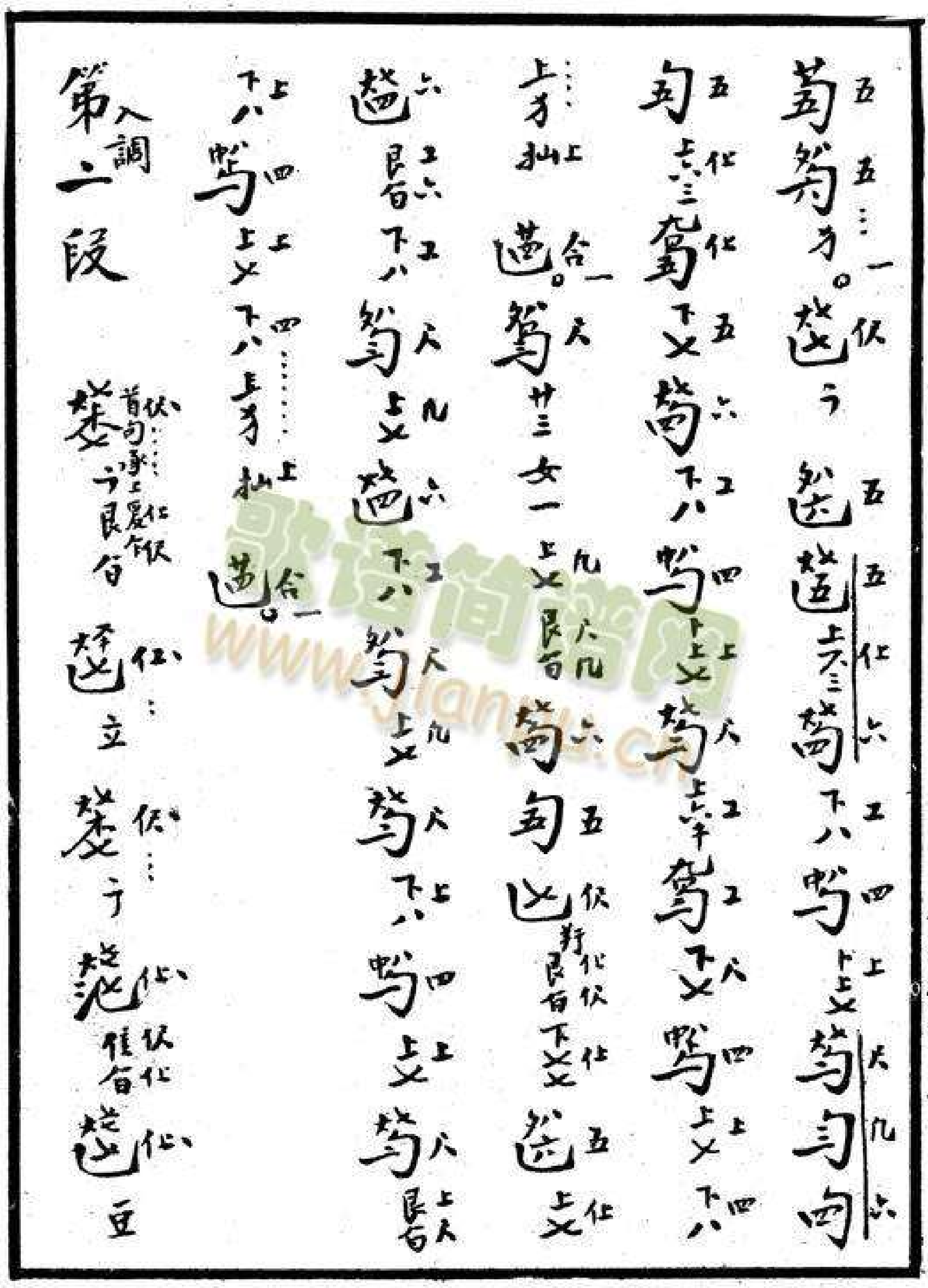
- 5
- 3
- 7
- 12
- I don't know

19. **8E. A famous Beijing opera actor toured multiple cities the US in 1930. His name is:** *
Mark only one oval.

- Mei Lanfang
- Cheng Yanqiu
- Shang Xiaoyun
- Xun Huisheng
- I don’t know

20. **9E. Which of the following is Abing's real name?** *
Mark only one oval.

- Liu, Tianhua
- Xian, Xinghai
- Hua, Yanjun
- Yang, Yinliu
- I don’t know


入調
第二段

21. **10E. The type of notation above is used for:** *
Mark only one oval.

- guqin music
- guzheng music
- pipa music
- erhu music
- I don't know

Music theory and notation questions

22. **1T. There are/is________ stave(s) present in this musical example.** *
Mark only one oval.

- 1
- 2
- 4
- none
- I don't know

23. **2T. "ff" indicates that the piece should be played:** *
Mark only one oval.

- loudly
- slowly
- fast
- softly
- I don't know

24. **2T. Beat one in measure one is a:** *

Mark only one oval.

- quarter note
- quarter rest
- eighth note
- eighth rest
- I don't know

25. **3T. What pitch does this excerpt start on?** *

Mark only one oval.

- C
- D
- A
- G
- I don't know

26. **4T. The fermata occurs on what pitch or note?** *

Mark only one oval.

- E flat
- D
- F
- A sharp
- I don't know

27. **5T. How many flats are in this key signature?** *

Mark only one oval.

- 1
- 2
- 3
- 0
- I don't know

28. **6T. “Allegro con brio” is a_______ marking.** *
Mark only one oval.

- key
- tempo
- dynamic
- accidental
- I don't know

Final questions

29. **If you previously reported being familiar with Western classical music, were the Western classical pieces you heard today of a sub-genre that you are familiar with?**
Mark only one oval.

- Yes
- No

30. **How often do you listen to this sub-genre of Western classical music?**
Mark only one oval.

	1	2	3	4	5	
Very often						Never

31. **If you previously reported being familiar with traditional Chinese music, were the traditional Chinese pieces you heard today of a sub-genre that you are familiar with?**
Mark only one oval.

- Yes
- No

32. **How often do you listen to this sub-genre of traditional Chinese music?**
Mark only one oval.

	1	2	3	4	5	
Very often						Never

33. **If you'd like to elaborate on your experience with the types of music you heard today, please do so in the box below.**

....

....

....

....

....

Thank you for taking the questionnaire!

Please hit submit and let the experimenter know that you have finished.

Appendix G

Debriefing statement.

DEBRIEFING STATEMENT

Study title: Emotional responses to music
Experimenter: Eleonora Beier (eb4385@bard.edu)
Supervisor: Dr. Justin Hulbert, Psychology Program (jhulbert@bard.edu)

In this study, you listened to three kinds of pieces: 1. Western classical music pieces; 2. traditional Chinese music pieces; 3. pieces generated by separately scrambling the pieces used in the previous two conditions. Based on your responses on the initial survey you took online, you were entered in one of two groups: a group of participants familiar with Western classical music but not traditional Chinese music (Western-only group), or a group of participants familiar with both types of music (Western+Chinese group).

My research question is whether it is possible to experience chills in an unfamiliar musical tradition. While it has been previously proposed that chills are induced by culture-specific structural elements of music such as harmonic modulations (Sloboda, 1991), recent evidence indicates that there might be certain cross-cultural cues of emotion that allow listeners from diverse cultural backgrounds to be able to infer what mood (e.g. happiness, fear, anger…) is being expressed in a piece from a different culture (Laukka et al., 2013). Thus, it is possible that similar cross-cultural cues are capable of eliciting chills even in people who are not familiar with music from one particular tradition. We can measure these chills through self-report (button presses) or using the body's natural sweat response, which reflects physiological arousal.

I hypothesized that if these cues are present, then participants in both groups (Western-only and Western+Chinese) would have chills in both the Western classical music and the traditional Chinese music pieces. The scrambled pieces acted as a control, as they presented similar acoustic features to the other pieces, but not any distinguishable musical structure. If the results of this experiment match my prediction, they would support the broader idea that music can act as a "universal language" even for strong emotions. This challenges the theory that all musical meaning is expressed by associations with the music learned within one culture.

If you have any questions, please ask the experimenter now or contact Eleonora Beier at eb4385@bard.edu.

Thank you so much for your participation.

Please do not share the details and hypothesis of this study with anyone who might participate in the future. Thank you for your cooperation.