Empathy: Does it Enhance Experience of Groove in Emotional Contexts?

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Abstract

The present study sought to determine whether one's level of trait empathy has any effect on their perceptions of groove while listening to music with either happy or sad lyrics. Previous literature shows that individuals high in empathy tend to enjoy and feel more intense emotion when listening to sad songs. This prompted the general hypothesis that individuals higher in trait empathy would also experience stronger urges to move to sad music, as groove is closely linked with pleasure. Data were collected through an online survey using SONA and Prolific as primary recruitment platforms. A total of 112 participants took part in this study, answering several questionnaires (e.g., Toronto Empathy Questionnaire) and rating 40 30-second music clips on five relevant dimensions. Paired sample *t*-tests, Pearson correlations, and two-way ANOVAs were conducted to analyze the data. We found no significant effect of empathy. However, it was found that individuals rate happy songs higher on all dimensions but enjoyment, confirming literature that suggests inherent pleasure in sad music. Results also shed light on the importance of lyrics as a musical property that individuals seem to attend to when listening to music. This study offers a potential basis for future research examining empathy and lyrics in experiences of groove.

Acknowledgements

First and foremost, I would like to express my sincere gratitude to Dr. Grahn for the guidance provided throughout the span of this project; I consider myself fortunate to have had this experience conducting research under her supervision. I would also like to extend a thank you to Riya Sidhu, who guided and encouraged me through every step of this thesis. Her expertise and invaluable support fostered a positive and rewarding experience which I am incredibly grateful for. Lastly, I would like to thank my friends, my family, and my boyfriend, all of whom provided encouragement that I could not have completed this project without.

Statement of Contribution

The research question of this project was developed with help from Riya Sidhu, and approval from Dr. Jessica Grahn. The procedure was adapted from a previous study conducted by Riya. The Qualtrics survey was developed by me, with Riya's guidance. The musical stimuli were acquired and trimmed by me, with funding from the Grahn lab. The statistical analyses were conducted by me with feedback from Riya. Finally, the manuscript and figures were written and created by me with feedback from Riya and Dr. Grahn.

Empathy: Does it Enhance Experience of Groove in Emotional Contexts?

Music-listening, a uniquely human, universal phenomenon, elicits a variety of responses, ranging from emotional to physical. One physical response, defined as groove, is the urge to move in response to music (Senn et al., 2019). This urge is most often accompanied by pleasure, as are many of the emotions evoked through music. The spontaneous movement arising from 'being in the groove' can come in many forms, such as tapping a foot, nodding to the beat, dancing, or even adjusting the tempo of walking. Interest in the construct of groove is well-established in psychological and music literature (Senn et al., 2019). More recently, however, research has suggested an important effect of individual and personality differences on the listening experience, and perhaps even on groove. One individual difference that is relatively understudied in groove literature specifically is trait empathy. Empathy, in the most basic sense, is the capacity to understand and experience the emotional states of others (Barker, 2008). Research suggests that music-induced emotional responses may involve empathy (Miu & Vuoskoski, 2017). Therefore, it is likely that empathy may similarly be implicated in music-induced *physical* responses such as groove. Current studies that implicate empathy in the construct of groove, however, elaborate little on the specific musical properties that may contribute to how empathic individuals differently experience music. Thus, not only is literature on empathy and groove scarce, but so is research identifying the mechanism through which empathy moderates the individual groove experience.

To bridge these research gaps, I propose that empathy may be moderating the feeling of groove by affecting the emotional valence of music, specifically focusing on song lyrics. Below, I will review literature relevant to the concepts and connections between groove, empathy, and emotional valence of music. I will be situating these three concepts in a proposed psychological

model of groove to best conceptualize the three-variable interaction I plan to assess in my research. By addressing key studies and their limitations, I set the stage for why and how I conducted my current study.

Groove

Music and movement are intricately entwined; just as music is produced by movement of a composer or instrumentalist, music can induce movement in a listener. Such movement often occurs because a particular quality of music triggers an urge to move, which we refer to as groove. While 'feeling' the groove in music can result in movement, the term groove itself does not actually refer to movement of any kind. Rather, movement is a response to the perception of groove. Although some research may treat spontaneous movement as groove, this refers to a concept termed *elicited* groove (e.g., Zelechowska et al., 2020). However, to stay true to the psychological definition, I will be examining only the 'feeling' of groove, or *perceived* groove. Of course, we cannot discuss groove without mentioning the inherent aspect of pleasure. Several studies have shown that when people want to move, dance, or synchronize to the rhythms of music, they accordingly experience pleasure (e.g., Witek et al., 2014). Groove is a universally relevant construct, not restricted to any particular age, culture, or experience. It is often felt subconsciously, making it an intrinsic facet of the human experience.

Despite being a universal experience, groove is not experienced identically across individuals. In the same way that music is subjective, the extent to which one perceives whether a piece of music is groovy or not depends on a variety of personal characteristics. One study, using an online listening experiment, aimed to assess the extent to which factors such as musical taste, familiarity, and musical expertise, affect the groove experience (Senn et al., 2021). It was found that perceived groove tends to be strongest when a listener is both familiar with the song,

and likes its style. Musical style was also shown to affect the groove experience; pop and funk music stimuli triggered a stronger groove experience, likely due to certain musical properties (e.g., a strong beat, syncopation). This finding is supported by other studies (e.g., Janata et al., 2012). Another interesting finding from this study was that musical expertise had a minimal effect on perceptions of groove. This supports the notion that feeling the groove of music is not limited by any personal characteristics, but rather influenced and enhanced.

Conveniently, Senn and colleagues (2019) propose a psychological model of groove (see Figure 1) which combines the aforementioned characteristics that make groove so subjective. This model conceptualizes how variables of music-listening distinctly act on the urge to move in response to music, triggering body movement. These variables include the concrete listening situation, musical properties, and personal background. In the context of this study, I will be specifically discussing personal background and musical properties as they are most related to my research question. Different interactions of these three variables can affect our perception of groove and determine whether perceived groove will trigger entrained body movement.

Considering groove is based in body movement, it is crucial to outline the relevant underlying motor mechanisms. It has been proposed that the representation of temporal regularity the human brain develops while listening to music informs motor planning, which in turn, triggers entrained body movement in response to groove (Senn et al., 2019). In support of this motor link, Chen and colleagues (2008) found that listening to an auditory rhythm, and tapping along to it, activates supplementary motor areas (SMA) and the premotor cortex. This suggests a bidirectional relationship between music and movement, mediated by the brain's motor regions. Moreover, given that the motor activation was found even when the participant was not moving (e.g., not tapping), we can consider that there may be a movement component to

music even without a real physical response. This is relevant to perceived groove, as it too can be conceptualized as having a movement component, but no visible, physical response.

Accordingly, another study showed, through transcranial magnetic stimulation, that high groove music engages the motor system (Stupacher et al., 2013). High groove music, in simple terms, refers to music that elicits a strong urge to move (as opposed to low groove, which likely elicits minimal or no urge to move). In this study, researchers selected high and low groove musical excerpts based on audio features such as event density (number of note onsets per second, pulse clarity (strength of the beats), and fluctuation (rhythmic periodicity). This is just one example of how musical properties can affect the experience of groove. Stupacher and colleagues (2013) further suggest that temporal (to do with timing) features of music seem to be of particular importance, as they may inducing people to 'tune into its beat'. This is consistent with Senn and colleague's (2019) psychological model of groove.

From this evidence, we can see that the relationship between music and movement, and thus groove, is facilitated by the motor system. Interestingly, the motor system also seems to play a role in how we empathize (e.g., Chen et al., 2006). Moreover, empathy can be considered an element of one's personal background, which is one of the variables of the psychological model of groove (Senn et al., 2019). Considering this, the potential link between groove and empathy is worth examining.

Empathy

As depicted in Senn and colleagues' (2019) psychological model of groove, listeners' personal backgrounds affect their responses to music (whether that be physical or emotional). They propose that elements of personal background (upbringing, musical expertise, personality, etc.) affect the pleasure that increases the urge to move in response to music. As previously

mentioned, trait empathy is an element of personal background, specifically of personality. Empathy is a complex psychological process including cognitive and affective components that allows for the understanding of others' emotions and perceptions (Bamford & Davidson, 2019).

Interestingly, empathy, just like groove, appears to have roots in the motor system. The Mirror Neuron System (MNS) is suggested to be the neural mechanism for empathy. Mirror neurons, a group of specialized cortical cells, fire during both the execution and observation of movements (Rizzolatti & Craighero, 2004). This process has been termed 'mirroring', involving the activation of brain regions whose function is fundamentally or predominantly motor (e.g., superior temporal sulcus, inferior frontal gyrus) (Bamford & Davidson, 2019). This finding suggests that groove and empathy may be governed by some of the same brain regions, or at the very least regions that are similarly implicated in motor response. Relatedly, research has suggested that MNS is also involved in musical perception, which is relevant to both empathy and groove. It has been observed that the MNS activates when participants entrain to, or imagine musical stimuli (Chen et al., 2006; Nistri et al., 2006).

Previously, trait empathy has been implicated in studies of spontaneous movement in response to music. For instance, Bamford and Davidson (2019) found that individuals high in trait empathy adapted their movement according to tempo changes in musical stimuli, while those low in empathy did not. This suggests that empathic individuals may be particularly sensitive to certain musical properties that moderate physical responses to music. Accordingly, Zelechowska and colleagues (2020) found that high trait empathy (and empathic concern) is associated with accurate synchronization to musical rhythms and is a significant predictor of spontaneous movement to musical stimuli. Although this study examined elicited rather than perceived groove, this study substantiates the relationship between empathy and motor response.

Now that we have understood the motor link between groove and empathy, we can turn to the mechanism through which empathy may be modifying the groove experience. Given that individuals higher in trait empathy tend to more accurately recognize and feel other's emotions, it is possible that they also feel the inherent pleasure of high groove music more strongly. Kreutz and colleagues (2008) proposed a music-specific manifestation of trait empathy termed "music-empathizing". This is a cognitive style of processing music that places the emotional recognition and emotion of the music over the tendency to analyze and predict the structural rules of music. It may be that highly empathic individuals engage in music empathizing and preferentially attend to the subjective pleasure of high groove music.

Based on this collective evidence, it seems that empathy may affect groove, likely through the amplified effect it has on the pleasure elicited by music. In other words, empathy may be able to change the way a person experiences music and the movement response that follows. I propose that empathic individuals may be achieving these different experiences by attending to specific musical properties that maximize pleasure.

Musical Properties

Properties of music are yet another variable that acts on the pleasure that increases the urge to move to music, as proposed in the psychological model of groove (Senn et al., 2019). Musical properties include, but are not limited to, rhythm, structure, and lyrics. A study by Janata and colleagues (2012) found a positive association between highly syncopated music and perceived groove, as well as an association between high-groove music and enjoyment. This not only confirms that pleasure is fundamental to groove, but also highlights that individuals may be preferentially attending to the structural properties of music. However, this study does not focus

on the emotional aspect of music and groove, which may be underpinning some of the enjoyment listeners experience in response to music.

Just as music is closely linked to movement, it has a bidirectional relationship with cognition. Widely known is the fact that music both expresses and elicits emotion. Previous literature has shown that musical sounds and characteristics inherently have emotional meaning, and listeners tend to agree remarkably well with one another in labeling the musical emotion a song elicits (Krumhansl, 2002). Paradoxically, the experience of music-listening is unique to each individual listener, due to listening context and personal backgrounds modifying our cognitive perception of music. Scherer and Zentner (2001) explain that cognitive empathy is a central route (via the central nervous system) by which music induces emotion in the listener. This study further elaborates on this mechanism, describing that highly empathic individuals achieve enhanced emotional responses to music through the identification and sympathy for the emotions the performer conveys through their song. These individuals tend to relate such perceived emotions to their own lived experiences and presumed lived experiences of the performer (Scherer & Zentner, 2001).

Although there is a variety of music properties that can convey emotion, a relatively underappreciated one in the context of groove is lyrics. Just as in written prose, words in songs are semantically rich and have the capacity to induce feelings including joy, love, passion, and sadness. A study shows that lyrics enhance emotional responses to music portraying negative emotions (e.g., sad, angry) (Ali & Peynircioğlu, 2006). Thus, the lyrical property of music, more specifically the varying emotional valence of lyrics, is worth examining. I propose that the strongest emotional response to music arises when listeners preferentially attune to and empathize with the emotions presented through song lyrics.

Emotional Valence of Sad Music

Lyrics, but also other musical properties, communicate emotion in music. Given that emotional responses to music can be pleasurable, it seems logical that this pleasure (also inherent in groove) can produce urges to move to music. However, a property that has been neglected in groove research is the emotional valence of sad music. Despite sadness being perceived as an unpleasant emotion, several studies have highlighted that there is an inherent pleasure in listening to sad music (e.g., Schubert, 1996; Huron, 2011). Sad music evokes positive and complex emotions such as nostalgia, wonder, and peacefulness (Vuoskoski et al., 2011). Foreseeably, empathy seems to be related to this paradox of pleasurable sadness. A study by Vuoskoski and colleagues (2011) found that individuals high in trait empathy enjoyed sad music and experienced the most intense emotional response compared to individuals high in other traits. This finding confirms the notion that trait empathy is positively associated with enhanced emotional responses to music. However, this study is largely limited by a lack of insight into specifically which musical properties in sad music empathic individuals find pleasurable. In fact, this limitation extends beyond this one study, to the larger literature. Moreover, this study employed excerpts from film music as the stimuli. By using music that listeners are likely to associate with the content (and thus emotion and past experience) of a film, the authors confound the emotional perception of sad music in its core form.

Groove, Empathy, and Emotional Valence of Song Lyrics

Upon examining the established concepts of groove, empathy, and musical properties (e.g., lyrics), we can see that there are distinct connections between each concept, but we have yet to see research that analyzes a three-way relationship between them. I have shown, through literature findings, the following: empathy and groove are underpinned by similar neural

mechanisms (motor systems), pleasure is inherent in both physical response to music (groove), and emotional response (response to musical properties), and lyrics may elicit heightened emotional responses, particularly for empathic individuals. Combining these conclusions, I propose that empathy moderates the relationship between emotional valence of music and groove by acting on the perception of musical properties, specifically lyrics, to maximize pleasure. This brings me to my current study.

Current Study

Given the lack of research examining song lyrics in the relationship between empathy and groove, my current study focused specifically on the emotional valence of lyrics while holding other musical properties constant. Specifically, I hoped to address the effect of empathy on perceived groove ratings for songs with varying emotional lyrical content. To do so, I designed an online study which involves participants listening to 40 30-second song excerpts with similar tempo but with a manipulation of the emotional valence of lyrics (happy versus sad). Participants were asked to rate the excerpts on dimensions of perceived groove, enjoyment, familiarity, and emotional valence. Finally, participants provided relevant dance and musical experience. To assess my research question, I presented two main hypotheses. First, I hypothesized that differences in emotional content of music (specifically the lyrics) would result in differential perceptions of groove. More specifically, I predicted that overall, individuals would rate songs with happy lyrics higher in groove. Second, I hypothesized that trait empathy would moderate this relationship between emotional content ratings and perceived groove. I predicted that those higher in trait empathy would perceive stronger urges to move than those low in empathy for songs with happy and sad lyrics.

Methods

Participants

Participants *(n* = 112) were recruited through two separate platforms to maximize our sample size and demographic range. The first set of participants (*n* = 92) were undergraduate students ranging in age from 17 to 23, with an average age of 18. These participants were recruited through Western University's Undergraduate Psychology SONA Research Pool. In exchange for their participation, participants were offered 1.0 research credit as compensation. The second set of participants (*n* = 20) were recruited through Prolific; participants ranged in age from 18 to 55, with an average age of 37. Each participant received £6 as a form of compensation. In order to partake in the study, eligibility criteria were as follows: participants must have normal or corrected-to-normal vision and hearing, participants must be fluent in English, and participants must have access to an electronic device connected to Internet to be able to access the experiment survey. Participant's data was excluded from the analyses if they: failed to pass the attention check, failed to complete 90% (four songs) of the music ratings, and spent less than twenty minutes completing the survey. Based on these criteria, we excluded the data of 11 participants from our analyses. This study was approved by the Non-Medical Research Ethics Board at Western University (see Appendix A).

Measures

Empathy

Empathy was measured using the Toronto Empathy Questionnaire (Spreng et al., 2009). The authors of this questionnaire claim that it examines the construct of empathy at the broadest level, combining both cognitive and affective components of empathy. Moreover, it aims to have

high internal consistency, construct validity, and test-retest reliability, thus making it an ideal measure for the purposes of this study (Spreng et al., 2009). Participants answered 16 questions regarding thoughts, feelings, and behaviours relating to empathy (e.g., "When someone else is feeling excited, I tend to get excited too"), which were measured on a four-point Likert scale (from 0 = "never" to 4 = "always") (Spreng et al., 2009). Scores were summed to derive a total, comprehensive measure of trait empathy.

Music and Dance Experience

Music and dance experience have previously been shown to modulate individual experiences of groove, impacting sensitivity to various aspects of music such as harmonic complexity, rhythmic complexity, beat synchronization, and even emotional response (e.g., Blood & Zatorre, 2001; Grahn & Rowe, 2009; Matthews et al., 2019; Stupacher et al., 2013; Fitch, 2016). Thus, it is important for this current study to account for any music and dance engagement or formal training (of any level) that participants may have.

Music experience, or expertise, was measured using the Goldsmiths Musical Sophistication Index (Gold-MSI) (Müllensiefen et al., 2014). The 38-item Gold-MSI assesses self-reported musical skills and behaviours on five dimensions: active musical engagement (i.e., how much time and monetary resources are spent on music), self-reported perceptual abilities (i.e., accuracy of musical listening skills), musical training (i.e., amount of formal musical training received), self-reported singing abilities (i.e., accuracy of one's own singing), and sophisticated emotional engagement with music (i.e., the ability to talk about emotions that music expresses) (Müllensiefen et al., 2014). For the purposes of this study, we employed a shorter, general subscale of the MSI (i.e., General Musical Sophistication), and the emotional engagement subscale. Participants rated each item on a seven-point Likert scale (from 1 =

"completely disagree" to 7 = "completely agree", with a neutral option ("neither agree nor disagree") in the middle).

Similarly, dance experience was assessed using the Goldsmiths Dance Sophistication Index (Gold-DSI) (Rose et al., 2022). The Gold-DSI, adapted from the Gold-MSI, consists of 26 items that measure individual differences in participatory and observational dance experience on a continuous scale. The questionnaire was separated into four factors: Body Awareness (e.g., "I find it easy to learn new movements"), Social Dancing (e.g., "If someone asks me to dance, I usually say yes"), Urge to Dance (e.g., "When I hear a great track, it just makes me want to dance"), and Dance Training (e.g., "I have taken regular dance classes at least once a week for: 0 years; 1 year; 2 years…10 or more years"). Participants rated each item on a seven-point Likert scale (from 1 = "completely disagree" to 7 = "completely agree", with a neutral option, "neither agree nor disagree", in the middle).

Perception of Lyrics

The independent variable assessed in this study was the emotional valence of music, operationalized as song lyrics. Manipulating lyrics allowed us to modify the emotional valence of songs without altering any of the structural properties (e.g., tempo, syncopation, rhythm) of the music that contribute to its high groove. To assess how participants perceive lyrics, we administered the 19-item Lyrics Focus Questionnaire (Vuvan et al., 2022), which aims to quantify individual differences in lyric focus during song listening (See Appendix B). Items from this self-report tool measure an individual's memory of lyrics (e.g., "I often get song lyrics stuck in my head"), attention to lyrics (e.g., "I always listen to what is being said in the lyrics"), and emotional impact of lyrics (e.g., "The lyrics of a song really draw me in"). Participants rated

each item on a seven-point Likert scale, from 1 = “strongly disagree” to 7 = “strongly agree”. Scores were averaged for each participant to derive a comprehensive measure of lyric perception.

Demographics

At the beginning of the study, participants were asked to respond to a series of questions regarding their demographics. This section of the survey included topics such as age, gender, hearing ability, education, and others in order to gain a better understanding of our sample.

Stimuli

Music

40 high-groove songs were selected from an initial set of 50 that were narrowed down through piloting (see Appendix C). Songs were retrieved from the iTunes Music Store and represented a variety of genres, such as hip-hop/rap, alternative, R&B/soul, and pop. 20 of these 40 songs had objectively happy lyrics, while the other 20 had objectively sad, or dark, lyrics. To ensure that the chosen songs were unanimously rated high in groove and either happy or sad in lyrical content, a pilot survey was sent to several members of the Grahn Lab for feedback. Each song was cut to a 30-second excerpt based on where in the duration of the song the groove was deemed high and the lyrics optimally conveyed a happy or sad message, respectively.

Procedure

Participants who were deemed eligible to participate in the study accessed the Qualtrics survey via their SONA accounts or their Prolific accounts. First, participants were given access to a Letter of Information (see Appendix D), which they were asked to read before providing informed consent to their participation and use of their anonymized data. Upon providing

consent, participants proceeded to complete a series of questionnaires in the following order: Demographics Questionnaire, Toronto Empathy Questionnaire, Gold-MSI, Gold-DSI, and the Lyrics Focus Questionnaire. In the second phase of the study, participants were asked to listen to the aforementioned 40 song excerpts. Prior to listening, participants were prompted to pay close attention to the lyrics of each music clip. Song excerpts were played in a randomized order for each participant. After each 30-second music excerpt, participants were presented with a series of questions prompting them to rate the song clip they had just heard on a scale from 0-100. More specifically, participants rated the excerpt on Perceived Groove (e.g., "How much did the music make you want to move?"), Enjoyment (e.g., "How enjoyable is this piece of music?"), Familiarity (e.g., "How familiar is this specific song?"), and Emotional Valence (See Appendix E). To assess participants ratings of emotional valence, two separate questions were presented; one regarding general perceptions of emotion (e.g., "How happy or sad did you find this song overall?"), and one regarding perceptions of the emotional valence of the lyrics (e.g., "How happy or sad did you find the lyrics of this song specifically?"). Emotional valence was also assessed on a scale from 0-100, where 0 = very sad and 100 = very happy. After repeating listening to and rating each music clip, participants completed the survey and were presented with two debriefing questions. The first asked participants to rate, on a scale from 0-100, how well they were able to hear and understand the lyrics of the songs they heard. The second was an open entry question giving participants the opportunity to leave any comments or concerns for the researcher. Compensation was awarded after completion of the survey through the SONA portal or the Prolific platform, respectively.

Results

Overview

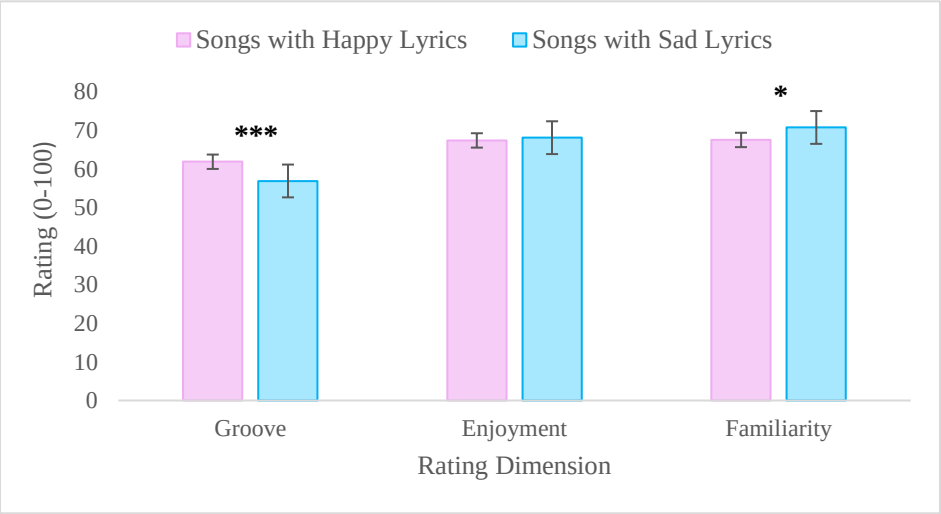
Data were analyzed using JASP statistical software, version 0.17.1. The threshold of statistical significance for each test was set at $p < .05$. For correlations, +/-0.30 or above indicated a weak linear relationship, +/-0.50 or above indicated a moderate linear relationship, and +/-0.70 or above indicated a strong linear relationship. For the general and lyrical emotion rating scales, we subtracted 50 from each score after averaging across songs for each participant. Meaning, anything above 0 now indicated a 'happy' rating, while anything below 0 now indicated a 'sad' rating. This was done to give these rating scales a bidirectional relationship as this best encapsulated what our study design was attempting to capture with these scales.

Statistical Analyses

Paired sample T-tests were performed to examine associations between ratings for happy and sad songs across the five relevant dimensions (groove, familiarity, enjoyment, general emotional valence, and emotional valence of lyrics). As seen in Figure 1 and 2, results of this analysis showed that participants rated happy songs significantly higher than sad songs in terms of groove, $t(111) = 5.47$, $p < .001$, familiarity $t(111) = -3.26$, $p < .05$, general emotion, $t(111) = 16.77$, $p < .001$, and lyrical emotion, $t(111) = 21.513$, $p < .001$. However, there was no significant difference in enjoyment ratings between happy and sad songs.

Figure 1

Ratings of Groove, Enjoyment, and Familiarity Across Songs with Happy vs Sad Lyrics

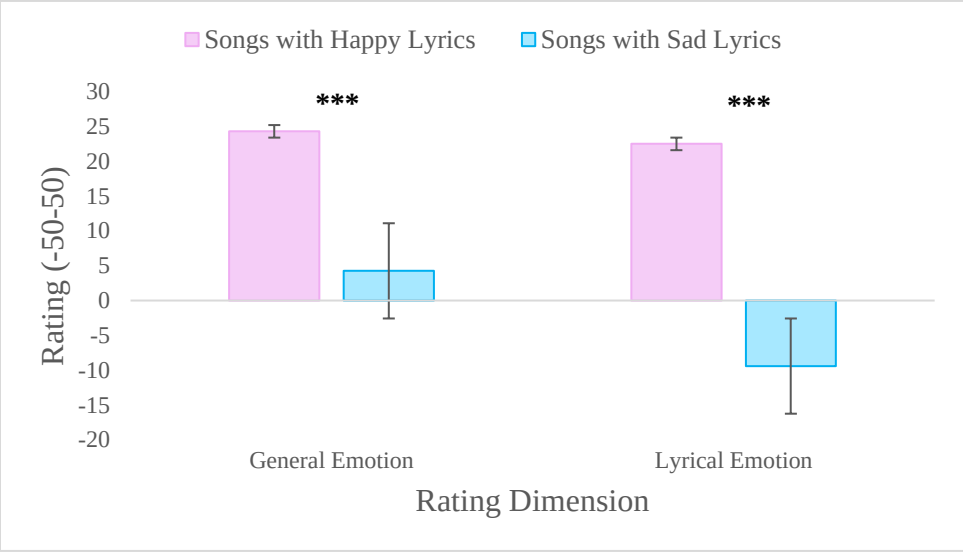


* $p < .05$, ** $p < .01$, *** $p < .001$

Note. This figure demonstrates *t*-test scores comparing differences between ratings for happy vs sad songs on three dimensions. Participants rated happy songs significantly higher than sad songs for groove and familiarity, but there was no significant effect found for enjoyment. Error bars represent standard error.

Figure 2

Ratings of Groove, Enjoyment, and Familiarity Across Songs with Happy vs Sad Lyrics



* $p < .05$, ** $p < .01$, *** $p < .001$

Note. This figure demonstrates *t*-test scores comparing differences between ratings for happy vs sad songs on two dimensions of emotion. Participants rated happy songs significantly higher than sad songs for general emotion and lyrical emotion. Error bars represent standard error.

Pearson correlations were conducted amongst our variables to assess any potential relationship and determine whether further statistical analyses were needed. We found that groove ratings were positively correlated with general emotion, $r(111) = .65$, $p < .001$, and with lyrical emotion, $r(111) = .43$, $p < .001$, although the latter only showed a weak association. Interestingly, groove ratings were significantly, positively correlated with a higher tendency to attend to lyrics, $r(111) = .23$, $p < .05$. However, this correlation is below the .30 threshold for it to be considered a 'weak' relationship. In line with previous findings regarding groove, we also found that general emotion ratings were moderately correlated with both enjoyment, $r(111) = .68$, $p < .001$, and familiarity $r(111) = .58$, $p < .001$. Similar patterns were found for lyrical

emotion, though these correlations were weak based on our determined thresholds (lyrical emotion and enjoyment, $r(111) = .49$, $p < .001$; lyrical emotion and familiarity, $r(111) = .43$, $p < .001$). Typically, when people listen to music they enjoy and are familiar with, they experience stronger emotions. Groove and familiarity were also found to be moderately, positively correlated, $r(111) = .57$, $p < .001$, similarly suggesting that familiar songs elicit stronger groove.

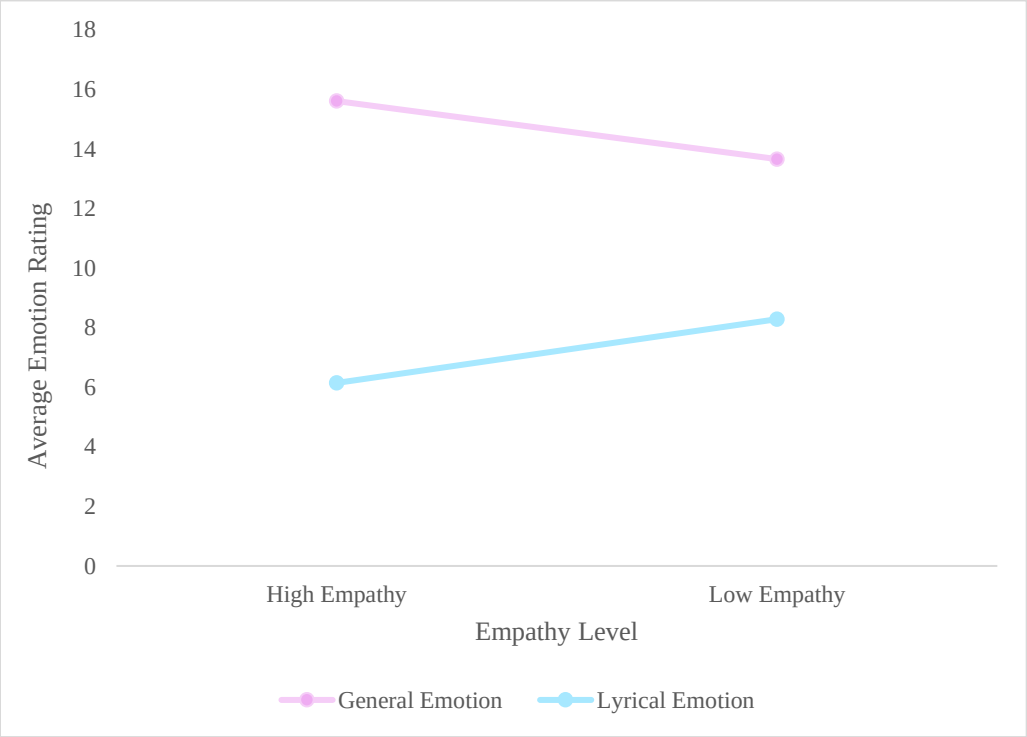
We also used Pearson correlations to assess whether there was a possibility of a relationship with empathy and the other variables, namely groove and emotion. While groove and general emotion were not correlated with empathy, we found a very weak negative correlation between empathy and lyrical emotion for sad songs, $r(111) = -0.19$, $p < .05$.

Two-way analyses of variance (ANOVAs) were conducted in order to further assess any existing effects of empathy. For each ANOVA, we used the upper and lower quartile ($n = 28$) of the TEQ (empathy) scores to create categorical variables. The first ANOVA examined groove ratings at different levels of empathy (high vs low) and different emotional valence (happy vs sad). The results showed a significant main effect of lyrical emotion, $F(1, 27) = 16.32$, $p < .001$, but no main effect of empathy or interaction was found. The second ANOVA, as seen in Figure 3, assessed emotion ratings at different levels of empathy and different emotional properties of the music (general emotion vs lyrical emotion). There was a significant main effect found for emotion, $F(1, 27) = 85.41$, $p <.001$, and a significant interaction between empathy and emotion, $F(1, 27) = 5.20$, $p < .05$. Evidence of an interaction warranted further analysis, which we achieved through a post-hoc test. The adjusted alpha level for the Bonferroni correction was set at 0.5/6 = .083. The mean difference between ratings of general emotion and lyrical emotion amongst the high empathy individuals was significant, $t(27) = 7.87$, $p < .001$. The effect size for the significant difference was large ($d = .97$), with high empathy individuals rating general

emotion (*M* = 15.61, SD = 8.23) higher than lyrical emotion (*M* = 6.14, *SD* = 7.87). A similar pattern of differences between general and lyrical emotion ratings was observed in the low empathy group, $t(27) = 4.47$, $p < .001$. The effect size here was moderate ($d = .55$), indicating that low empathy individuals also rated general emotion (*M* = 13.66, *SD* = 11.33) higher than lyrical emotion (*M* = 8.28, *SD* = 10.98).

Figure 3

Two-Way ANOVA Examining Emotion Ratings



Note. This figure demonstrates the results of the two-way ANOVA comparing emotion ratings at two different levels of empathy (high vs low) for two different dimensions of emotion (general vs lyrical). There is a significant interaction.

Finally, we calculated the mean and standard deviation (M = 82.12, SD = 18.93) of scores on our debriefing question which asked participants to rate how well they heard and understood lyrics across all songs.

Discussion

The purpose of this study was primarily to determine whether empathy has an effect on the experience of groove when listening to music in different emotional contexts. It was expected that higher empathy would result in stronger urges to move under both happy and sad listening conditions (i.e., happy vs sad song lyrics), despite other characteristics of the music held constant. Previous research suggests that empathetic individuals feel pleasure (an objectively positive emotion) when listening to sad music, which is closely correlated with groove (Vuoskoski et al., 2011). This explains why we did not expect highly empathetic individuals to instead feel lower groove in response to sad lyrics.

Contrary to predictions, we did not see any significant relationship between groove and empathy. Instead, we saw some interesting findings regarding empathy and emotion. First, it appears that individuals who rated themselves higher on empathy tend to rate the lyrics of the sad music clips lower (i.e., sadder) in comparison to those lower in empathy. This again aligns with previous literature such as Vuoskoski and colleagues (2011) study; it has been established that while individuals high in trait empathy feel pleasure when listening to sad music, they also feel more intense emotions in response to sad music. Moreover, some research has shown evidence of hormonal changes in empathetic individuals when they listen to sad music such that it activates dopaminergic pathways in the brain (Eerola et al., 2021). These pathways are linked to reward theory, suggesting that empathetic engagement with sad music should provide the listener with pleasure. Such evidence of pleasure and reward-processing associated with music-listening

have also been widely implicated in gait and dance therapy for Parkinson's patients whose symptoms are characterized by dopamine deficiency (Gimenéz-Llort & Castillo-Mariqueo, 2020). This is all to say that empathetic engagement with music seems to have robust effects on motor abilities in clinical populations, so it is quite unexpected for us not to see any significant connections between groove and empathy in a neurotypical sample. Moreover, as we previously saw, the correlation between empathy scores and ratings of sad lyrical content was quite weak, so we cannot be confident even in this result.

Lack of a main effect of empathy in the two ANOVAs leads us to further question the role empathy plays in the groove experience. Instead, our results seem to strengthen the role of emotion. The results of the first ANOVA confirmed the findings of the t-tests; individuals have different perceptions of groove when listening to happy versus sad songs, regardless of their empathy level. However, the interaction we saw in the second ANOVA initially seems to implicate empathy, suggesting that one's level of empathy influences how much they attend to either the general emotional properties of a song, or the specific lyrical properties. The post-hoc analysis revealed that there were significant differences in emotion ratings across high empathizers, and across low empathizers, for general versus lyrical emotion. However, this finding contradicts our hypothesis, as it demonstrates that there is no difference between individuals of high and low empathy across emotion ratings. The only difference that exists lies in judgements of general versus lyrical emotion. Although the findings of the post-hoc did not provide meaningful evidence for empathy in groove, they did demonstrate the validity of our study design. At both empathy levels, participants rated general emotion higher than lyrical emotion. Given that higher ratings in this study indicated happier perceived emotion, it seems that our song selection was effective at ensuring only our lyrics conveyed sadness in comparison

with the other musical properties that we aimed to hold constant. These differences in ratings may also suggest that individuals are attending to the content of lyrics as we initially hypothesized, albeit regardless of their empathy level. Overall, the evidence for the role of empathy in moderating groove is quite weak, leading us to accept a null hypothesis based off the results of the current study.

Despite this, we did see evidence to support our expectation that differences in the emotional content of songs would elicit higher groove ratings for happy songs. This finding is quite robust, given that happy songs were also rated significantly higher for dimensions typically associated with groove, such as familiarity. This finding closely aligns with existing literature; there is widespread agreement that groove experience is strongly influenced by their musical taste and familiarity with a musical repertoire (Senn et al., 2021).

Interestingly, we did not find a similar pattern for the relationship between groove and enjoyment. There is wide consensus in the literature that groove and pleasure are intrinsically linked, with groove often being understood as a pleasurable drive toward action (Janata et al., 2012). To most of us, pleasure and enjoyment are synonymous concepts, elucidating that if one is consistently experiencing an urge to move to happy music, they should be experiencing enjoyment to a similar extent. However, it could be the case that individuals enjoy sad music just as much as happy music, but it may not elicit the urge to move in the same way. This is contradictory to our initial prediction that sad music and its inherent pleasure may evoke stronger urges to move, particularly in highly empathetic individuals. Rather, it seems more likely that regardless of personal characteristics and enjoyment, sad music generally has less influence on one's urge to move. This is particularly intriguing because our study design maintained typical high-groove musical properties-only the lyrics were manipulated to convey happy or sad

messages. Thus, it is possible that lyrics are indeed very powerful at conveying sadness to an extent that it interferes with the urge to move.

However, it is difficult to pinpoint whether we see higher groove ratings for happy songs as a result of listeners attuning to general emotional, or lyrical emotional content (or perhaps neither). Our t-test analysis showed significant group differences for both dimensions. We also found that move was positively correlated with scores on the Lyric Focus Questionnaire (Vuvan et al., 2022), which indicates the extent to which participants actually attend to song lyrics. Although participants were instructed during the study to attend to the lyrics, the questionnaire gives us a better sense of habits during naturalistic, everyday listening. It is important to note that this correlation, although significant, was very weak. Thus, it would be unwise to conclude that individuals feel groove more strongly as a result of attending to and being moved by lyrics. Moreover, we did find that on average, participants reported being able to clearly hear and understand the lyrics. Meaning, we cannot attribute these inconclusive results to a lack of clarity in our stimuli. However, the clips presented in this study were only 30-seconds in length; it may be the case that despite understanding the lyrics, participants found it difficult to get a true sense of the emotions portrayed. Thus, because our initial hypothesis specifically pertained to perception of emotion through lyrics, we are unable to reject the null with this evidence.

Limitations

In constructing this study, a great deal of debate occurred surrounding perceived versus felt emotions. When discussing empathy, there is general consensus that people high in trait empathy first understand, and then share in another's emotional state or context, thereby internalizing and feeling the emotions themselves (e.g., Cohen & Strayer, 1996). Although it would have been conceptually best to focus on felt emotions in this study, logistically, perceived

emotions were a better fit. When faced with short music clips of only 30-seconds where we are asked to attend to several different factors at once (e.g., lyrics, how it makes us feel, etc.), it is difficult to truly internalize and feel what is conveyed in the song. Moreover, it was also important to consider that this was an online, unsupervised study whereby our control of the study environment was extremely limited. It is possible that participants were not wearing headphones, and were not in a space that was free of distractions as the study instructed. Any additional stimuli in the background would have impeded the listening experience further, likely resulting in participants reporting the emotions they perceived in the song anyways. Thus, we opted to specifically instruct participants to attend to emotions they *recognized and perceived* in each musical excerpt.

The online environment of this study posed another trade-off in terms of sample size. While it may have been best to conduct the study in a lab-based environment where we could have more control over confounds, it would have compromised the sample size. Participants are typically more willing to sign up for, and fully complete a study that is online and available to them in their free time than one that is in-person. The online study may also provide participants with more comfort and a more ecologically valid music-listening experience; many undergraduate students are hesitant to participate in laboratory studies due to preconceived notions of scientific experiments. However, a 'comfortable' environment may also beget less focus on the study itself, resulting in incomplete data from participants. In any case, we were able to collect a strong sample, only eliminating approximately 8% of the original dataset.

With regard to sample size, we also faced a loss of power in taking the top and bottom quartiles of empathy scores when conducting the ANOVAs. Although this provides a distinct point of comparison, it leads to exclusion of half our data points. It may be possible that using

the entire empathy sample may have afforded us more power and contributed to more significant results. However, we found that the spread of the empathy scores was narrower than we anticipated, with most participants clustered in the top quartile of the possible TEQ scores. Had we used the entire sample in grouping our categorical variables, it would have been even more difficult to observe a meaningful difference between high and low empathy individuals.

Future Directions

The current study found only weak effects regarding relationships between groove, empathy, and emotional valence. It is unclear whether the study design posed a drawback to this lack of findings. Although we didn't find any, it does not mean that differences between high and low empathy groups in groove experiences do not exist. It may be beneficial for researchers moving forward to consider a paradigm that employs concepts of social contagion and interpersonal synchrony. For instance, Novembre and colleagues (2019) have conducted work examining how interpersonal coordination is promoted by empathic perspective taking. Social contagion and collaboration are closely tied to emotion, empathy, and groove, and have prosocial benefits that this study otherwise lacked.

In keeping with a similar study design, it may be prudent to explore how empathy and emotional valence moderate groove in broader cultural music. This study focused on a narrow sample of Western, English-speaking participants and consequently Western music. Every culture integrates music differently; this is evident in variety of music styles, musical celebrations, and music use in traditional settings. Given the flexible format of our online study, it would be feasible to adapt it accordingly to a wider cultural sample.

Finally, future research in this field should further investigate lyrics as a factor of music-listening and groove. Despite their growing presence in popular music, they are relatively understudied as a mechanism in modifying groove experiences. Moreover, it seems that sad lyrics specifically have potential to moderate urges to move in response to music. Although our study did not provide any concrete findings regarding lyrics, our results point to the possibility that this musical property does indeed influence our perceptions of music.

Concluding Remarks

Despite its limitations, this study offers insight into the influence of (or perhaps lack of) empathy in the experience of groove in varying emotional contexts. Although we predicted that high empathy would be associated with higher groove ratings when listening to both happy and sad songs, we did not find any evidence of this. However, from this study alone it is difficult to entirely discount the role of empathy in moderating perceptions of groove, given its established role in emotional music-listening. We did find that individuals tend to attend to lyrics when listening to music of any emotional valence. This provides a basis for future research to further explore the role of lyrics in different music-listening and movement paradigms.

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Appendix A

NMREB Amendment Form & Re-Approval

Western Research

Date: 25 March 2022 **To:** Dr. Jessica Grahn

Project ID: 106385

Study Title: Behavioral studies of rhythm and music perception

Application Type: Continuing Ethics Review (CER) Form

Review Type: Delegated

Date Approval Issued: 25/Mar/2022

REB Approval Expiry Date: 30/Mar/2023

Dear Dr. Jessica Grahn,

The Western University Non-Medical Research Ethics Board has reviewed this application. This study, including all currently approved documents, has been re- approved until the expiry date noted above.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario
Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

Sincerely,

The Office of Human Research Ethics

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix B

Lyrical Perception Measure: Lyric Focus Questionnaire

1	2	3	4	5	6	7
Completely Disagree	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Completely Agree

1. _____I can remember the lyrics of a song after hearing it a couple times.
2. _____I often get song lyrics stuck in my head.
3. _____When a song is stuck in my head, I tend to sing the lyrics.
4. _____I am often moved by the lyrics of a song.
5. _____I am deeply moved by a singer's voice.
6. _____When listening to a song, I am often struck by the emotional content of the lyrics.
7. _____When listening to music, the lyrics really grab me.
8. _____The meaning of the lyrics is the most important aspect of song selection.
9. _____Songs with meaningful lyrics stand out to me.
10. _____When listening to music, I most often find myself drawn to the lyrics.
11. _____When choosing a song to listen to, I care a lot about the meaning of the lyrics.
12. _____After listening to a song, I often think about what the words meant.
13. _____When listening to a song, I connect emotionally to the singer's voice.
14. _____When listening to a song, I connect emotionally to the lyrics.
15. _____I always listen to what is being said in the lyrics.
16. _____I will listen to a song because I want to hear the lyrics.
17. _____The lyrics of a song really draw me in.

18. _____When listening to music, I pay the most attention to the lyrics.

19. _____I usually memorize the words of songs.

Appendix C

Musical Stimuli

Songs: High Groove/Happy Lyrics

1. Just a Cloud Away *(Pharrell Williams)*
2. Little Dance *(Neon Dreams)*
3. Walking On Sunshine *(Katrina and the Waves)*
4. I'm Coming Out *(Diana Ross)*
5. September *(Earth, Wind, and Fire)*
6. Three Little Birds (Alternate Mix) *(Bob Marley & The Walters)*
7. Mr. Blue Sky *(Electric Light Orchestra)*
8. The Sweet Escape *(Gwen Stefani)*
9. Dancing in the Moonlight *(Toploader)*
10. Put Your Records On *(Corinne Bailey Rae)*
11. No Tears Left to Cry *(Ariana Grande)*
12. Sunshine *(One Republic)*
13. The Rhythm of the Night *(Corona)*
14. Alright (2015 Remastered Version) *(Supergrass)*
15. Ain't No Mountain High Enough *(Marvin Gaye ft. Tammi Terrell)*
16. Don't Stop Me Now *(Queen)*
17. Looking Good, Feeling Gorgeous *(RuPaul)*
18. Break My Soul *(Beyonce)*
19. Treasure *(Bruno Mars)*
20. Dancing Queen *(ABBA)*

Songs: High Groove/Sad Lyrics

1. Hey Ya! (Radio Mix/Club Mix) *(Outkast)*
2. The Less I Know the Better *(Tame Impala)*
3. Pumped Up Kicks *(Foster the People)*
4. Mr. Brightside *(The Killers)*
5. Out of Time *(The Weeknd)*
6. Blame *(Calvin Harris ft. John Newman)*
7. Cool Kids (Echosmith)
8. All of the Lights *(Kanye West)*
9. Somebody Else *(The 1975)*
10. Hard Times *(Paramore)*
11. Go Your Own Way *(Fleetwood Mac)*
12. Swimming Pools (Drank) [Extended Version] *(Kendrick Lamar)*
13. Under Pressure *(Queen ft. David Bowie)*
14. Little Talks *(Of Monsters and Men)*
15. Some Nights *(Fun.)*
16. Day ‘n’ Nite *(Kid Cudi)*
17. Heat Waves *(Glass Animals)*
18. SOS *(ABBA)*
19. I’m Not Alright *(Loud Luxury ft. Bryce Vine)*
20. Misery *(Maroon 5)*

Appendix D

Consent Form & Letter of Information

Below is a consent form for you to carefully read through. This consent form covers a wide range of studies, for the current study you will only be required to provide demographic information, fill out a survey, and rate musical stimuli.

Behavioral Studies of Rhythm and Music Perception

Principal Investigator:
Dr. Jessica Grahn
Department of Psychology, The University of Western Ontario, London, ON
Telephone: (519) 661-2111: Email: jgrahn@uwo.ca

Introduction

You are being invited to participate in a research study about human perception of music and rhythm. The purpose of this study is to investigate how humans perceive rhythm and music, and how rhythm and music might change our experience of or memory for other sights and sounds.

The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research. It is important for you to understand why the study is being conducted and what it will involve. Please take the time to read this carefully, and feel free to ask questions if anything is unclear or if there are words or phrases you do not understand.

Research Procedures

The experiments conducted as part of this study will test how humans hear, see, remember, and move when they listen to auditory rhythms (including music) or see visual rhythms. If you agree to participate, you will be asked to listen to or watch rhythmic stimuli. You may be asked to make simple responses about whether you detect the presence of or differences between stimuli, to tap or walk in time with the stimuli, and/or to make ratings about your impressions of the stimuli. You might also be asked to perform a task testing your memory or attention while you are listening to music. It is anticipated that the entire task will take no more than 3 hours. The task(s) will be conducted in the Brain and Mind Institute in the Natural Sciences building, the Social Sciences Building, or the Robarts Research Institute on the University of Western Ontario campus. There will be a total of 750 participants.

Inclusion and Exclusion Criteria

Individuals who are at least 17 years of age having hearing and vision adequate to perform the task are eligible to participate in this study. Individuals who are younger than 17 years of age or who have hearing damage or vision problems too severe to complete the task will be excluded from the study.

Risks and Benefits

There are no known or anticipated risks or discomforts associated with participating in this study. Although you may not directly benefit from participating in this study, the information gathered may provide benefits to society as a whole which include enhancing our scientific understanding of music perception and leading to advancements in medical care (for example, music or motor therapy) for disorders like Parkinson's disease.

Compensation

You will receive course credit (1 credit per hour) or monetary compensation (£6 per hour) for your participation in this study. If you do not complete the entire study, you will still be compensated a pro-rated amount.

Voluntary Participation

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future academic status.

Confidentiality

Any information obtained from this study will be kept confidential and will be accessible only to the investigators of this study. In the event of publication, any data resulting from your participation will be identified only by case number, without any reference to your name or personal information. The data will be stored on a secure computer in a locked room. Both the computer and the room will be accessible only to the investigators. After completion of the experiment, data will be archived on storage disks and stored in a locked room. Any documents identifying you by name will be kept separately from your data, and will be destroyed after 5 years.

Representatives of the University of Western Ontario Health Sciences Research Ethics Board may require access to your study-related records or may follow up with you to monitor the conduct of the study.

Contacts for Further Information

If you would like to receive a copy of the overall results of the study, or if you have any questions about the study please feel free to contact the Principal Investigator at the contact information provided above.

If you have any questions about your rights as a research participant or the conduct of the study you may contact:
The Office of Research Ethics
The University of Western Ontario
519-661-3036
E-mail: ethics@uwo.ca

By clicking the button below, you acknowledge that you have read the above letter of information, know what is being asked of you, and agree to take part in the study.

Appendix E

Music Rating Scale