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The influence of music induced chills on time estimation.

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ABSTRACT

The present study investigated the effect of music induced chills on time estimation. Ten individuals who ranked above a threshold rating on a scale which measures sensitivity to music induced chills participated in the study. Using a prospective paradigm, the experiment gauged participant accuracy during a time estimation task in two conditions. In one of these conditions, participants completed the task while listening to music that did not induce chills. In the other condition, participants completed the task while listening to music that did induce chills. The hypothesis anticipated that people's accuracy while performing a time estimation task would be impacted by listening to music that produces a chills response. This hypothesis was supported by the results, and the implications of these findings for furthering an understanding of the social-emotional function of music induced chills are discussed, as well as the limitations of the current study and suggestions for future research.

1. Introduction

Aesthetic emotional experiences are linked to the reward system, with vast individual difference in terms of both the frequency and intensity of these emotions. Although visual aesthetic experiences are well researched, recent studies have only begun to identify the causes and purposes of auditory aesthetic experiences. Music induced chills are a physical manifestation of aesthetic-emotional experience, with visceral and abstract symptoms ranging from a sensation of the heart skipping a beat to feelings of absorption or being moved (Sachs, Ellis, Schlaug & Louis, 2016). Despite individual variance in accompanying symptoms, music induced chills are characterized by the feeling of shivering combined with piloerection in the absence of cold, accompanied by pleasurable, intense emotion (Grewe, Kopiez & Altenmüller, 2009). Recent research pertaining to music induced chills has illuminated the neural structures which provide a biological basis for this phenomenon (Sachs et al., 2016). Observing the implications and effects of music induced chills may help create a more complete picture of the purpose and impacts of this function, shedding light on why such variation exists between individuals. Music induced chills also provides an opportunity for examining the role of emotion in time estimation and music, by presenting a measurable physiological response that can be defined much more clearly than emotions themselves can (Grewe et al., 2009).

The power of music to influence time perception has been well documented.

Recent years have seen many studies which aim to isolate the musical factors that impact the internal human clock in both retrospective and prospective paradigms. Perceived time seems to elapse faster when listening to music (Droit-Volet, Bigand, Ramos & Bueno, 2010). A study conducted by Droit-Volet, Ramos, Bueno and Bigand found that tempo, when isolated, accounted for increased arousal and sped up the internal clock (2013). The researchers recommended future study to isolate and examine the role of emotion in time perception and music. One study that reported a link between the emotional valence of the music and time perception considered emotional valence to be a combination of tempo and mode (Panagiotidi & Samartzi, 2013). These studies show that isolating the effect of emotion from music structure variables has been challenging, as music structure elements combine to account for a perceived emotional valence.

The current study explored utilizing the presence or absence of music induced chills to examine the effect of emotion on time perception in music. This was done by manipulating the experience of music induced chills with music chosen to induce or inhibit a chill response. The participants performed time estimation tasks during each condition of the experiment where time was estimated in seconds in reference to a trained length of time. This was done while listening to an emotionally neutral song during the control condition, and a song that causes music induced chills in the experiment condition. A prospective paradigm was used for the experiment, wherein participants were aware that they would be performing a time estimation task.

It was expected that the accuracy of the participants' estimation of time would be impacted while experiencing music induced chills, considering the existing research on time estimation, emotional arousal, and music induced chills. Droit-Volet and Berthon (2017) produced a study that indicated that heightened emotions distort time perceptions. When participants self assessed their emotional arousal below a rating of 5 on the 9 point Self-Assessment Manikin (SAM) scale (adapted from Bradley & Lang, 1999), there was little distortion of time. Emotions ranked above this did produce an effect of time distortion. Based on this, and the research of Grewe et al. (2009) which revealed the emotional significance of music induced chills, it can be be concluded that music induced chills may distort time perception by virtue of the emotionality of this experience.

2. Methods

2.1 Participants

Participants were found through an open call out over social media, with those interested contacting the experimenter and being required to fill out the Aesthetic Experience Scale for Music (Sachs et al., 2016) to determine their likelihood to experience music induced chills in an experiment setting. Those responding to the questions with an average ranking of 3 on the 7 point scale were invited to participate in the experiment.

Ten individuals were chosen to participate in the current study, which each participant completing both the control phase as well as the experiment phase. Their ages ranged from 20 to 45 years old with an average age of 30 years old. 5 females and 4 males participated, with 1 individual who did not categorize their sex in the terms of male or female. All participants had university level education of a bachelor's degree or higher. The participants had a range of prior musical training from 0 to 15 years, with an average of 2 years.

2.2 Materials and Apparatus

The present study utilized materials which included a MacBook Pro computer (15-inch, 2011) for collecting data and playing audio. Cowen E7 Pro noise cancelling headphones were used by participants to listen to audio tracks. Participants used a digital Sportline 220 Sport Timer stopwatch with the read out covered with white card stock and tape for time estimation tasks. The Self Assessment Manikin (SAM) scale, adapted from Bradley and Lang (1999) to isolate the question regarding emotional arousal, was filled out on the computer. It consists of 9 images to rank emotional arousal (see Appendix C for the version of the SAM scale used in this study). The Aesthetic Experience Scale for Music (AES-M) (Sachs et al., 2016) consisted of 15 questions regarding the nature and frequency of the music induced chills experienced by each participant, with a 7 point scale ranging from (1) never/rarely to (7) nearly always (see Appendix B for a copy of the AES-M used in this experiment). A digital copy of the AES-M was filled out by each participant and emailed to the experimenter. The audio files consisted of 15 seconds of white noise, Where You Lead by Carole King (2008), and The Hanging Tree by James Newton Howard arranged for choir by Friedemann Petter (2014). These audio files were cued on the computer and were adjusted for approximate consistency in loudness by ear prior to the experiment. The white noise audio was used during the training stage for both conditions. Where You Lead by Carole King was chosen by the participants as unlikely to produce chills, and was used in the control condition, or No Chills Phase. It is a studio recorded song with a female singer and an accompanying band and an upbeat tempo. The Hanging Tree by James Newton was chosen by participants as for the experiment condition, of Chill Phase. It is a choral performance recorded in a theatre with a male solo vocalist, a piano accompaniment, and a slow tempo.

2.3 Procedure

Participants were invited to listen to a selection of music and vote on the piece most likely to induce chills, and the piece least likely to induce chills. The two songs voted most and least likely to induce chills, respectively, were selected for the experiment.

Participants completed the experiment one at a time, in a quiet room. At the beginning of the experiment, they were seated and filled out a consent form that gave a basic description of the experiment. As the experiment uses a prospective paradigm, their roles in performing a time estimation task was included in the consent form. They were then given a stopwatch with the read out covered. The researcher explained that the participants would be completing a test phase, during which they would listen to and attempt to remember a span of time indicated by white noise. The participants were not informed that this span of time consisted of 15 seconds. They were also informed that they would be asked to reproduce their estimation of this span of time after the test phase, by activating the stop watch and halting it when they believed the span of time was over. Data was recorded from the stop watch and the SAM scale at the end of each condition of the study.

Both of the conditions, the No Chills Phase and the Chills Phase, began immediately following a test stage. In the test stage, the participants listening to a white noise clip for 15 seconds. Each participant listened to the white noise clip three times at the beginning of both conditions.

At the beginning of the No Chills Phase, the researcher informed participants that they were to begin the stop watch when cued to do so by the researcher, as well as to stop it when they believed an amount of time equivalent to the time experienced in the test stage had elapsed. After this was complete, the researcher asked the participants to rank the intensity of their experience listening to the control song on the SAM scale to assess the intensity of music induced chill response in participants for each condition of the study, and control for the potential of a confounding music induced chill response during the No Chill Phase.

At the beginning of the Chills Phase, the researcher asked the participants to start the stopwatch only when they felt a strong music induced chill, and to stop the stop watch when they believed the time shown in the test stage had elapsed. The participants once again rated their experience on the SAM scale to conclude the Chills Phase. At this point, the participants were more fully informed about the experiment and the hypothesis.

3. Results

The level of significance set in this experiment was 0.05. The average difference in seconds between the time estimated and trained time during the No Chills Phase was 1.58 (sd = 0.93). The average difference in seconds between the time estimated and trained time during the Chills Phase was 4.01 (sd = 1.70). See Figure 1 for a summary of the descriptive statistics. These data were analyzed using an independent samples t-test and the results were statistically significant $t(9) = 4.8$, $p = 0.001$, suggesting that participants were less accurate in estimating time while experiencing music induced chills.

4. Discussion

The hypothesis that listening to music that induced chills would have an effect on time estimation is supported by the findings. This is in keeping with the findings of Droit-Volet & Berthon (2017), which indicated that experiences of emotional intensity rating over a 5 on the emotional arousal component of the SAM scale are sufficiently intense to distort time perception. All participants in the present study ranked a minimum of 6 on the emotional arousal component of SAM scale during the experiment phase, with lower accuracy. No participants rated above 2 during the control phase, during which accuracy was higher.

One potential explanation could be attentional division, as the emotional experience may occupy greater attention and distract from internal time keeping. Divided attention has been found to impact the internal clock in time estimation tasks in other studies (Block, Hancock & Zakay, 2010). However, other studies have found that emotional arousal can directly impact the internal clock, regardless of attention level, and that this could be a result of a dopamine release (Cheng, Tipples, Narayanan & Meck, 2016 as cited in Droit-Volet & Berthon, 2017). Considering the link between music induced chills and reward response, this seems like a reasonable explanation (Sachs et al., 2016).

There are some limitations in the current study. Due to limitations in software to manipulate audio, tempo could not be controlled. Utilizing software to more precisely control for tempo and loudness variations between audio files would

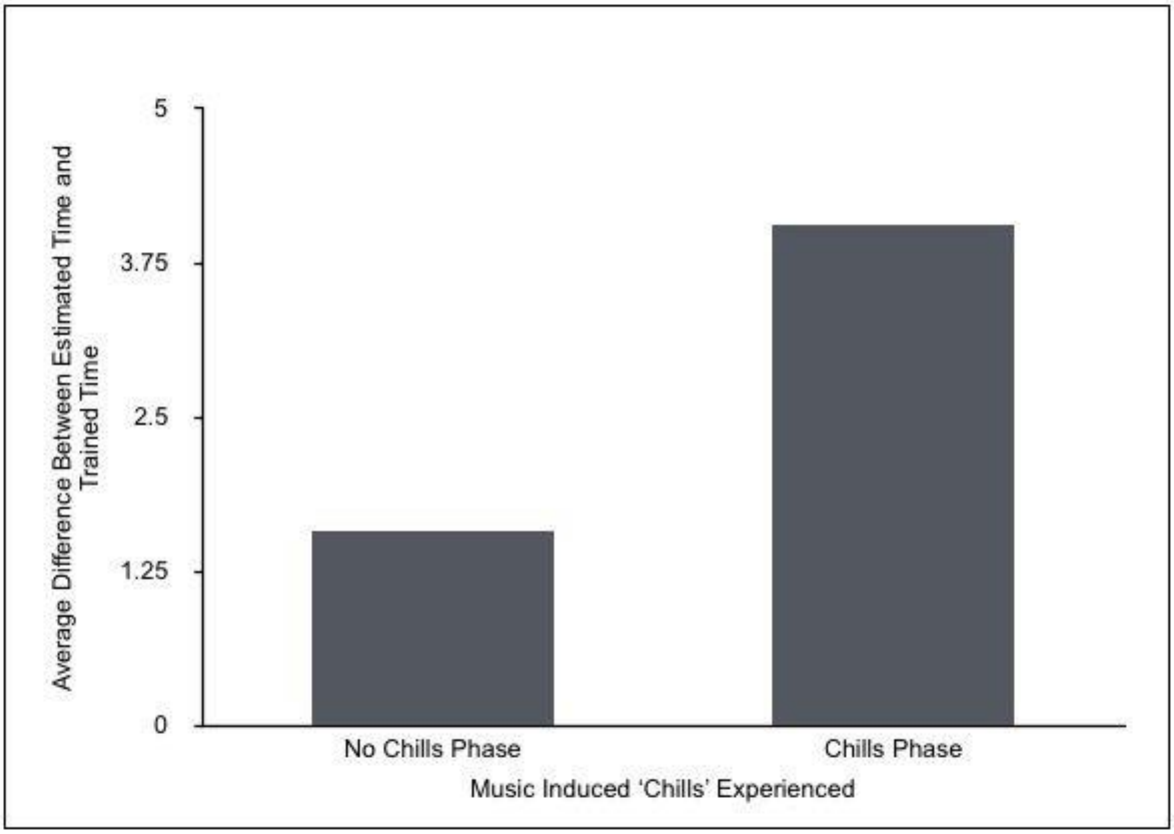

Figure 1. Average difference in seconds between time estimated by participants and the trained time during the Chills and No Chills Phases.

produce consistency that the current study was not resourced to produce. Also, measuring galvanic skin response would have permitted a more reliable reading of physiological arousal while the timer was being triggered, rather than an overall arousal impression provided by the SAM scale. Finally, access to a larger population and more time may provide a group of participants with a baseline even higher on the AES-M survey, with less individual variation within the group on susceptibility and intensity of music induced chills.

The findings of the current study have implications for understanding the evolutionary function of music induced chills. Sachs, Ellis and Schlaug (2017) posited that human evolution favoured social-emotional communication, and their study found a neurological basis for this. Their findings provide a physiological reason for music induced chills triggering reward activation in response to auditory stimuli that is aesthetic in nature. In other words, music induced chills present a unique aesthetic emotional experience, one that is highly variable between individuals and has been linked to empathy and pro-social behavior (Parkinson & Wheatley as cited in Sachs et al., 2017). Understanding how music induced chills impacts time perception has implications for clarifying how the complex variables of white matter connectivity, reward sensitivity, and dopamine levels may impact an individual's engagement with music, their pro-social function, and their perception of time.

Future research could be done with focus on the direction of inaccuracy, in terms of whether time was over or underestimated, in order to interrogate the role of attention in the current findings. Other studies report that divided attention skews perceived time in one direction for retrospective time, and in the other for prospective time (Block, Hancock & Zakay, 2010). Results that are inconsistent in this may imply explanations for the current results other than divided attention. Future research should also be done to ascertain any difference between retrospective and prospective paradigms as research in time estimation has shown different findings within prospective and retrospective paradigms (Ziv & Omer, 2011).

White matter connectivity, reward sensitivity, dopamine levels, pro-social functioning have all been associated with music induced chills and could each be isolated studied in future studies to examine effect of each in producing variation in music induced chills and time perception.

The results obtained in the current study suggest that music induced chills could be applied as a paradigm in future studies of emotion and music in laboratory settings, as music induced chills produce an peak emotional experience that can be manipulated as well as mapped with Diffusion Tensor Imaging (Sachs et al., 2017).

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Appendix A

Informed consent used in the experiment.

A Psychological Study on Music-Induced 'Chills' and Time Estimation

This study is investigating factors that impact time estimation while listening to music. Before taking part in this study, please read the consent form below. If you understand the statements and freely consent to participate, please provide a signature and date at the bottom of the page.

Consent Form

This study is designed to understand what effect the experience of music-induced chills has on an individual's perception of time. The study is being conducted by Gabriel Waite, a student of psychology at Camosun College for the partial fulfillment of the requirements for Psychology 110, Experimental Psychology. The study has been approved by the Instructor of the course, Grace Chan.

Participation in the study typically takes approximately 20 minutes and is strictly anonymous.

All responses will be kept completely confidential, and in no case will responses from individual participants be identified. Rather, all data will be pooled and then analyzed.

Participation in this study is voluntary, and participants may withdraw from the study at any time.

Participants begin by completing a questionnaire prior to the experiment. They will then be asked to participate in two stages of the experiment, with each of the two stages including a training phase and a test phase. During the training phase, participants will be asked to listen to white noise for a length of time. During the test phase, participants will be asked to recreate the length of time experienced during the training phase on a timer, while listening to a song. After completing each stage of the experiment, the participants will be asked to fill out a third questionnaire.

If participants have further questions about this study or their rights, they may contact the principal investigator, Gabriel Waite (gabriel.w.waite@gmail.com), or the course instructor, Grace Chan at 250-370-3217 (chang@camosun.ca).

If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, please sign below:

Signature:___________________________________
Date:__________________________________

Appendix B

Aesthetic Experience Scale in Music (AES-M)

The following Aesthetic Experience Scale in Music (Sachs, Ellis, Schlaug & Loui, 2016) was used to select participants for the experiment:

1---------------2---------------3--------------4--------------5---------------6---------------7

Never/Rarely   Nearly Always

When listening to music, how often do you . . .

________feel absorbed and immersed
________completely lose track of time
________feel chills down your spine
________get goose bumps
________feel like you're somewhere else
________feel like your hair is standing on end
________feel like crying
________feel touched or moved
________feel detached from your surroundings
________feel a sense of awe and wonder
________feel a lump in your throat
________feel sensation in the pit of the stomach
________feel like your heart is racing
________feel like your heart skips a beat

How often do you feel a strong emotional response directly to music? ________

Appendix C

Self Assessment Manikin (SAM) Scale

The following Self Assessment Manikin (SAM) Scale (adapted from Bradley & Lang, 1999) was used in the control and experiment phase:

Please select the figure below that most accurately describes the **intensity** of your feelings while listening to the previous song.