The Effect on Music on Pain Perception

by

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Abstract

The purpose of this study was to explore a possible explanation for the beneficial role that music has been demonstrated to play in pain tolerance. Previous research has suggested that listening to self-chosen music reduces one's perceived levels of pain and makes it easier to endure the pain for a longer duration of time, but the reason for this benefit is not well understood, nor whether the benefits of music are fundamentally similar to those you would find with other pleasurable distractions. To explore the role of pleasure in pain tolerance, the cold pressor task was used to test pain tolerance times of 39 participants, who each performed the cold pressor task while listening to preferred music, eating cookies, listening to an audiobook, and waiting in silence. This task, which involves submerging one's hand in 41 degree water and holding it there as long as one can tolerate, is commonly used to test pain perception in experimental settings. After participants completed all four conditions of the cold pressor task, they were asked to re-experience each of the four distractors once more but without the pain induction and provided a pleasure rating for each distractor. Results showed that there was a significant effect of conditions on tolerance time. The music condition showed significantly longer tolerance times than the silence condition, but no other significant differences were observed. Self-reported pleasure was significantly higher in the music and cookie conditions than in the silent and audiobook conditions. The cookie condition showed to have higher levels in pleasure compared to silence and the audiobook as well.

The Effect on Music on Pain Perception

Everyone listens to music, but not everyone knows how helpful it can really be. Music can evoke emotions and can help distract a person from the pain they are feeling. There has been research done that shows that listening to music can create longer pain tolerance times compared to listening to a comedy routine, performing mental arithmetic, and viewing art (Mitchell, MacDonald, & Brodie, 2006; Mitchell, MacDonald, & Knussen, 2008). The current study focused on whether or not pain tolerance is affected by the individual's preference for the distractor stimulus or perhaps the subjective pleasure of their experience. Does music have unique benefits for pain tolerance, relative to other distractions? Or do all distractions that a participant finds enjoyable help with pain tolerance?

Review of literature

Previous work has examined whether self-chosen music can have an effect on pain tolerance, perceived pain intensity, and perceived sense of control. Mitchell et al. (2008) tested pain tolerance in participants while they listened to music, looked at a painting, or endured the pain without distraction. Each participant selected music from their own collection. They were asked to select one painting that they wanted to view out of fifteen that were provided to them by the experimenters. Participants completed all three conditions of the experiment. The cold pressor task, which is widely used in pain perception research, was selected as the pain induction task for this experiment. The cold pressor task requires a participant to initially place their hand in warm water to normalize hand temperature. Then the participant places their hand in the ice cold water for however long they can tolerate it. The participant is timed from the moment their hand enters the cold water until they remove their hand, generally with a time limit of five minutes. The results of this study demonstrated that musical distractions resulted in longer tolerance times, lower subjective pain intensity ratings, and led to less reported anxiety than when viewing the paintings or enduring the pain without distraction. The music also gave most participants a greater sense of control over the pain, relative to the other conditions.

Listening to music hold one's attention and keeps one focused on the sounds as it unfolds. This may help take one's mind off pain. However, since music was the only stimulus in the Mitchell et al. (2008) experiment that engaged one's attention over time, it is unclear whether the pain perception benefits were due to music, per se, or simply due to the fact that music holds one's attention over time. This raises the question of whether *any* distraction that engages one's attention over time can create an effect on pain tolerance.

A stimulus that can hold one's attention over a period of time does seem to have a better effect on pain tolerance than a stimulus that does not engage one's attention. However, when attention is roughly controlled across conditions, other factors seem to matter. A study done by Mitchell, MacDonald, and Brodie (2006) used three types of temporally-unfolding stimuli to create distractions from the pain felt during the cold pressor task. This was done by having participants listen to self-chosen music, listen to a comedy routine, and complete a mental arithmetic task while completing the cold pressor task. All three of these distractor conditions required sustained attention, but they varied in other ways. Many individuals would probably regard music and humor to be more enjoyable distractions than performing mental arithmetic (though subjective enjoyment of the distractors was not measured in this experiment). Results from this study showed that listening to the music and comedy routine led to longer tolerance times than performing mental arithmetic. Music also resulted in longer tolerance times than humor. Notably, there was an interaction between these conditions and gender. Although females only exhibited a benefit in the music condition, the males experienced equal benefits in the music and comedy conditions. This may be related to different levels of subjective enjoyment. The comedy routine was performed by a male comedian, and it is possible that some of the comedy was off-putting for females, making it no more beneficial for them than doing mental arithmetic. The males may have enjoyed the comedy routine just as much as they enjoyed the music, leading to differences in tolerance times between genders for these conditions.

The subjective enjoyment of a distractor stimulus may influence how well it engages our emotions and holds our attention. Most people find music to be highly enjoyable. Many people have a personal connection to their preferred music, and music triggers a variety of affective experiences (see Bharucha, Curtis, & Paroo, 2005), which may transport one's feelings to another place and help them tolerate the pain for longer periods of time. Would having that personal connection to music help increase one pain tolerance?

Participants who were able to select their own music exhibited longer pain tolerance times due to their personal connection to the song they picked (Mitchell & MacDonald, 2006). Fifty-four participants completed the cold pressor task while distracted by white noise, experimenter-selected relaxing music, and self selected music. Results showed that when self selected music was played, it created a longer tolerance time compared to white noise and experimenter-selected relaxing music. There is more of a personal connection with the self chosen music, which makes it more engaging and enjoyable.

Affective Engagement and Pain Tolerance

Music induces pleasure, which may possibly serve as one of the factors that makes it an effective distraction from pain. Studies have shown that emotionally engaging stimuli may be particularly good distractions. For instance, Pasero (1998) wanted to see if humor could be used as a therapy to help patients who experience pain. Through a survey, she found that people reported laughter as the most effective way of controlling pain on their own. Laughter has a lasting effect and is effective at distracting patients. Pasero cited an anecdote stating that just 10 minutes of laughter left reportedly left a man with hours of pain-free sleep. Patients in this study reported that they thought laughter/humor was the most effective therapy and helped tolerate pain longer; they also thought that laughter was an effective therapy. Laughter was the only thing that increased discomfort threshold, even though patients had higher discomfort levels when listening to laughter tapes and relaxing tapes.

Stimuli that are emotionally engaging may effectively distract people from pain, even if those stimuli are associated with emotions other than pure enjoyment. Weaver and Zillmann (1994) had participants, men and women, watch funny and sad videos and tested them on pain endurance. Results showed that men displayed higher levels of pain endurance after watching both tapes, but comedic videos were more effective. Women did not experience any benefit from watching the tragedy video tape or the comedy video tape. Some types of laughter will help in reducing pain, but it depends on the person's preference and how well it distracts their mind.

Stimuli that induce aggression and arousal have also been linked to pain tolerance. A study conducted by Stephens and Allsop (2012) tested the effects of manipulated state aggression on pain tolerance. They tested this by having participants play a first person shooter game versus a Tiger Woods' golfing game and then after ten minutes of game play submerging their hand into ice cold water and measuring how long they were able to keep their hand in the water. Playing the first person shooter game for just ten minutes increased state anger, aggression cognition, heart rate, and cold pressor latency, and also decreased perceived pain. This study suggests that aggression (or, perhaps more generally, high autonomic arousal) can help cope with pain. It was also noted that saying curse words help participants tolerate the pain from the cold pressor task for at least 30-40 seconds longer (Stephens, Atkins, Kingston, (2009). Cursing may provoke an emotional response which may lead to a fight or flight response which leads to increased pain tolerance. The mechanisms by which different emotions relate to pain tolerance may differ, as the effectiveness of pleasurable stimuli cannot be explained according to fight or flight response. However, collectively, these studies point to the importance of emotional engagement in pain tolerance.

The current study tested how pleasurable stimuli and non-pleasurable stimuli affect pain caused by the cold pressor task. Self selected music and eating cookies served as pleasurable stimuli, and an audio book and silence served as less pleasurable stimuli. Tolerance time was compared across the four conditions, along with subjective pleasure ratings of each distractor stimulus. It was hypothesized that the more pleasurable distractions would result in longer tolerance times than the less pleasurable distractions.

Method

Participants

Thirty-nine participants were recruited from Purchase College State University of New York. Individuals were recruited from the Psychology Participant Pool. All participants were compensated with one credit towards their Intro to Psychology course.

Materials

A Styrofoam cooler was used to hold the cold water where participants submerged their hands, and a bowl was used to hold the warm water. A digital thermometer was used to monitor the temperature of the water. The cookies the participants chose from were Oreos, E. L. Fudge,

Fudge Stripes, and Vienna Fingers. Participants listened to the audio recording of Adam Smith's *Wealth of Nations.* Participants selected the music they would be listening to on Spotify, and noise-cancelling headphones were used to listen to the music. Tolerance time was measured by using a stop-watch to monitor the moment each participants' hand could no longer tolerate the stimulus. The subjective enjoyment of each distractor stimulus was measured with a single-item Likert scale.

Design

The independent variable in this study was distractor, which was manipulated within subjects across four conditions: music, cookies, the audiotape, and silence. The dependent variables were tolerance time and pleasure of distraction condition. A Latin square design counterbalanced the order of conditions so for each participant the order of conditions were different.

Procedure

Participants were given a consent form and after they signed it, the experiment began. Participants were asked to use the lab Spotify account to select one song that they enjoy, which they then listened to while they were in the music condition. They were also asked to pick three cookies from the selection, and these were eaten during the cookie condition. They were given the headphones and informed that they would wear these for the whole experiment. Before each condition, participants placed their hand in warm water to regulate the temperature of their hand and then placed it in the cold water (38 F°). Participants left their hand in the water for as long as they could tolerate it and were timed from the moment their hand entered the water to the moment they took it out. There was a 3 minute time limit for how long the participant could keep their hand in the water. For each condition, the hand put into the water would switch. For example, in the first trial they would be using their dominant hand, for the next condition they would use their non-dominant hand, and so on and so forth, until the end of the conditions. After all the cold pressor trials were completed, the participant warmed their hand one last time and then began the pleasure questionnaire. During the pleasure questionnaire, participants went through all the distractor conditions again but this time while not doing the cold pressor task. They reexperienced all four conditions for 30 seconds and then rated how pleasurable they thought each condition was. Once the questionnaire was completed, they were debriefed and compensated one credit.

Results

Tolerance time data from 39 participants were analyzed. Pleasure rating data from only 25 of those participants were analyzed due to a procedural error made in the initial stage of data collection.

Mean tolerance times and pleasure ratings are displayed in Table 1. A repeated measures ANOVA revealed an effect of distractor condition on tolerance time, $F(3, 120) = 3.14$, $p = .028$, such that tolerance times in the music condition ($M = 55.24$ seconds, $SD = 45.14$) were significantly longer than those in the silent condition, $p = .034$ ($M = 40.94$ seconds, $SD = 37.51$), according to Bonferroni post hoc analysis. No other significant differences in tolerance time were observed.

A repeated measures ANOVA revealed an effect of distractor condition on pleasure ratings, $F(3,72) = 21.18$, $p < .001$. Post-hoc analysis indicated that pleasure ratings for the music condition ($M = 6.16$, $SD = 1.14$) were significantly higher than those in the silent condition, $p < .001$ ($M = 4.0$, $SD = 1.71$) and audiobook condition, $p < .001$ ($M = 3.56$, $SD = 1.53$). The pleasure ratings for the cookie condition ($M = 5.56$, $SD = 1.29$) were also significantly higher than those for the silent condition, $p < .002$ ($M = 4.0$, $SD = 1.71$) and audiobook condition, $p < .001$ ($M = 3.56$, $SD = 1.53$).

To directly assess the relationship between pain tolerance and the subjective pleasure of the distractor, a one-tailed Pearson correlation was conducted between these measures. The one-tailed test was used instead of a two-tailed test because we hypothesized that there would be a positive correlation between these two factors. (Given the within-subjects nature of the design, each participant is represented four times in this correlations--tolerance times and pleasure ratings for each of the four conditions.) A significant positive correlation was observed between tolerance time and subjective pleasure ratings of each distractor, $r = .191$, $p = .028$.

Discussion

This study was able to replicate previous studies in that there was a significant difference in pain tolerance time between music and silence, but there were no significant differences between music, cookies, and the audiobook. Pleasurable ratings also showed a significant difference between music and the audiobook and silence, but music was not rated as more pleasurable than cookies. The cookies condition was also rated as more pleasurable than the audiobook and silence. This pattern of results does not paint a consistent picture about the relationship between pleasure and tolerance time but does suggest that pleasure serves as a potential explanatory factor for music's utility in pain perception. It is unclear why music was significantly better than silence for increasing pain tolerance, while cookies were not, when both were rated as significantly more pleasurable than silence. The significant positive correlation between pleasure ratings for each distractor and tolerance time while in that distractor condition suggests that subjective pleasure may play a role in pain tolerance, but perhaps it is just one of many explanatory factors. Other factors could be the physical effort that is required to reach for the cookie and eat them, music on the other hand doesn't require any effort to enjoy.

The current project could have been improved in several ways. The data set is incomplete due to the missing pleasure ratings data from 14 participants. The correlation between pleasure and tolerance time is based on data from 25 participants, whereas the main effect of condition on tolerance time is based on data from 39 participants. Due to time constraints, further data collection was not possible, but this project would be improved by having a larger number of complete data sets.

The water temperature used for the cold pressor task is usually controlled by a specialized device designed for this task, but our research lab does not have that equipment. We use ice to regulate the water temperature and monitor it during testing. However, the variability of the water temperature in the current study was likely to be higher than is typical for studies of this nature. This study could have been improved by using specialty equipment designed for the cold pressor task.

Further research could study how different pleasurable stimuli, not just preferred music and cookies, can increase an individual's pain tolerance. It would be interesting to see if emotions play a role as well. For example, would a song that evokes a happy emotion create a longer pain tolerance time than a song that evokes a sad emotion or a fearful emotion? Does fast music work better than slow music? Or does the most effective music differ so much from person to person that there is no unifying characteristic other than preference and, perhaps, pleasure? There are many future avenues by which to explore the power of music in the management of pain.

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Table 1. Mean tolerance times and pleasure ratings for each distractor condition.

Conditions	Mean Tolerance Time (SD)	Mean Pleasure Rating of Distractor (SD)
Cookie	49.86 s (39.59)	5.56 (1.29)
Music	55.24 s (45.14)	6.16 (1.14)
Audiobook	42.28 s (38.66)	3.56 (1.53)
Silence	40.94 s (37.51)	4.0 (1.71)

Note: s equals seconds