

Pain Perception

by

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Abstract

How can one resist the urge of feeling too much pain? Can external stimuli influence how much pain is felt? This project examines whether music is an effective distraction from pain, relative to other distractor conditions. It tested the hypothesis that pleasurable stimuli would be more effective distractors than less pleasurable stimuli. Pain was induced using the Cold Pressor task, which involved submerging one's hand in cold water and holding it there as long as one can tolerate. Seventeen participants completed the Cold Pressor task in four different conditions: in silence, while listening to self-chosen music, while eating cookies, and while listening to an audiobook on economics. Music and cookies were the pleasurable distractors and silence and the audiobook were the non-pleasurable distractors. Tolerance time was measured in each condition. A repeated ANOVA revealed no significant differences in tolerance time between conditions, though the pattern of means was consistent with those predicted, with the highest tolerance times seen in the music condition. The current results may be regarded as inconclusive.

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Pain Perception

The cold pressor task is commonly used to examine pain perception and tolerance time in an experimental setting. The task involves a participant submerging their hand in ice cold water until the participant cannot tolerate the sensation; this tests the participant's pain tolerance. For the current study, we tested whether pleasurable distractions can influence pain tolerance.

Previous research has focused on music as a pleasurable distraction, as it has many qualities that may make it an excellent distractor stimulus. The current study compares the utility of music as a distractor to another pleasurable distractor, eating cookies, as well as two less-pleasurable distraction conditions: completing the task in silence and while listening to an audiobook.

In the past literature, the cold pressor test is the primary method by which pain is induced experimentally. Early findings point to sources of variability on task performance, with one study noting gender differences on the task, regardless of distraction type. Mitchell, MacDonald, and Brodie (2004) designed a study that examined tolerance on the cold pressor test in 12 males and 14 females. The study concluded that males had significantly longer tolerance times than females, although there were no gender differences with regard to the self-reported level of discomfort or pain. From this study, the takeaway seems to be that both males and females experienced pain of the same intensity but males were able to tolerate that same level of pain a bit longer.

How might one influence the perception of pain? Various distractor stimuli have been tested. Mitchell, MacDonald, and Knussen (2008) designed a study that examined if music and art can serve as effective distractions from pain. In the study, 80 participants underwent 3 trials of the cold pressor task with the conditions: listening to self-chosen music, viewing art, and

silence as a control. For the conditions, participants were mostly involved in picking what was pleasurable for them. They picked their preferred music to listen to, and picked out a painting from a set of 15 that had been pre-selected by the experimenters. The study measured tolerance time. To start out, the participants immersed their hand in warm water to regulate initial hand temperature. They were then asked to transfer their hand into cold water with the maximum allotted time being five minutes. Three trials took place with five minute breaks in between, one trial had preferred music playing while hand was immersed in cold water, one trial involved viewing the painting while having hand immersed in cold water, and the last trial involved completing the task in silence. Like the previous research, this study showed that males tolerated the pain longer than the females. For both genders, tolerance time was longest in the music condition. This could be because listening to music may keep one more actively engaged than the other distractor conditions. Music is a stimulus that unfolds over time--one must continue to attend to process the lyrics, melody, harmonic structure, and other emerging musical events. The same cannot be said of the viewing art; as the image is presented all at once, the attentional demands are not to same as those required for the processing of music. Perhaps the temporally-engaging nature of music makes it an effective distractor. If this interpretation is correct, it would suggest that other stimuli that unfold over time should also serve as good distractors.

The utility of using temporally-unfolding stimuli as distractions from pain was tested by Mitchell, MacDonald, and Brodie (2006). They examined performance on the cold pressor task in three conditions: while participants listened to self-chosen music, while they listened to a recording of a comedy routine that had been selected by the experimenters, and while they

completed a mental arithmetic task. All three conditions in this experiment involve a task that requires one to sustain their attention. Two of these sustained attention conditions (music and comedy) may have been more enjoyable to participants than the third (arithmetic). In the study, there were 44 participants who all underwent all three trials of the cold-pressor task. The results showed that music was a better distractor than the comedy special and the arithmetic task, resulting in longer tolerance times. This suggests that music's value is not simply in the fact that it requires sustained attention. When compared to other sustained attention tasks, music was a superior distractor. It is unclear why it was a better distractor than the comedy routine, as this was also thought to be an enjoyable distractor. However, it may be the case that certain participants found the comedy routine, which was selected by the experimenters, to be less enjoyable than the self-selected music. Thus, self-selection may play an important role in the effectiveness of a distractor stimulus.

Further research points to the importance of self-selection of distractor stimuli. Mitchell and MacDonald (2006) examined cold-pressor performance in 54 participants who underwent three different distractor conditions: white noise, self-selected music, and experimenter-selected relaxing music. Listening to self-selected music was found to result in longer tolerance times than white noise and experimenter-selected relaxing music. This result is similar to the results of the other studies, as it seems that self-chosen music is the best distractor while engaging in the cold pressor task.

The current study attempted to replicate and extend the previous research. It tested the hypothesis that the use of highly-pleasurable distractor stimuli would result in superior performance on the cold-pressor task than less-pleasurable distractor stimuli. Self-selected music

and self-selected cookies (selected from four options provided by the experimenter) were used as pleasurable distractor stimuli. Tolerance time in each of these conditions was compared to tolerance time in the two less-pleasurable conditions: silence and listening to an audiobook that was selected by the experimenter. It was hypothesized that both pleasurable distractions will enable participants to tolerate pain longer than silence but that there will be no difference between the tolerance time for the music and cookie conditions.

Methods

Participants

Seventeen participants were recruited from the Psychology Participant Pool and compensated with course credit. One participant's data was not included in the analysis because the participant forgot to sign the consent form. Of the remaining 16 participants, their mean age was 19.63 years old, ranging from 18 to 28. Seven participants identified as female, eight as male, and one as nonbinary.

Materials

Materials included a styrofoam cooler that was used as the cold-pressor task water bucket, four types of cookies (Oreos, E. L. Fudge, Fudge Stripes, and Vienna Fingers), music (selected by the participants and played on the lab Spotify account via a MacBook Pro), and an audio-recording of Adam Smith's *Wealth of Nations*. A digital thermometer was used to monitor the temperature of the water. A stopwatch was used to track tolerance time. Sony noise-cancelling headphones were worn by the participants in all four conditions (though sound only played through the headphones in two of the four conditions). A bucket of warm water was

also be provided, so as to enable participants to initially regulate the temperature of their hand before completing the task and to return their hand to a comfortable temperature after completing each round of the task.

Design

The study used a repeated measures design with four conditions (music, cookies, audiobook, and silence). Tolerance time was the dependent measure.

Procedure

The procedure was conducted in strict accordance with the approved IRB protocol. Participants were informed prior to volunteering for the study that they would be asked to hold their hand in painfully-cold water, eat cookies, and listen to music. Only those who were comfortable with those activities were invited to participate in the study.

Upon arriving in the lab, the experiment was thoroughly explained to each participant (who were tested individually). After consent was obtained, participants were asked to select a song that they enjoy that they also think might serve as a good distraction from the task. Participants were asked to select three cookies from the varieties provided by the experimenter. The order of conditions was counterbalanced using a Latin squares design, although only one order of conditions will be used here to explain the procedure. Each participant completed four trials of the cold pressor task. In the first trial, participants were asked to submerge their dominant hand into the warm water first, then to submerge their hand into the cold water (38 degrees F) for as long as they could tolerate the sensation while listening to their chosen song over headphones. The experimenter started the song and began recording tolerance time when the participant started the trial. The stop-watch was stopped when the participant removed their

hand from the water. Any participant who kept their hand in the water for 3 minutes on any trial was instructed to stop, and 3 minutes was used as their tolerance time. After the first trial, there was a 1-2 minute waiting period, during which the participant could warm their hand in the bowl of warm water. The experimenter regulated the water temperature at this time, as needed. For the second trial, the participant submerged their non-dominant hand in the warm water and then in the tub of ice water while eating cookies. Tolerance time was measured. During the 1-2 minute waiting period, the participant regulated their hand temperature and the experimenter regulated the water temperature as needed. For the third trial, the participant submerged their dominant hand in the warm water before submerging it once again in the cold water while standing in silence. Tolerance time was measured. During the 1-2 minute waiting period, the participant regulated their hand temperature and the experimenter regulated the water temperature as needed. For the fourth trial, the participant submerged their nondominant hand in the warm water before submerging it once again in the cold water while listening to the audiobook. After the fourth round was complete, the participant was instructed to warm their hands in the warm water, and they were debriefed, thanked, and compensated.

Results

A repeated measures ANOVA was used to determine whether there were significant differences in tolerance time across the four conditions. No effect of distractor condition was found, $F(3,45) = 2.07$, $p = 0.118$, $\eta^2 = 0.121$. Although the mean tolerance times for the music condition ($M = 57.96$ seconds, $SD = 50.17$) and cookie condition ($M = 54.71$ seconds, $SD = 50.79$) were nominally higher than the mean tolerance times for the audiobook ($M = 40.83$

seconds, $SD = 40.35$) and silence conditions ($M = 38.06$ seconds, $SD = 39.43$), these differences did not reach the level of significance.

Discussion

This study failed to replicate the previous work demonstrating longer tolerance time for musical distractions than other forms of distraction during the cold pressor task. In attempt to extend previous studies, this study also investigated whether pleasurable distractions in general have benefits for tolerance time. No differences were observed between any of the conditions in the experiment.

The pattern of means, though they did not reveal significant differences between conditions, were consistent with the hypothesized pattern. Performance was superior in the music and cookie conditions, with tolerance time being 15 to 20 seconds longer in these pleasurable conditions than in the two less-pleasurable conditions. These results suggest that pleasurable distractions may hold some promise for pain tolerance, but more data would need to be collected in order to thoroughly assess this.

The same size of the current study, 16 participants, was quite small, particularly when compared to previous research on this topic (54 participants, Mitchell & MacDonald, 2006; 44 participants, Mitchell, MacDonald, & Brodie, 2006; 80 participants, Mitchell, MacDonald, & Knussen, 2008). The power analysis revealed that the sample size for this study was not large enough to test the hypothesis, $\eta^2 = 0.121$.

Further limitations of the sample may include a lack of generalizability, as the sample was obtained from one class at an undergraduate liberal arts college, and the age range was limited (18 to 28 years old).

Another limitation was that it was challenging to control the water temperature. The experimenter had to use ice cubes to regulate the water temperature to be roughly 38 degrees, but it was difficult to achieve this precise temperature. In practice water temperatures between 38.0 and 38.9 degrees were deemed sufficient for the task. This experiment would have benefited from having the ability to precisely control the water temperature.

Research on nonpharmacological treatments or interventions for pain is important, as medicinal methods of pain management often carry risks, ranging from the risk of kidney damage induced by non-steroidal, anti-inflammatory drugs to the risk of dependency associated with narcotic pain killers. Further exploration of this important topic may provide evidence for the efficacy of safe alternatives to medicinal treatments traditionally used as the first line of defense against pain.

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