

Effects of Emotion Inducing Music on Short-Term Memory

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1 Abstract

The intersection of music and cognitive activity has been studied in various ways. Our study aims to address the intersection of emotion-inducing music and cognitive activity to understand the effect of different types of music. Our experiment consisted of 10 Northeastern Computer Science students. We conducted a within-subjects study where each student memorized words in 3 conditions, no music, happy music, and sad music. We had them complete a memory test to evaluate their memory performance. The results showed that participant memory was significantly better in the control condition than in the 2 music conditions ($p < 0.05$). This finding revealed that type of music does have an effect on memory and opens the door to further research with a larger variety of music and memory tests to evaluate memory performance more wholly.

2 Introduction

Most of us have experienced listening to music while studying or performing cognitively demanding tasks, but have you ever wondered if that music is beneficial to you? The influence of music on memory has been an intriguing subject of study. Previous research has investigated the effect of music on long-term memory, and studies have shown that music can elicit strong emotions. However, there is a gap in our understanding of how emotion-inflicting music specifically influences short-term memory.

Previous studies have given us insights into the connection between emotion, music, and memory [8]. For instance, Eschrich et al. (2008) [5], found that emotional music enhances attention and long-term memory retention for the music itself. Another study, Janata et al. (2007) [7], found that autobiographical memories and nostalgic emotions are often evoked when hearing musical pieces from one's past. Historical data suggest that music that evokes strong emotion could aid in cognitive rehabilitation, and our study aims to expand our understanding of the subject.

Our experiment plans to alter student emotions

through music and observe the impact of that alteration on their short term memory through a memory test. This will give us the opportunity to understand how emotion-inflicting music affects memory. Our null hypothesis is that music has no effect on memory. Our alternative hypothesis is that the music does have an effect on memory. Knowing the impact of various emotional music on short term memory will help students and educators better prepare for exams. Students can improve their studying by listening to or avoiding certain types of emotional music, and educators can create a positive studying environment for their students by playing certain music. Beyond direct implications for studying, the results from our experiment will add to the broader field as well. Researchers can expand on the findings from our study to understand the impact of emotion-inflicting music on auditory memory and compare it with the impact on visual memory. Our study will give researchers a baseline for conducting research with emotional music and short-term memory, they can expand upon this for comparable results among experiments and more general findings.

2.1 Background

Various studies have looked at the influence of listening to music on episodic memory, working memory, long term memory, and cognitive function in general. Low arousal music creates an extra route of recall when it comes to recognition memory [11]. However, music has been previously proven to be interruptive when it comes to verbal working memory due its overlap in processing area in the brain [8]. On the other hand, verbal long term memory has shown to be better in people who have listened to music from a young age [4]. Music especially helps in the encoding part of verbal memory [6] and in the learning and reconstructing parts as well [14]. There are many varying influences of music on memory and much discussion happening in this area.

Other studies have explained that music has an effect on emotions, triggering areas of the brain that are usually activated by pleasant/unpleasant activities [3] [10]. Arousing music and nostalgic music can often bring up autobiographical memories among

people [7], and in general music tends to improve mood [1].

The relationship between memory and emotion has also been explored. It has been found that more positively perceived items are better remembered than negatively perceived or neutral items [5]. These studies collectively underscore the perplexing relationship between music and memory. They highlight the intertwined roles of emotion, cognitive processes, and neurobiological mechanisms, and the potential for music to serve as a powerful tool in enhancing memory functions.

3 Methodology

3.1 Participants

We recruited 10 Northeastern University Computer Science students to participate in our experiment. 7 students were undergraduates and 3 were graduates, reflecting the estimated 70-30 split [13] in undergraduate and graduate students at Northeastern University as a whole. Participants ranged in age between 20 and 24 and were a mix of both pure Computer Science majors as well as combined majors.

3.2 Materials

We used an arousal-valence diagram to gauge the emotion of participants prior to starting the experiment. During the experiment we used three lists of 100 words each to test participant memory. The lists were generated by a phonics word list generator to ensure equal amounts of various types of words, and the difficulty of each list was checked using a language scoring API to ensure equal difficulty of each list. We also used Spotify to play the different music involved in our study through our computers. The songs used were chosen because we believed they were representative of their respective emotion. The happy songs chosen were: Walking on Sunshine by Katrina and the Waves, Happy by Pharrell Williams, and September by Earth, Wind & Fire. The sad songs chosen were: Someone Like You by Adele, Train Wreck by James Arthur, and All of Me by John Legend. The

experiment was conducted in classrooms containing desks across Northeastern University. After the experiment, we had participants fill out a Google Form survey to get more qualitative information about their experience.

3.3 Design

The experiment used a within-subjects design. Upon entering, participants were told to mark their current emotion on the arousal-valence diagram provided. Next participants were given instructions and started the different conditions. For each condition, participants were given a different word list and told to memorize it for about 11 minutes (exactly 11 minutes were given for the silent condition, the other conditions ran for the length of the relative playlist). Then there was a 20 second interval followed by three minutes to write down as many words as they remembered. Participants were given a one minute break, then moved on to the next condition. The order of conditions was no music, in which participants memorized words in silence, happy music, in which participants memorized words with our happy music playlist playing, and sad music, in which participants memorized words with our sad music playlist playing. Each condition had a different word list, but all participants were given the word lists in the same order (list 1 for silent condition, list 2 for happy, and list 3 for sad). After the three conditions were completed, we thanked participants and had them fill out our survey to get qualitative information about their experience. 3 participants completed the study in a group due to time constraints, but the rest did so individually.

4 Results

4.1 Tested Performance

The objective of this study was to investigate the impact of emotion-inducing music on short-term memory. Considering the repeated measures design across three rounds with different music conditions, we transformed the collected data into longitudinal form and opted to fit a linear mixed-effects model (LMER)

Table 1: LMER Fixed Effects Result (Tested Performance)

Round	p -value
Round 1 (Control)	9.83e-07
Round 2 (Happy)	0.00342
Round 3 (Sad)	0.01395

Table 2: Pairwise Comparison of Rounds (Tested Performance)

Round Pairs	p -value
Round 1 (Control) - Round 2 (Happy)	0.0091
Round 1 (Control) - Round 3 (Sad)	0.0355
Round 2 (Happy) - Round 3 (Sad)	0.7968

[2] to analyze it.

Significant differences in means of all three round scores was observed (p -values < 0.05 , rejecting null hypothesis of means equality) (Table. 1), which was elaborated by conducting post-hoc analysis using Tukey’s Test [9] to show pairwise comparison between the rounds. Results indicated a significant decrease in performance during both music rounds compared to the Control (Table. 2). No significant difference in performance between happy music and sad music rounds was observed, however, there is a visually noticeable trend of a slight performance increase during sad music round [Fig. 3]. Cohen’s D [12] value for the 3 rounds show a large effect size, positive for Round 1 and negative for Rounds 2 and 3, giving our results more validity as the effect is observed in a large portion of our sample.

However, checking the LMER model [2] for assumptions showed a delineation from flat line in the ‘Normality of Residuals’ [Fig. 1] plot, indicating signs of non-normality in our data, which was also confirmed during our EDA (round scores are slightly right-skewed). This does not necessarily invalidate our results as this model is robust to non-normality to some degree, but could mean our sample was insufficient in size and a larger sample might be more normally distributed.

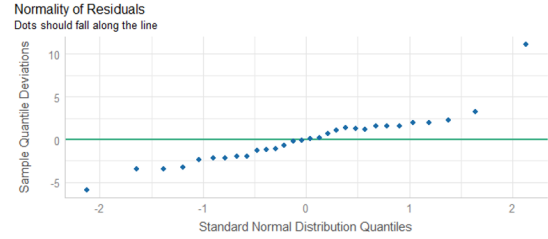


Figure 1: Normality of Residuals for LMER Model

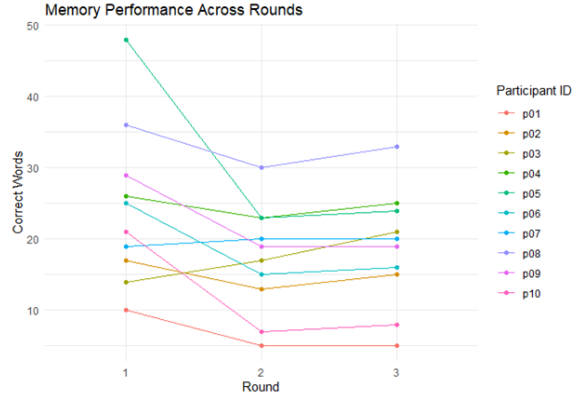


Figure 2: Tested Performance Across Rounds

Table 3: Pairwise Comparison of Rounds (Perceived Performance)

Round Pairs	p -value
Round 1 (Control) - Round 2 (Happy)	0.0539
Round 1 (Control) - Round 3 (Sad)	0.8434
Round 2 (Happy) - Round 3 (Sad)	0.1523

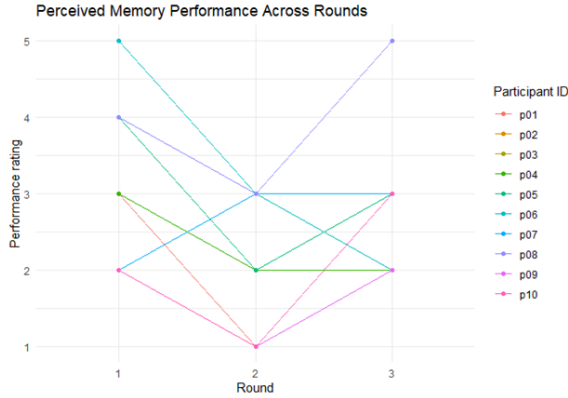


Figure 3: Perceived Performance Across Rounds

4.2 Perceived Performance

We also asked participants in the post-study survey to rate their perceived performance during each round to see if there is any perceived advantage to listening to music that may not have been quantified in our experiment. The perceived performance was recorded using rating scales for all 3 rounds of testing and then fitted with a LMER model [2] similar to the tested performance analysis.

Pairwise comparison (Table. 3) showed a significant decrease in perceived performance between Round 1 and Round 2, which aligns with our tested performance. While the other pairs do not show a significant difference in perceived performance, the participants did feel their performance improve during sad music round compared to happy music. The p -value of 0.15 gives us 85% confidence in stating that participants felt their performance was better with sad music than with happy music.

5 Discussion

The objective of this study was to examine the impact of emotion-inflicting music on short-term memory. The results showed that we can only somewhat accept our null hypothesis. From our post experiment survey we were able to gather useful qualitative data. Our results showed a general decrease in performance after the control group round. Interestingly, when looking at the participant’s perceived performance rating, participants evaluated themselves highest for the control group and lowest for the happy music round. This aligns with the qualitative trend, where participants performed slightly better in the sad music round compared to the happy music round. Participants also noted that the music during the happy music round was more distracting than the sad music round with a rating of 3.6 and 3.2 respectively. This brings us to the discussion of if the performance of the participants was not based on the emotion inflicted but instead on the tempo of the song. Naturally, the sad songs have a slower tempo, making them less distracting than the happy songs which have a higher tempo. Only 3/10 of the participants stated that they would have not wanted any background noise or music, many of them mentioning classical or lo-fi beats.

5.1 Future Research

In the future, more research could be conducted on different types of music. Many students listen to music while studying but don’t want to be distracted by the lyrics or tempo of the song. This opens up avenues to research the effect of even more different types of music. For example conducting similar tests with instrumental music or even different types of background noises. This is a potential exciting research area for musicians interested in the tempo, key, or tone of songs and how that can affect people. The different effects could be examined by manipulating them individually. This study focused specifically on short-term memory but this research question can be further researched for long-term memory and different types of cognitive tests. Due to the nature of our project, we were

only able to test short-term memory. However, if we were to do this with a longer period of time, we can see how music and memory interact even further. Another aspect we can look further into is standardizing the songs selected for each category. For this experiment we chose 'sad' and 'happy' songs from our best judgement, but having a more standardized way to pick these songs might lead to more accurate results. Especially, if we personalize the sad and happy songs for each participant by having them indicate to us beforehand which songs they personally find emotion-inflicting. Although we touched upon individual differences on the post experiment survey, looking at more specific musical preferences, personality traits, or cultural backgrounds can be areas for further research as well.

6 Limitations

A few of the limitations of our experiment were our sample size and time constraints. Our study only included 10 undergraduate students, and this was a very small sample size. If we had more time and resources, we would have liked to conduct this experiment with at least 30 participants to get more accurate and representative data. We also conducted this experiment at separate times with some people in groups and others individually. If we had more time, we would have liked to conduct the experiment in one day with each participant individually. This would allow us to control more variables and mitigate changes in results due to the presence or lack of other participants in the room.

7 Conclusions

Leveraging a linear mixed-effects model [2] analysis approach, our results yielded valuable insights into the effects of emotion-inducing music on short-term memory. The significant findings show a negative impact of music, in general, on short-term memorization tasks, accompanied by a decrease in perceived performance too (significant decrease with happy music). There are also insights on potential relationships that

we gained from this study showing that sad music has a positive impact on participants' perceptions, particularly for performance in memorization tasks. These effects can be expanded upon and investigated in future research studies that may be more oriented towards that objective.

The implications of our findings can be vast, from using music in educational settings for non-traditional learning environments to using music as therapy to affect people's perceptions. By employing a robust statistical approach, our study contributes empirical evidence to the ongoing discussion of the intricate relationship between music, memory, and emotion [8].

8 Statement of Contribution

All members contributed to this project equally. All 3 members were part of the idea development phase of the project as well as data collection. Rei and Lavanya were responsible for the word generation and choosing playlist songs. Rijul did most of the data analysis and testing. All 3 members contributed to the report, Lavanya focused on the methodology and limitations, Rijul focused on the results and conclusion, and Rei focused on the discussion and future research, all 3 worked on the introduction and references.

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