

# The Effects of Baroque Music on Short-term Memory

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**ABSTRACT:** This study evaluated the effects of Baroque era music exposure on participants short-term, working memory. The purpose of this study is to analyze the effects of music on short-term memory. More specifically, does non-lyrical music such as Baroque affect short-term memory? We hypothesized that listening to Baroque music will enhance the outcome of short-term recall. The 9 participants of the experiment were tested using a short-term recall test while wearing an electroencephalogram headset (EEG). Music and non-music exposure groups were compared using the data from the memory test and the EEG. Results of the study showed increased average test scores and EEG activity for the music group, particularly in the 5th and 6th trials, in which the music exposure group had higher mean scores and EEG readings compared to the non-music exposure participant group. However, the difference between music and non-music groups was not statistically significant. The results of the study suggest that Baroque music may not have a significant effect on short-term memory. Results could be improved upon by increasing the sample size. The study contributes to the understanding of the effects of certain Baroque music on short-term memory and EEG data.

**KEYWORDS:** Cognitive Psychology; Neuroscience; Short-term memory; Baroque; Electroencephalogram (EEG).

## ■ Introduction

Memory is the means by which we draw on our past experiences in order to use this information in the present. There are three major processes in memory: encoding, storage, and retrieval.<sup>1</sup> There are also three types of memory: short-term, long term, and sensory memory. Short-term memory refers to the ability to store a small amount of information in a readily available state for a short period of time, and short-term memory can hold only up to seven plus or minus two digits.<sup>2</sup> For example, an individual is able to store and memorize a phone number that has just been recited. Short-term memory is of central importance because it shapes an individual's ability to learn, comprehend, and store information that is essential to their daily lives. If this ability is impaired, everyday aspects of life will be challenging. Thus, variables that could mitigate damage to short-term memory needs to be further investigated.

Various studies have been conducted analyzing the effects of music on memory, but there have been mixed results. Music is characterized by the combination of frequencies which, in certain compositions, can have notable effects, such as a temporary improvement of spatial reasoning skills and epilepsy.<sup>3</sup> In contrast, another study concluded that music negatively affects memorization compared to silence when memorizing nonsense syllables.<sup>4</sup> Music was also found to have no effect on complex working memory tasks, though the song choice could influence the participant's recollection of words depending on the word's valence. The study concluded that working memory performance could be affected by the type of music used.<sup>5</sup> Furthermore, emotional state was shown to affect memory for songs with high emotional arousal or valence.<sup>6</sup> This was indicated in a study measuring memory encoding in which good mood states showed more elaborate encoding compared to bad mood states.<sup>7</sup>

The effects of Baroque music on cognition are significantly less studied than those of other eras of music. Baroque music has less dynamics (increases and decreases in volume used to convey emotions or play expressively) compared to later eras of music, except for the practice of terraced dynamics, in which composers use multiple parts overlapping to increase the dynamics and vice versa. More specially, the harpsichord which is the central instrument of baroque music, has no capacity to change dynamics due to the mechanics of the instrument (the piano was developed with the capacity for dynamics, and the rise in popularity of the piano is considered the beginning of classical era of music because the piano directly replaced the harpsichord resulting in a coinciding rise in the use of dynamics, though the end of the baroque era is associated with the death of J.S. Bach in 1750.<sup>8</sup> Dynamics were eliminated by selecting a harpsichord solo for use in the experiment, and the piece was chosen to be mild and lesser-known so that it would have less valence and would not have memories associated with it. The piece chosen for the experiment, Henry Purcell's Round O ZT 684, is characterized by a Moderato tempo and the repeated themes of a round, and the recording was also a mild interpretation of the piece. With this the effects of music on cognition are mostly observed rather than the effects of emotion on cognition. Taken together the purpose of this study is to analyze the effects of music on short-term memory. More specifically, how does non-lyrical music such as baroque, affect short-term memory. We hypothesized that listening to baroque music will enhance the outcome of short-term recall. To address the question, we used an online short-term memory recall test designed by the University of Washington along with EEG to investigate the effects of music listening. The short-term memory test consisted of six trials, with each trial increasing in difficulty. The contribution of our study is that if listening to Baroque music does improve short-term memory,

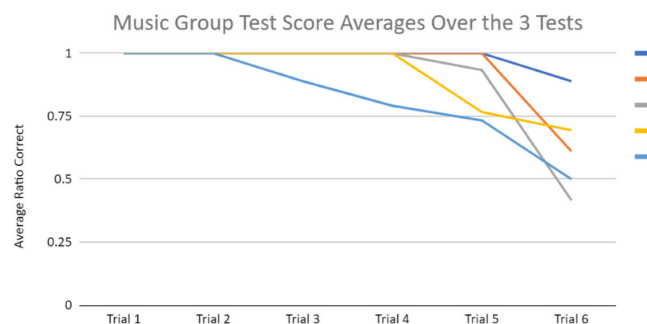
then it could be a helpful contributor to improve learning and reasoning.

## ■ Methods

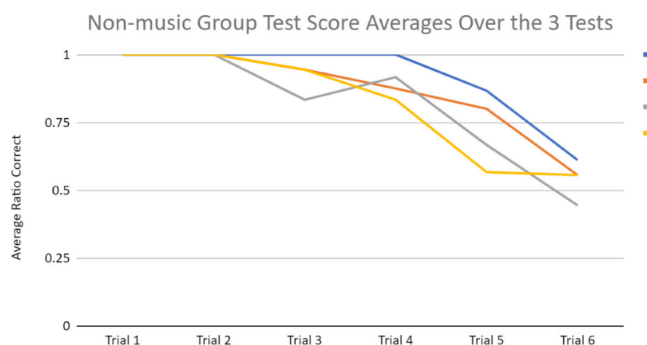
For COVID-19 safety precautions, all participants were temperature-checked, provided hand-sanitizer, and asked of any COVID-related symptoms at the entrance of PV NET Academy for STEM, a community technology organization. Prior to the start of the experiment, participants were asked to sign consent forms. Participants were briefed on the details of the procedure and acknowledged the option to opt out at any given time during the procedure. Our participants consisted of six teenage boys from the ages of 14-18 and three middle-aged women from the ages of 49-55. Participants were given a stress survey that asked a yes or no question for if they were stressed before beginning experimentation. An electroencephalogram headset designed by Emotiv was placed on the participant's head (the 5 nodes are on AF3, AF4, T7, T8, and PZ Brodmann areas). Using a standard PC, a short-term memory test link obtained from (<https://faculty.washington.edu/chudler/stm0.html>) was uploaded to begin the multi-trial short term memory test. The memory test sheet for the participants to record answers was placed in front of the participant along with a sanitized pencil. Distilled water was sprayed above the five nodes of the EEG headset. The app MYEMOTIV was loaded onto a Samsung galaxy Note 4 to start data collection.

To begin the experiment, the participant was asked to relax with their eyes open for 15 seconds, then with their eyes closed for 15 seconds. The five participants in the experimental group were exposed to non-lyrical music, Henry Purcell Round O ZT 684, (obtained from <https://www.youtube.com/watch?v=ocbm6tZoQ2>) for two minutes using a JBL Charge 3 speaker while the control group received no music for two minutes, participants were selected to be in the experimental group at random. All participants were then subjected to a multi-trial short term memory test, called "Short Term Memory Test" by the University of Washington. Whereby each trial, a series of letters were presented on the screen for 3 seconds and answers were recorded for each trial. Starting with trial one, they were presented with two letters on the screen. Each proceeding trial increased by two letters, so by trial six the participant had twelve letters to recall. The amount of time that the letters were presented on the screen was the same for each trial, which increased its difficulty. The short-term memory recall test was administered a total of three times with 30 second break in between tests. All short-term memory data collection from EEG MYEMOTIV app and written responses were recorded onto an Excel spreadsheet. The MYEMOTIV app would compute the readings from the EEG headset into a numerical value, this value measures the electrical impulses in the brain based on electrical charges from the activity of brain cells. This value was input into the spreadsheet along with the number of correct letters recalled in each trial of the memory test. To observe the difference between groups, a two-tailed T-test was used with  $<0.05$  determination for significance. This experiment was conducted on nine participants, with four participants in the control group and five participants in the

was conducted on nine participants, with four participants in the control group and five participants in the experimental group. Experimentation was conducted throughout the last week of December 2020 between 1PM and 3PM. (Figure 1.1, 1.2)



**Figure 1.1:** Average percentage of correct letters for the recall test (converted into decimals), each line represents a participant.



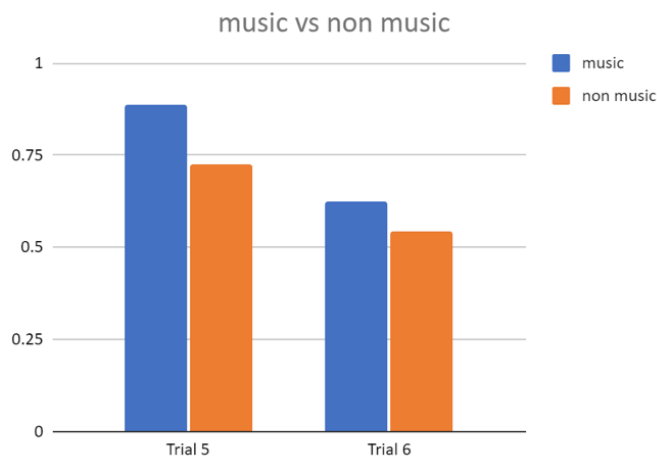
**Figure 1.2:** Average percent of correct answers for the non-music group converted into decimals, each line represents a participant.

## ■ Results

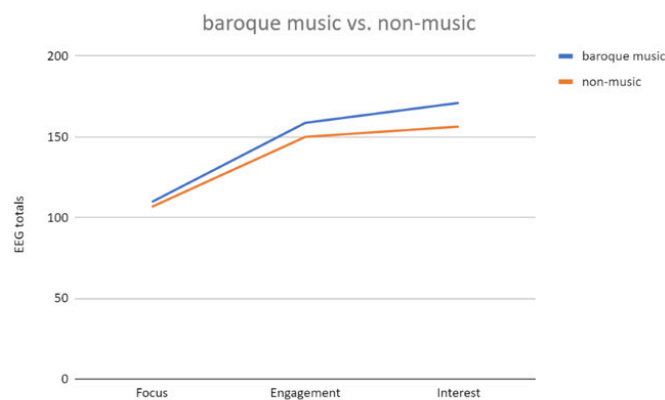
**Recall Test Data:** Music and non-music groups were measured for short-term recall tests and EEG data. Data calculations were performed in Excel. The recall test had an ascending number of letters presented for memorization with trial one starting with two letters and doubling the number of letters for each trial for a total of six trials. The recall test had 6 trials with an ascending number of letters presented for memorization. All participants performed with 100% accuracy for trials one through trial four. More specifically, the trial five music group ( $M=88.67\%$ ,  $SD=0.13$ ) and non-music group ( $M=72.50\%$ ,  $SD=0.13$ );  $t(8)$ ,  $p=0.114$ , and the trial six music group ( $M=62.22\%$ ,  $SD=0.18$ ) and non-music group ( $M=54.17\%$ ,  $SD=0.07$ );  $t(8)$ ,  $p=0.404$  were shown to not have a statistically significant difference (Figure 1.3, Figure 1.4, Figure 1.5), as the p-values were above 0.05. The recall test data trended improvement due to music, but this difference was not statistically significant.

### EEG Data:

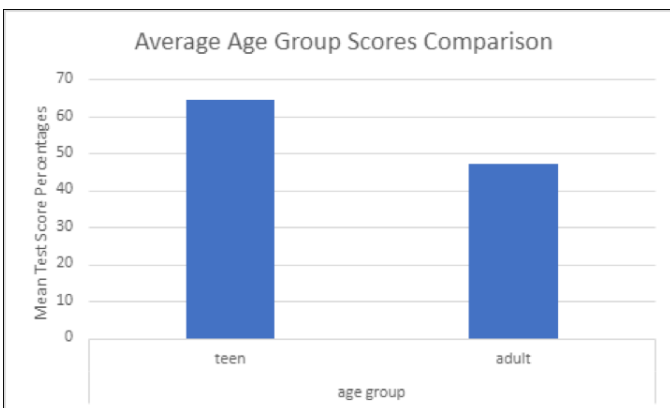
The electroencephalogram data, in which the data provided is the average number on a 1-100 scale measuring brain activity computed into an algorithm over the time of the EEG reading, was only acquired for six participants as the instrument had difficulties reading through participants' hair. Due to this,



**Figure 1.3:** Average percentage of correct answers (converted into decimals) over the last two trials.



**Figure 1.4:** Sums of average EEG data of the music and non-music groups.



**Figure 1.5:** Average score of the teen and adult age groups

depending on the word's valence.<sup>5</sup> Our study produced results consistent with the findings of this study as Borella specifies valence as influencing the working memory and music as not. Since our study found no influence to working memory caused by a piece with little to no valence, our results are consistent with the conclusion of Borella *et al.* because they found that music did not influence working memory, but that valence did; our experiment had music but little to no valence, thus no significant effects on working memory.

Our hypothesis was answered from this study because the data collected showed no significant difference between the music and non-music groups, demonstrating no large effects of Henry Purcell's Round O ZT 684 on short-term memory.

A future study that could be conducted is testing the difference between emotional and non-emotional music and their effects on short-term memory. A future implication of our findings is the improved use and understanding of music in aiding cognition as a situational benefit, as it has been proven to have negative effects by Musliu *et al.* and shown by our study to have no effects in the specific circumstance. The benefits of music known as the "Mozart effect" now can be optimally achieved as it was found that Baroque non-emotional music does not cause this effect, and Baroque composers are often confused for Classical composers.<sup>3</sup> Our study has shown that non-emotional music may not affect short-term cognition, so in the future music should be used in its emotional aspect, as emotions have been shown to affect memory and music is an effective manipulator of emotional state.<sup>7</sup> Implications of this are that effects of music exposure can be optimized.

To improve the study, we could increase the number of participants to increase the amount of data collected. This would increase the credibility of the data and the likelihood of statistically significant differences of a larger data set replicated our study's trends. We also could play Baroque music while the participants are taking the recall test instead of before to test how music affects the brain in conjunction with active cognition. The use of equipment such as an fMRI or a medical-grade electroencephalogram to gain better insight to the workings of the brain as the study is conducted. A problem encountered was regarding the gathering of small data, this problem was due to the COVID-19 pandemic, which did not allow us to obtain many participants due to community guidelines. The data may have supported our hypothesis had the number of participants been higher as this could make the differences between the two groups credible and more likely to be statistically significant.

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## Author

Jasmine Alagoz is a student at Palos Verdes High School, she will graduate in 2022. During her high school career, she has been a member of multiple honor societies, completed various medical-related programs, and has founded her own non-profit organization that helps underprivileged women in Los Angeles. She has always been interested in the concept of neuroscience and enjoys furthering her study of the inner workings of the brain. She has immensely enjoyed the process of scientific research and hopes to continue expanding her scientific knowledge in her future career.

William Bray plays three instruments and has experience in many genres. He interests in Baroque music through the violin and viola. He is a student at Palos Verdes High School, in which He is in both the orchestra and the scientific research class. William teamed with Jasmine for their research project through PVNet.