Exploring the Impact of Binaural Beats and Various Music Genres on Cognitive Performance and Concentration: A Pilot Study

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Abstract

The intention of this study is to explore the influence of binaural beats, in comparison to other sonic environments, on cognitive performance. The study participants were ten University at Buffalo students aged 18-22 (five men and five women) with no prior exposure to binaural beats. This was a within-subjects design involving three sonic environments: binaural beats, music of their choice, and silence. At first, the participants performed three cognitive training games in silence: Train of Thought, Color Match, and The Chalkboard Challenge, all of which are games found on Lumosity (2024), an online platform which aims to improve memory, attention, and problem solving through its games. A week later they were randomly divided into two groups. Group 1 performed the same tasks while listening to binaural beats. Group 2 performed the same tasks as the week prior, but they were allowed to listen to their own choice of music, which could be anything *except for* binaural beats. Different scores for the cognitive performance games were yielded across the sonic environments. Comparisons were made within each participant to determine which sonic environment yielded higher scores.

Keywords: Music & Focus, Music & Attention, Music & Memory

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Introduction

A binaural beat is an auditory illusion perceived by the brain. Exposure to 415 Hz in the left ear and 405 Hz in the right ear results in hearing a third tone that is not actually there. The result is a binaural beat with a frequency of 10 Hz (Colzato et al., 2017). When listening to an audio clip with a binaural beat of 10 Hz, the brain enters an alpha brainwave state, since 10 Hz corresponds to Alpha Waves. Subsequently, one enters a relaxed, focused state. Studies show that binaural beats corresponding to Alpha waves can have a temporary positive effect on working memory (Kraus & Porubanová, 2015) and can bring an increase of performance in cognitive processing (Cruceanu & Rotarescu, 2013). It is important to note that different binaural beat frequencies are related to different brain waves, thus they would be useful for various cognitive functions.

In this experiment I focused on 35 Hz and above, which in literature are associated with gamma waves, resulting in enhancing cerebral functions such as perception, attention, memory, consciousness, and motor control (Amo et al., 2017). I used binaural beats soundtracks made available to the public (Magnetic Minds, 2017) claiming to improve focus, with the aim of exploring the relationship between binaural beats and cognitive performance.

Method

This is a repeated measures experimental research design, though since the sample size is small, this could be considered a pilot study. Ten University at Buffalo students volunteered to participate in the pilot study ages 18-22, five men, and five women. The students had no prior knowledge of binaural beats. A short pre-study survey was completed, where students were asked if they prefer to study while listening to music or in silence. Their response was 41.2% reported that it's easier to study in silence while 58.8% responded that it's easier to focus while listening to music. I concluded that some students listen to music while studying and some do not. During the experiment, I aimed to determine if cognitive performance is optimal while listening to their music of choice, binaural beats, or while working in silence. The hypothesis was that listening to binaural beats improves scores on the tests.

The subjects performed three cognitive training games in silence: Train of Thought, Color Match, and The Chalkboard Challenge. A week later they were randomly divided into two groups. Group 1 performed the same tasks while listening to binaural beats this time. Group 2 also

performed the same tasks, but they were allowed to listen to their own choice of music, which could be anything *except* binaural beats.

Train of Thought is a test of divided attention. Divided attention refers to the ability to simultaneously respond to multiple tasks or task demands. The task is to guide an increasing number of trains to their stations using computer software. The subject must guide them all simultaneously at their stations.

For Color Match, the Stroop Test was administered. The Stroop Test challenges a person's selective attention. The test is to see how quickly one can identify if the text color matches the meaning of the text. For example, you will have the meaning written on the left, "red" and on the right you will have the word "yellow" written out with a red color. The task is to realize that the meaning "red" matches the color red while ignoring the fact that it says "yellow," and just look at the color.

The Chalkboard Challenge improves quantitative reasoning and problem-solving skills. Part of quantitative reasoning is numerical estimation — the ability to approximate numerical relationships quickly. One is given two mathematical equations and must quickly determine which one is larger. The first round of scores from group 1 were compared to the second round of scores from group 1, to see if there was any change in scores. Subsequently, the first round of scores from group 2 were compared with the second round of scores from group 2. After this I took note of which group had a higher average improvement rate.

Results

The Lumosity (2024) website provided the calculated scores for each of the tests. In order to measure the data, I took the scores after the tasks had been performed in silence, and I took the scores after the tasks were performed while listening to binaural beats or music of choice. The number of participants that improved their scores were averaged out and compared for both groups. The group listening to binaural beats yielded a 73.3% improvement rate and the group listening to the music genre of their choice yielded a 46.6% improvement rate.

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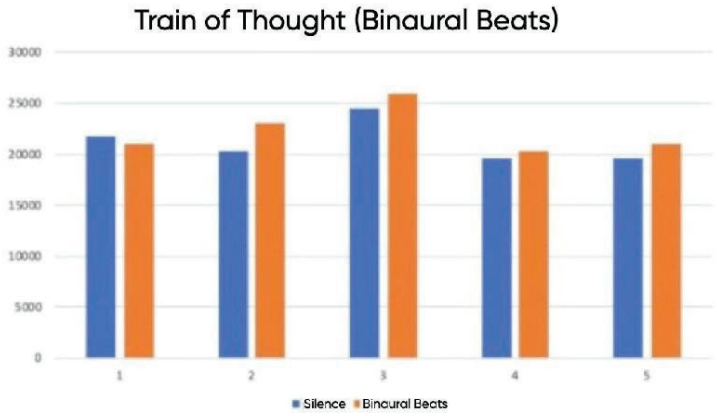
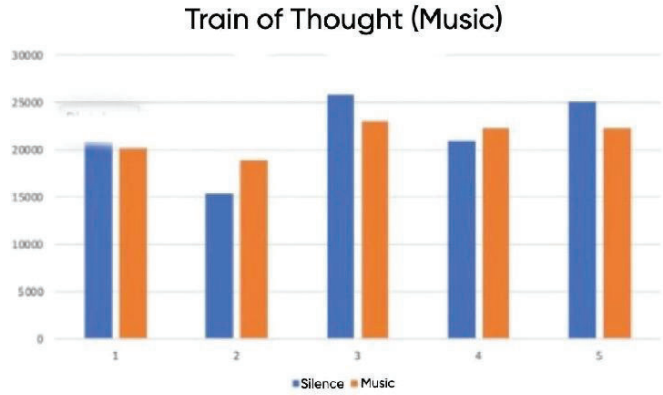
Train of Thought

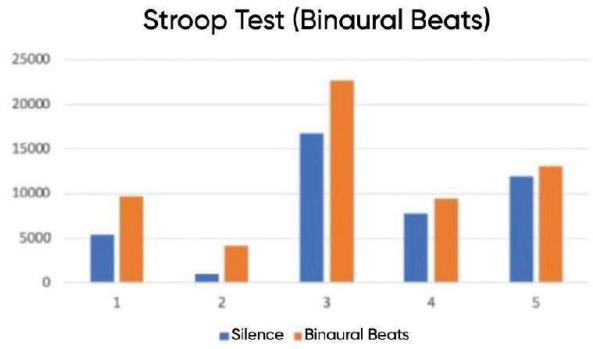


80% of students improved their scores when listening to binaural beats.

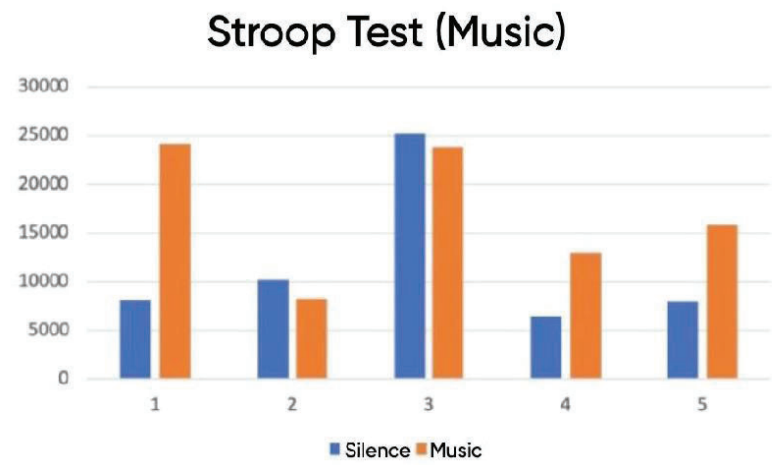


40% of the students improved their scores when listening to their own music choice.

Color Match (Stroop Test)

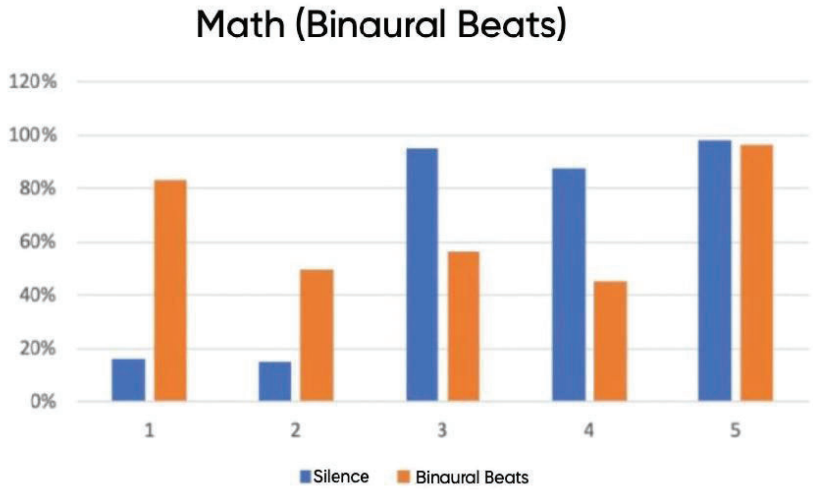


100% of students improved their scores when listening to binaural beats

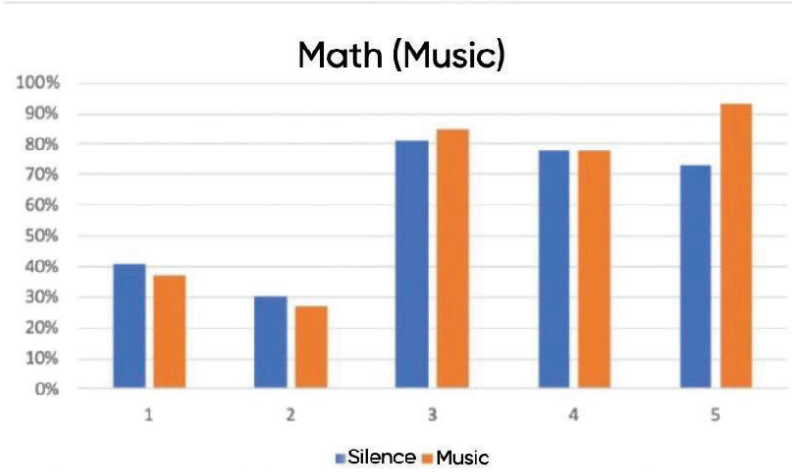


60% of students improved their scores when listening to their own choice of music

Chalkboard Challenge



40% of students improved their scores when listening to binaural beats



40% of students increased their scores when listening to their own music choice.

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Discussion

From this pilot study I concluded that listening to binaural beats improves scores on cognitive training games more than music of choice. The method could have been improved by having participants listen to binaural beats for about ten to fifteen minutes before the start of the task in order to ensure that the brain has had the time to process the binaural beats, and that the participant was already in the focused state before starting the task. When this study is repeated, the binaural beats should also be less distinguishable, and played simultaneously with a recording of rain or the ocean waves as was done in a previous research study (Kraus & Porubanová, 2015), in order to ensure that the meditative music itself doesn't affect participant's brains. Participants would then be allowed to play their music of choice again. A song would be played twice, once with binaural beats in the background and once without.

It is also important to note that the research was only conducted with students at the University at Buffalo. The study may yield different results if performed in a non-academic setting and on people of different schooling backgrounds. Practice effects were a concern during this research study as well, because they could compromise the internal validity of the study, as participants could have improved their scores simply based off of doing the task twice. In an effort to avoid this, each student was administered the tests a week apart. Additionally, Lumosity (2024) generates slightly different tests each time, though the concept remains the same. It is also important to note that since we didn't have access to an EEG, we could not assess in which brainwave state the participants were in while they were listening to the binaural beats, so we cannot determine if the participants were indeed in a gamma state. A larger study is needed to confirm the findings of this pilot study.

References

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