The Impact of Background *Binaural Beats* on Mathematical Achievement in College Students

FSU PSYCHOLOGY

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ABSTRACT

"There is geometry in the humming of the strings. There is music in the spacing of the spheres." [1]

The goal of this research project is to investigate the impact of background binaural beats at a moderate beta frequency of 18 Hertz on mathematical achievement in college students.

The study aims to determine whether a 25-minute sound intervention using binaural beats enhances participants' performance on specific mathematical tasks compared to silence.

By using a within-participant design, each student will complete a series of mathematical tasks in two conditions: one with binaural beats and the other in silence.

This investigation will contribute to the understanding of how auditory stimuli, specifically binaural beats, can enhance cognitive functions such as attention, visuospatial working memory, and problem-solving abilities in mathematical contexts.

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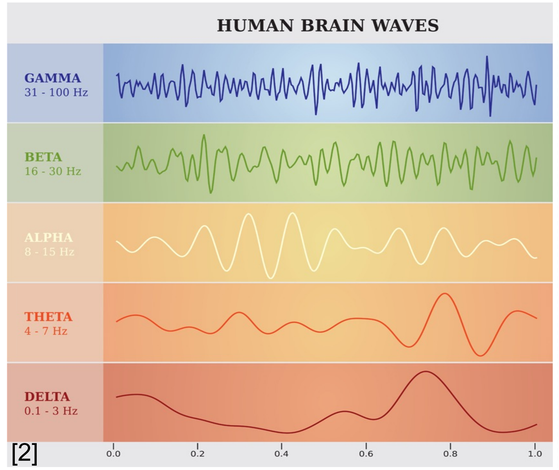
Background on Binaural Beats

Binaural beats are when two slightly different frequencies are presented to each ear, the brain perceives a "third beat" at the difference between the two.

This auditory illusion aligns with EEG brainwave frequency bands, including beta waves (13–30 Hz), which are associated with active problem-solving, focused attention [4], and analytical thinking [5].

The **brainwave entrainment hypothesis**: auditory stimuli at specific frequencies can synchronize brain activity, enhancing cognitive performance [6].



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Research Question/Hypothesis

Research Question: "Does listening to binaural beats at a frequency of 18 Hz influence performance on mathematical tasks in college students compared to in a silent environment?"

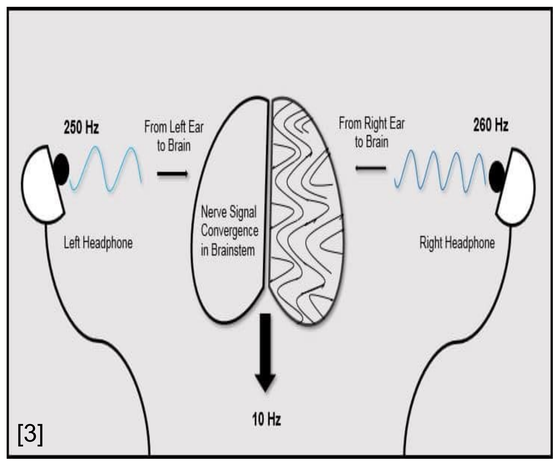
Hypothesis: "Implementing an auditory stimulus of binaural beats at a frequency of 18 Hz will positively enhance specific mathematical problem-solving abilities in college students compared to in a silent environment."

Method

A within-participant design allowing each participant to experience both conditions (Silence and Binaural Beats). Which block and condition comes first is in a counterbalanced order.

Participants include 90 students aged 18–30 from FSU, recruited through the SONA system.

Blocks: Two 25-minute task blocks separated by an 8-10-minute walking break to reset cognitive states.



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Tasks

- **Algebraic equations** (abstract reasoning)
- **Arithmetic word problems** (linguistic and numerical comprehension)
- **Geometric spatial tasks** (visuospatial reasoning)
- **Non-math-related** (paired associate task)

- Main prediction: Binaural beats will improve performance on the three mathematical tasks but will not affect performance on the non-math-related task.

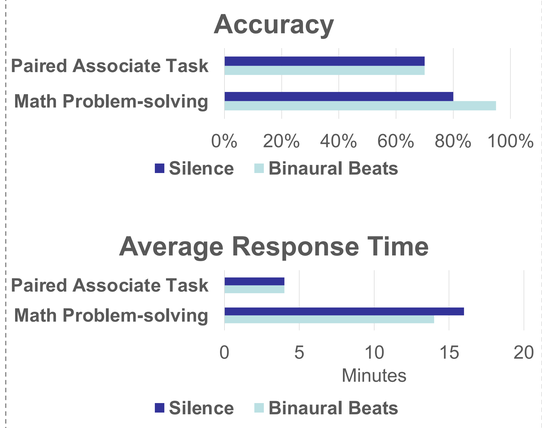
Analysis

A mixed-design ANOVA will be conducted to analyze the data.

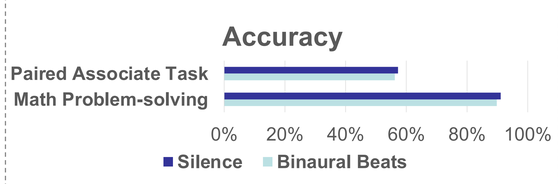
•**Within-Subjects Factor:** Condition (Binaural Beats or Silence)
•**Between-Subjects Factor:** Block Order (Binaural Beats first or second)

Dependent Variables:
•Accuracy: Correctly solved problems.
•Response Time: Average time to complete tasks.

Expected Results



Current Results



Analysis from 43 participants data so far shows no significant correlation between accuracy on overall math tasks and the sound frequency condition.

Response time, the paired associate task, individual math tasks, and possible ADHD correlations still need to be analyzed.

DISCUSSION

Beta-frequency binaural beats are hypothesized to influence brain regions associated with mathematical problem-solving, such as the dorsolateral prefrontal cortex and intraparietal sulcus, by promoting oscillatory activity in the beta range [10] & [11].

Enhanced performance in tasks requiring visuospatial reasoning and numerical manipulation aligns with prior findings of improved focus and cognitive control during beta-frequency stimulation [7] & [12].

Some past research:
Improvements in visuospatial working memory when exposed to 15 Hz binaural beats [8].
Beta-frequency waves are directly linked to brain regions responsible for numerical processing and abstract reasoning [9] & [10].

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