Investigating the Effects of Marijuana Use on Cognitive Performance Following Transcranial Alternating Current Stimulation (tACS)

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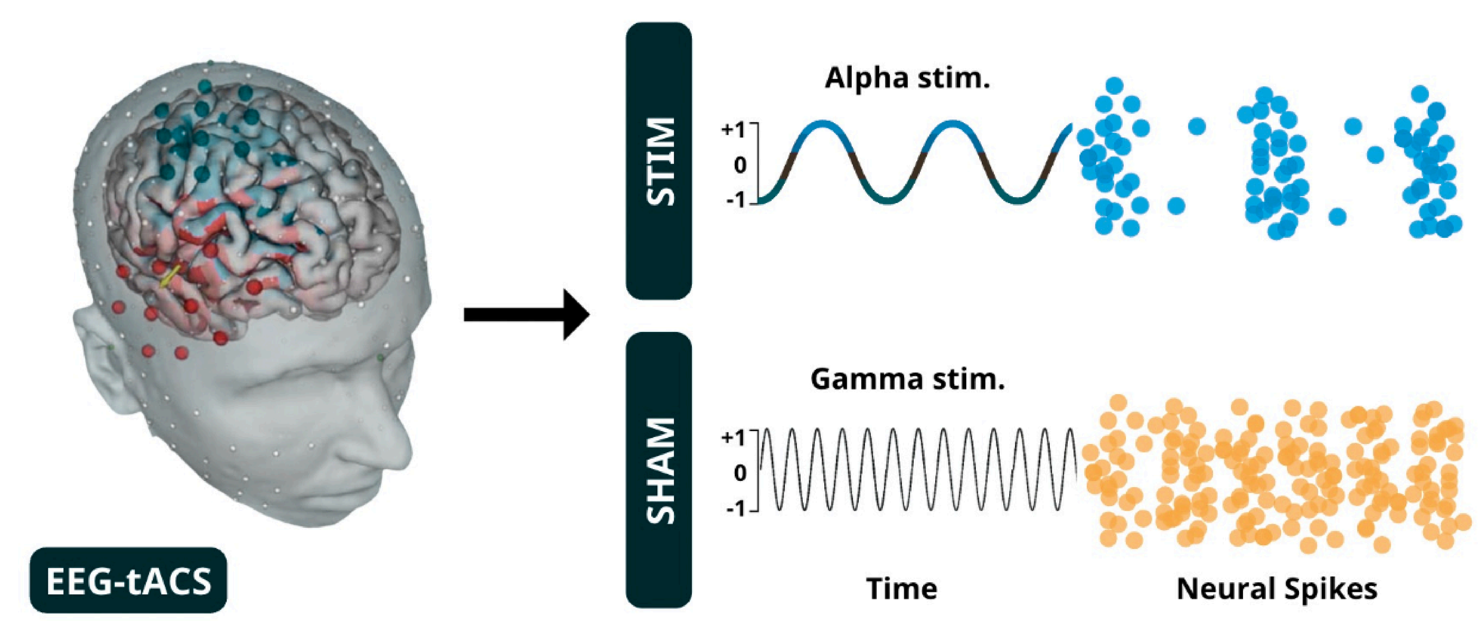
Introduction



Alpha Brain Waves and Cognitive Performance

Alpha brain waves (7–13 Hz) are dominant during relaxed wakefulness and play a key role in cognition. Higher alpha frequencies are linked to faster information processing and quicker responses, likely due to more efficient neural inhibition and excitation cycles. Moderate alpha synchronization may reflect the role of central timing systems, such as the thalamus, in coordinating cognitive activity.

Modulating Brain Activity with tACS

Transcranial Alternating Current Stimulation (tACS) is a non-invasive method that applies low-intensity electrical currents (0.025–0.1 mA/cm²) through scalp electrodes to influence brain rhythms. By syncing neural oscillations with external stimulation, tACS aims to enhance cognitive performance by aligning brain activity with specific frequency patterns.

Marijuana and Cognitive Function

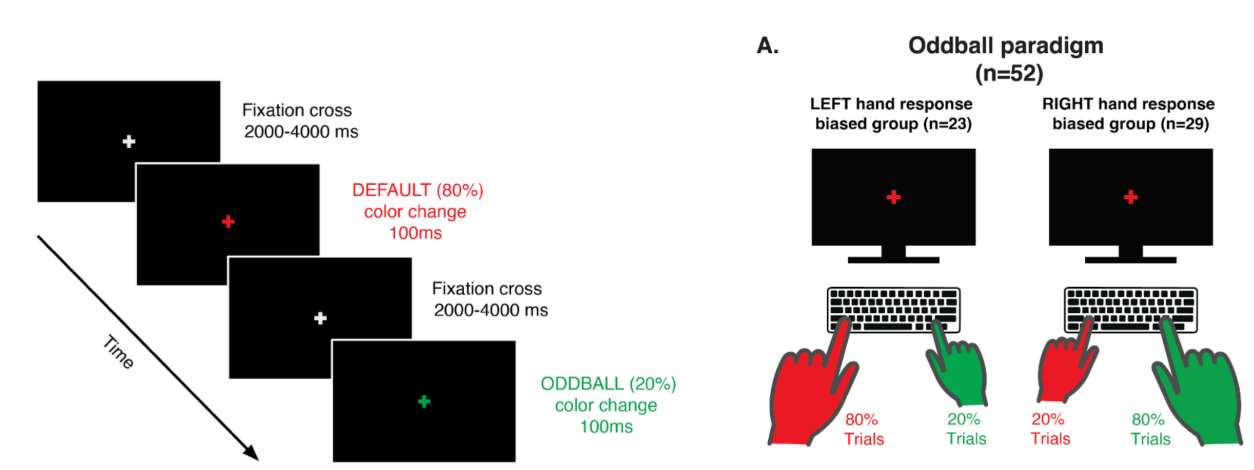
Marijuana use, even at non-heavy levels, can influence cognitive functions such as attention, memory, and decision-making. These effects may vary across individuals and can impact cognitive performance both during and after use. Understanding how marijuana use relates to brain function is important when examining individual differences in cognitive outcomes.

Study Objective

This study explores whether marijuana use interacts with the effects of transcranial alternating current stimulation (tACS) on cognitive performance. Specifically, we aim to examine whether marijuana use influences individual differences in behavior—particularly reaction time—before and after tACS. Understanding this interaction may help clarify how substance use affects responsiveness to neural modulation techniques.

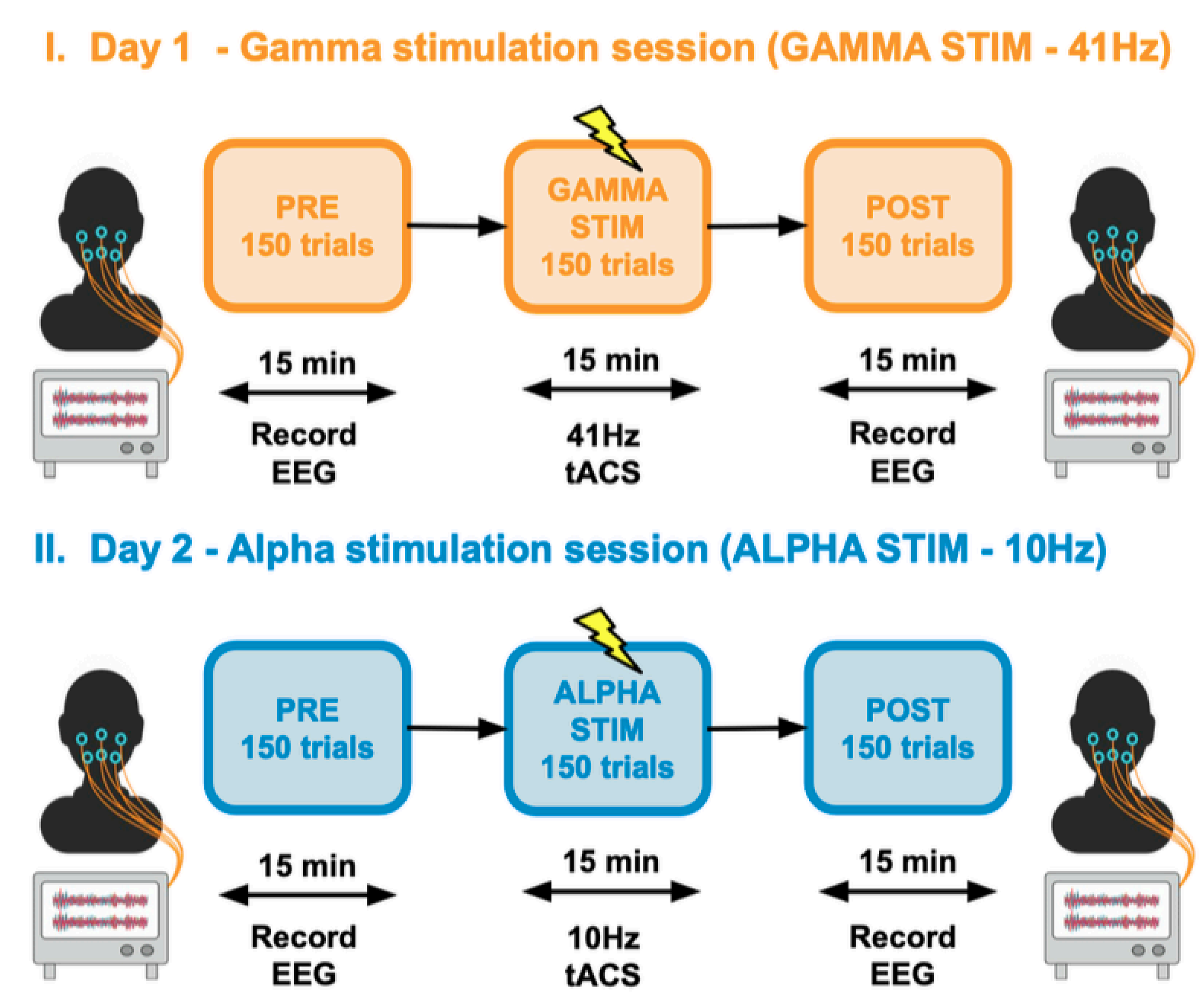
Procedure

Oddball Paradigm



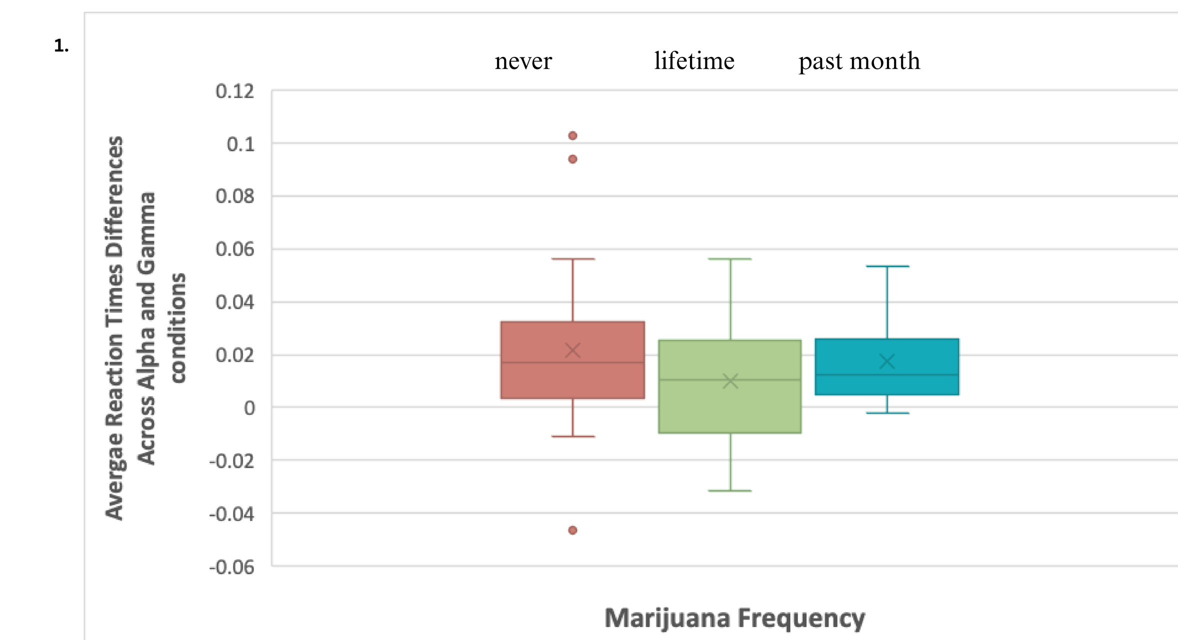
Participants (n= 52) performed an oddball task, responding to infrequent target stimuli (“oddballs”) presented among a series of frequent, non-target stimuli (“defaults”).

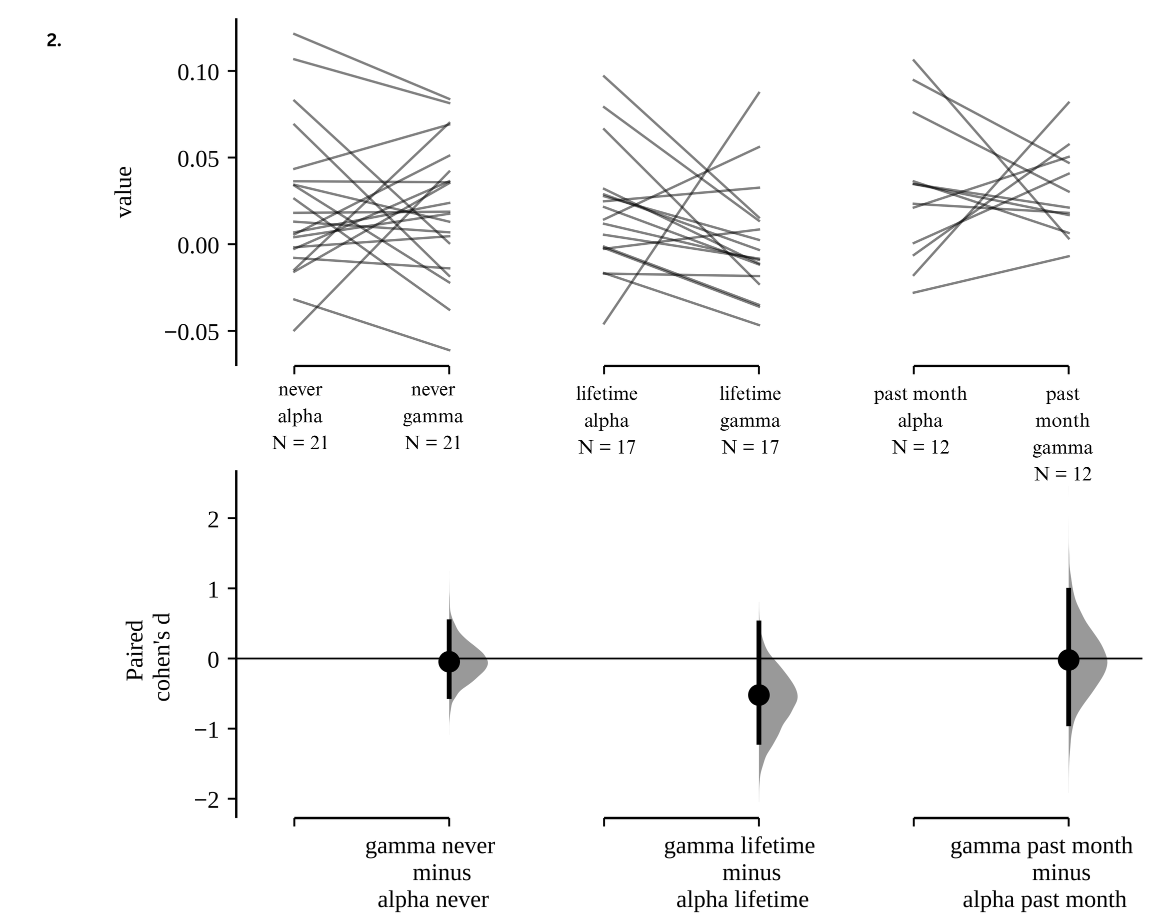
Block Design



Each participant received both alpha (10 Hz) and gamma (41 Hz) tACS in separate sessions on different days. During the STIM block, tACS was applied concurrently with the oddball task. Reaction time data was recorded across three blocks: before stimulation (pre), during stimulation (stim), and after stimulation (post).

Findings





The reaction time differences (individual and average), before and after tACS, across both the conditions and the frequency of marijuana usage did not have any significant interactions. Hence, no significant effects were found between tACS induced reaction time differences and marijuana usage.

Limitation

Our findings are based primarily on university students around 20 years old, whose marijuana use is generally not prolonged enough to produce significant cognitive impairment. As a result, this demographic may not fully capture the broader cognitive effects of marijuana use, limiting the generalizability of our results to other populations.

Acknowledgement

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