Investigating the Individual Differences in the Effects of Transcranial Alternating Current Stimulation (tACS) on Alpha Oscillations and Behavior

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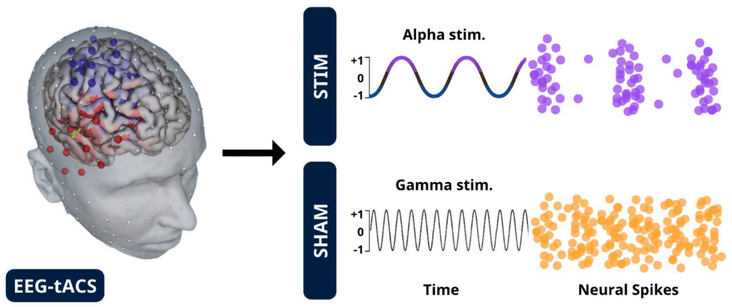
Introduction

Alpha Oscillations and Cognition

Alpha waves (oscillating at 7–13 Hz) occur during restful wakefulness and play a key role in cognition, particularly task performance.

- Higher baseline alpha frequency is consistently associated with faster reaction times (RTs), suggesting a role in information processing speed
- Higher baseline alpha frequencies enable more rapid neural inhibition–excitation cycles, facilitating quicker perception and response execution.
- During moderate alpha synchronization, alpha frequencies may reflect the activity of a central pacemaker (e.g., thalamus) that coordinates the timing of cognitive processes.



transcranial Alternating Current Stimulation (tACS)

tACS is a non-invasive brain stimulation method that delivers weak electrical currents to specific brain regions via electrodes on the scalp (~ 0.025-0.1 mA/cm2), intended to modulate brain oscillations.

Research Question

Does the intentional modulation of alpha oscillations via tACS produce similar outcomes to naturally occurring high baseline alpha frequency?

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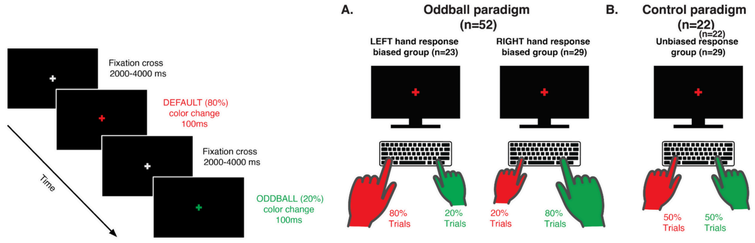
Brain Dynamics Lab

BC Children's Hospital
Provincial Health Services Authority

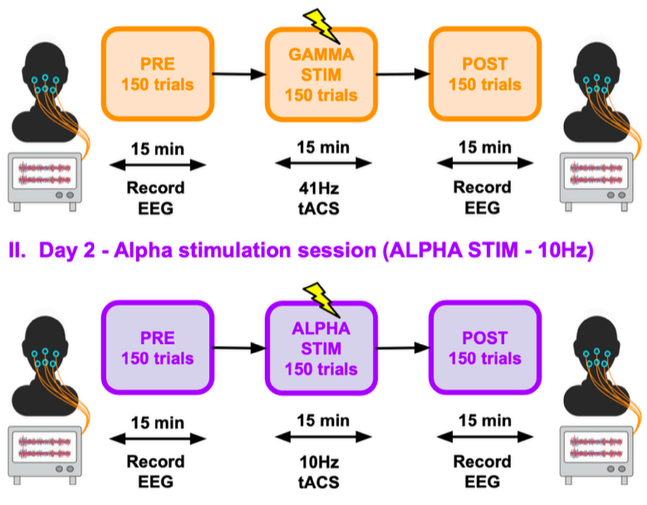
Procedure

Trial Sequence of Oddball Task



Participants (n=74) performed an oddball task where they responded with specific button presses when the fixation cross changed to red or green

Block Design

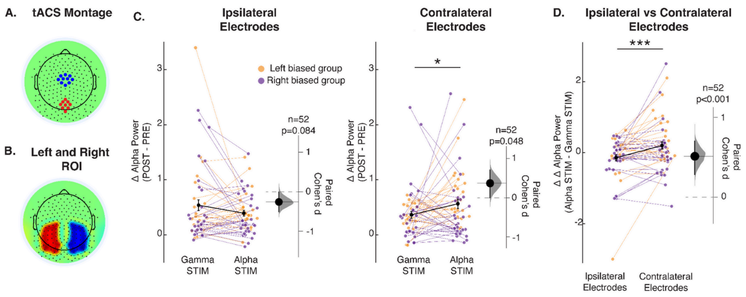


Alpha (10Hz) and gamma (41Hz) tACS were administered to each participant in separate sessions on two different days. During the STIM block, tACS was applied while participants performed the oddball task. EEG data were collected during the behavioral task in the PRE and POST blocks.

Findings

Preliminary Results

tACS selectively boosts lateralised power



Expected Findings

We hypothesize that because tACS (10HZ) correlates with an increase of alpha oscillations, we **predict that participants will display a faster reaction time in the experimental condition.** (Data analysis is ongoing)

Discussion

Implications:

- Would provide evidence that enhancing alpha oscillations via tACS may improve reaction time and cognitive efficiency.
- Supports personalized brain stimulation, tailoring protocols based on individual alpha profiles.
- Offers potential applications for cognitive enhancement in education, high-performance settings, and clinical interventions (e.g., ADHD, brain injury, aging).

Future Directions

- Does tACS independently correlate with reaction time?
- Investigate long-term effects of repeated tACS on alpha modulation and sustained cognitive improvement

Acknowledgements

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