Investigating the Effects of Transcranial Alternating Current Stimulation (tACS) on Electrophysiological Signals During a Task

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Introduction

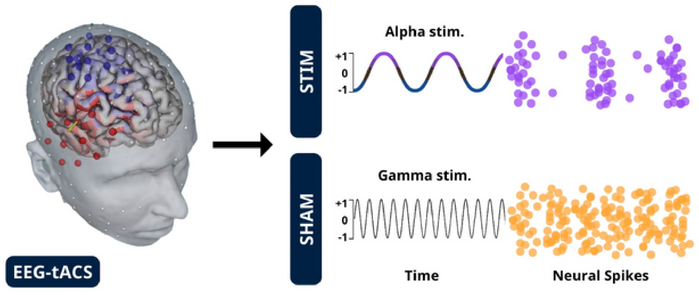
Alpha Oscillations and Cognition

Alpha waves (oscillating at 7-13Hz) are historically viewed as the signature of a passively idling brain state and task disengagement. However, recent findings have challenged this notion, suggesting that alpha waves are linked with cognitive processes, including

- reductions in visual attention, indicating an inhibitory role in sensory processing to regulate the timing and temporal resolution of perception.
- Facilitate the transmission of predictions to the visual cortex.
- Promote communication between frontal and posterior brain regions.
- Maintain ongoing perceptual states and play a role in top-down control.
- Alpha can play both inhibitory and excitatory roles depending on tasks.

transcranial Alternating Current Stimuli (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.



Acknowledgement

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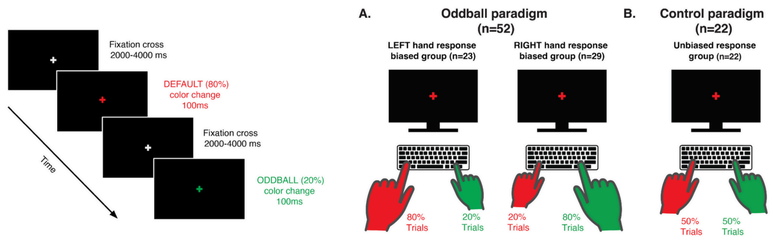
Method

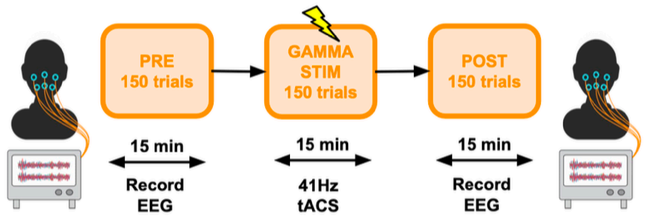
Trial Sequence of Oddball Task



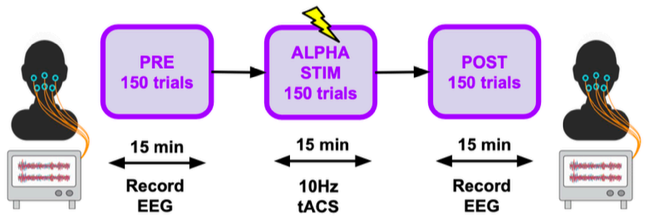
Participants (n=74) performed an oddball task where they responded with specific button presses when the fixation cross changed to red or green

Block Design

I. Day 1 - Gamma stimulation session (GAMMA STIM - 41Hz)



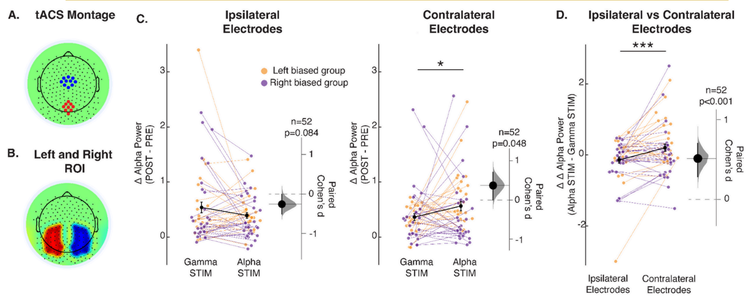
II. Day 2 - Alpha stimulation session (ALPHA STIM - 10Hz)



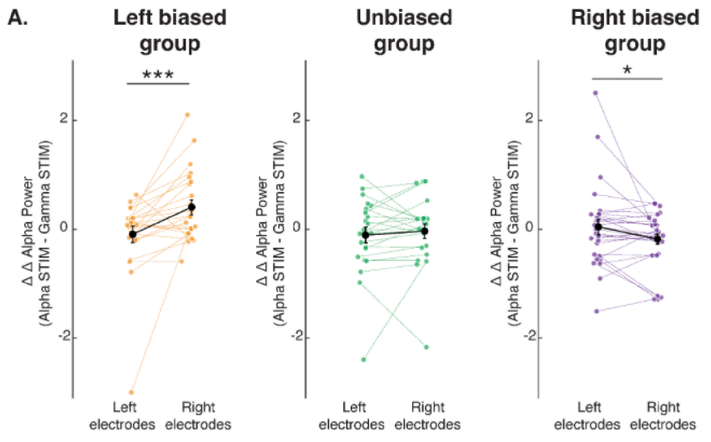
Alpha (10Hz) and gamma (41Hz) tACS were administered to each participant in separate sessions on two different days. During the STIM block, tACS was applied while participants performed the oddball task. EEG data were collected during the behavioral task in the PRE and POST blocks.

Findings

Finding 1: Alpha tACS Selectively Boosts Lateralized Alpha Power



Finding 2: tACS effects are task-dependent



Relevance

Our findings indicate that alpha tACS enhances alpha oscillations in a lateralized manner, with the effects influenced by the specific task being performed. These insights into neuromodulation mechanisms could contribute to refining treatment protocols for psychiatric disorders.

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