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Improving memory in young adults by stimulating key brain region for motivation

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BACKGROUND:

The role of motivation in enhancing memory performance is well-established. However, prior research on motivation and memory has relied on correlated design, and causal evidence of this relationship is lacking. This study seeks to experimentally induce motivation and examine its causal impact on memory performance in young adults.

Neuroimaging studies point to the anterior mid cingulate cortex (MCC) as a central node in motivation networks.[1] The activity and connectivity of MCC predicts persistence on difficult tasks, and stimulation of this region produces "the will to persevere" [2], suggesting this region plays a key role in motivation.

Goals: In this study, we aim to explore the contribution of motivation to memory performance by modulating MCC connectivity with non-invasive brain stimulation**.**

METHODOLOGY:

A double-blind, sham-controlled design was used to administer transcranial direct current stimulation (tDCS) in a sample of 27 cognitively normal young adults with a mean age of 23.3 years, of whom 14 were randomized to the active protocol and 13 to the sham protocol.

Following standard practice and optimizations for tDCS of superficial areas, Participants received stimulation targeting MCC via bilateral middle frontal gyrus (MFG). The stimulation for each participant involved 5 consecutive daily sessions of tDCS. Resting state fMRI and an associative memory task were conducted at baseline and after tDCS to measure changes in functional connectivity and memory performance.

Figure 1. Stimulation site of MCC via bilateral MFG

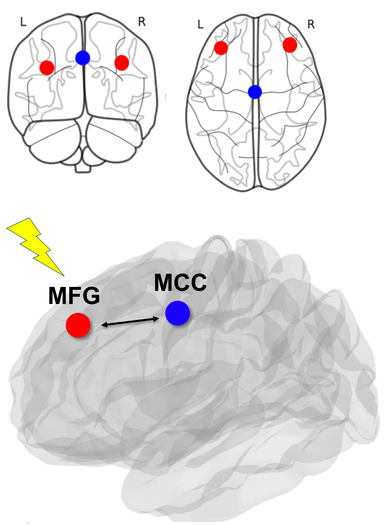
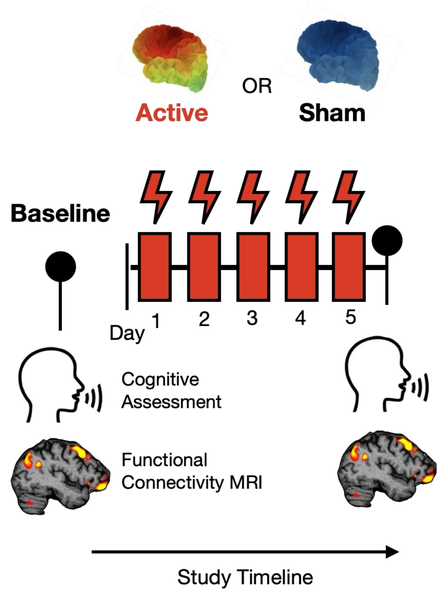
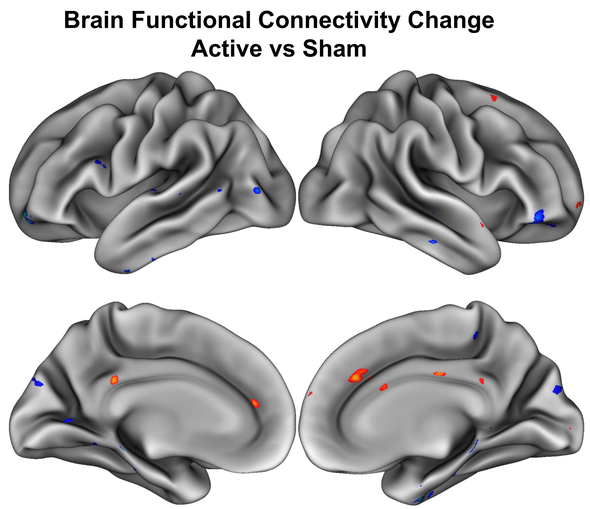


Figure 2. Experimental protocol schematic

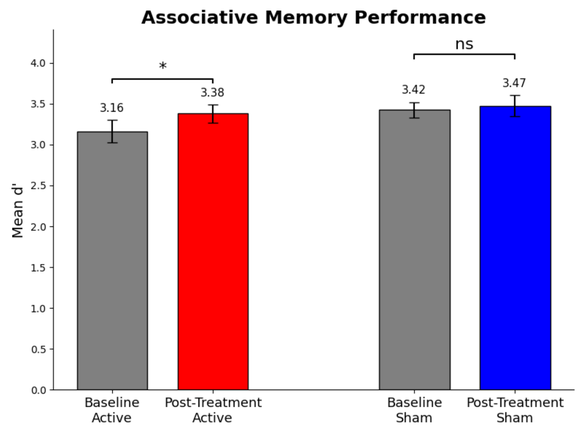


RESULTS:

A



B



A. Averaged functional connectivity changes between active sham sessions across subjects are represented in figure (A). A medial view of the brain shows this increased functional connectivity between the left and right MFG and the MCC following the active tDCS condition. Our behavioral findings showed that tDCS targeted at MCC produced a significant increase in associative memory performance (t = 2.87, p < .05). **B.** Additionally, there was a small effect on response bias, with tDCS resulting in a slightly more liberal bias (i.e. a higher likelihood of false alarm relative to hits) (t= 2.85, p < .05).

CONCLUSION:

- These findings suggest that using tDCS to target the MCC, a key motivation region preserved in cognitively resilient older adults, can enhance memory in young healthy individuals.
- Our protocol selectively improved associative memory, which is selectively impaired in prodromal and early stages of Alzheimer's disease (AD).[3,4] Thus, improving motivation could potentially mitigate cognitive decline in aging and AD, which may inform future clinical trials.
- While these results are promising, our analysis did not yield a significant correlation between the change in functional connectivity and associative memory. Further research is required to confirm the efficacy and potential long-term benefits of tDCS in increasing motivation in an older population of individuals presenting with cognitive decline and AD.

[1]Touroutoglou et al. 2020. Cortex. [2] Parvizi et al. 2013. Neuron. [3] Bastin C et al. 2014. Neuropsychologia. [4] Della Sala S et al. 2012. Neuropsychologia.

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