Can Transcranial Direct Current Stimulation modulate Generalized Fear Memories?

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Abstract

Background: Transcranial Direct Current Stimulation (tDCS) of the prefrontal cortex affects cognitive processes like learning and memory. However, the impact of tDCS on fear generalization and emotional memory modulation remains less explored. tDCS alters the cortical excitability of the neurons resulting in excitatory or inhibitory effects. Being a task-dependent process, it is highly variable in humans. It is dependent on several factors, including the magnitude of current, placement of the electrodes, duration of tDCS administration, the timing of administration, and the nature of stimuli used in the fear learning and memory process, which requires further investigation. This study aims to explores the appropriate tDCS protocols and their effect on the modulation of generalized fear memories.

Method: The sample size for the study will be determined using G*Power analysis. Employing a two-day fear generalization paradigm, ten rings of gradually increasing size will be used, with the largest and the smallest rings as the CS+ and CS- and the intermediate rings as generalization stimuli (GS). The Unconditioned stimulus (UCS) will be an aversive image, which is unpleasant but not unbearable. On Day 1, the participants will be randomly assigned into three groups: cathodal, anodal, or sham and tDCS of 1.5 mA magnitude will be applied at the left dorsolateral prefrontal cortex during the generalization or acquisition phase for 12 minutes. The effects of fear generalization will be tested and analyzed on Day 2 (24 hours after acquisition) through a generalization test. Multi-measure assessment through standardized questionnaires, UCS expectancy ratings, behavioural avoidance, skin conductance response, heart-rate variability, and respiratory rate will be used as indices of fear.

Expected Outcomes: tDCS may result in the modulation of generalized fear memories. We expect that the excitatory effect of anodal tDCS may enhance fear generalization, and the inhibitory effect of cathodal tDCS may interfere with the learning process and dampen fear generalization.

Conclusion: This study will explore the effect of tDCS on modulation of generalized fear memories and establish appropriate parameters for tDCS administration.

Keywords: fear memories, fear generalization, transcranial direct current stimulation, multi-measure assessment