Effects of high-definition transcranial direct current stimulation on conflict resolution: insights from behavioral, EEG and phenomenological measures.

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Abstract:

The efficacy of non-invasive brain stimulation techniques in enhancing conflict resolution abilities remains a contentious issue in cognitive neuroscience. To contribute further to this topic, we employed a sham-controlled between-groups design to investigate the cognitive, phenomenological, and physiological effects of anodal and cathodal high-definition transcranial direct current stimulation (HD-tDCS) targeting the bilateral dorsolateral prefrontal cortex (DLPFC) during conflict resolution tasks. Sixty participants completed a 30-minute flanker task, a widely used measure of cognitive control and conflict processing. Electroencephalography (EEG) activity was recorded at four time points: at rest, prior to task commencement, during task execution before tDCS administration, during task execution after tDCS administration, and post-task rest. Additionally, a novel method called temporal experience tracing (TET) was employed to retrospectively evaluate participants' subjective experiences throughout the experimental procedure. TET involved participants reporting the intensity of predefined experiential dimensions along a temporal axis. Findings revealed no statistically significant differences between tDCS groups in reaction time, accuracy data, drift diffusion modeling, or EEG frequency power analyses. Analysis of TET data unveiled an anticipated temporal pattern across all subjective dimensions, e.g., an increase in mind-wandering over time. Notably, significant differences between tDCS groups emerged in the "fed-up" and "boredom" dimensions, indicating varied subjective experiences influenced by stimulation conditions. Furthermore, Lempel-Ziv analysis demonstrated that EEG complexity escalated from the pre-task to post-task periods to a greater extent in the cathodal and sham conditions compared to the anodal condition. In summary, this study provides valuable insights into the nuanced effects of tDCS during conflict resolution tasks. Notably, the employment of the novel TET methodology allowed for a comprehensive assessment of participants' subjective experiences throughout the experimental procedure. These findings contribute to advancing our understanding of the cognitive and phenomenological effects of tDCS and underscore the importance of integrating innovative methodologies in neurostimulation research.