Cognitive plasticity: Modulation and monitoring through a neurophysiological approach

ABSTRACT:

In the first phase we tested the effects of different tES protocols in visuo-spatial contextual learning (VSCL).

The study comprised three sessions designed to evaluate tDCS-induced changes in VSCL measures collected during the execution of a visual search task widely used to examine statistical learning in the visuo-spatial domain. In Experiment1 (E1), we probed for the effects of left-posterior parietal cortex (PPC) anodal-tDCS (AtDCS) at different timings (offline and online) and intensities (3mA, 1.5mA). The protocol producing the more robust effect in E1 was used in E2 with a swapped electrodes montage, while In E3, left-PPC 3mA cathodal-tDCS (CtDCS) was applied offline and online to investigate the effects on neuronal excitability reduction on VSCL.

Results revealed that high intensity offline AtDCS reduced VSCL regardless of the stimulation side (E1 & 2), while no behavioural changes were produced by both online AtDCS protocols (E1) and offline/online CtDCS (E3). The reduced VSCL could result from homeostatic mechanisms produced by the interaction of two excitability-increasing events hindering normal task-related neuroplastic phenomena.

In the second phase of project, we examined the neurophysiological correlates of modified cognitive performance by 3mA anodal-tDCS offline on left-posterior parietal cortex (PPC).

We acquired various electrophysiological measures in order to fully investigate the neural modifications induced by the application of the tES protocol producing the more robust effect in the first phase of the project. Electrophysiological measures were recorded both during the execution of the behavioural task (ERP measures) and during TMS-EEG co-registration at three different intervals (before tDCS (TEP1), after tDCS but before task (TEP2) and after task (TEP3)).

ERPs revealed a significant difference in the amplitude of N1 and P3 and this modulation could be interpreted as a general memory-mediated attentional capture produced by visual contexts that were repeated over time. Interestingly, Real-tDCS also produced a strong significant increase in the amplitude of the posterior P2 component in response to both repeated and not-repeated visual contexts. This modulation could reflect a stimulation dependent reduction of perceived saliency associated with the presentation of the visual search arrays. TMS-evoked potentials show that the only application of tDCS does not produce changes in connectivity, but there is a different pattern between real and sham conditions when participants are also asked to perform a cognitive task and it improves with time. Furthermore, the difference between TEP 1 and TEP 3 in sham condition, and not in the real one, suggests a reduction of cortical activation after real stimulation.

Keywords

Cognitive plasticity, Connectivity, Memory, Neuromodulation

Published Work:

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