Network-level mechanisms underlying effects of transcranial direct current stimulation (tDCS) on visuomotor learning

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Abstract
Transcranial direct current stimulation (tDCS) is a non-invasive brain stimulation approach in which low level currents are administered over the scalp to influence underlying brain function. Prevailing theories of tDCS focus on modulation of excitation-inhibition balance at the local stimulation location. However, network level effects are reported as well, and appear to depend upon differential underlying mechanisms. Here, we evaluated potential network-level effects of tDCS during the Serial Reaction Time Task (SRTT) using convergent EEG- and fMRI-based connectivity approaches. Motor learning manifested as a significant ($p<.0001$) shift from slow to fast responses and corresponded to a significant increase in beta-coherence ($p<.0001$) and fMRI connectivity ($p<.01$) particularly within the visual-motor pathway. Differential patterns of tDCS effect were observed within different parametric task versions, consistent with network models. Overall, these findings demonstrate objective physiological effects of tDCS at the network level that result in effective behavioral modulation when tDCS parameters are matched to network-level requirements of the underlying task.

Author keywords
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