Exploring the effect of transcranial direct current stimulation during sleep on fear extinction learning

ABSTRACT:

Background
PTSD affects about 6.8% of people during their lifetime, often developing after severe trauma. One key factor in recovery failure is the inability to extinguish traumatic memories. Trauma-focused exposure therapy is effective for PTSD, as it promotes fear extinction, with the ventromedial prefrontal cortex (vmPFC) playing a central role.

Aims
This study aims to explore new avenues to promote fear extinction learning with the use of a non-invasive brain stimulation namely transcranial direct current stimulation (tDCS). We planned to test whether a prefrontal (PFC) modulation via tDCS, during sleep, boosts extinction learning. Moreover, we planned to investigate the neural correlates related to such extinction learning response.

Method
In all experiments, tDCS was delivered during a nap of 90 minutes duration. In a first experiment, participants were exposed to a conditioning/extinction protocol combined with one non-invasive brain stimulation session (e.g., active or sham tDCS, depending on the experimental group) over the left vmPFC. The stimulation was delivered during the REM sleep stage. In a second experiment, applying a similar methodology, we investigated respective neural correlates using fMRI.

Results
The results of the first experiment show that real tDCS effectively enhanced fear extinction memory consolidation during REM sleep. These results are confirmed by the second experiment, with the tDCS group exhibiting greater activation in areas associated with motor control, sensory processing, and emotional regulation, particularly in the context of REM sleep.

Conclusions
Overall, the reported findings suggest that tDCS may enhance the neural substrates involved in fear extinction learning during REM sleep.

Keywords
Fear extinction, REM Sleep, tDCS, PFC

Published Work:

Laroche, J., Tomassini, A., Volpe, G., Camurri, A., Fadiga, L., & D'Ausilio, A. (2022). Interpersonal sensorimotor communication shapes intrapersonal coordination in a musical ensemble. *Frontiers in Human Neuroscience, 16*: 899676. doi: 10.3389/fnhum.2022.899676

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