Implicit task sequence learning and consolidation: a tDCS study

The task sequence learning (TSL) paradigm measures implicit sequence learning without the involvement of motor learning (Weiermann, Cock, & Meier, 2010). Furthermore, patients with frontal lobe lesions showed no sequence learning (Meier et al., 2013). The aim of this study was to evaluate the causal role of the dorsolateral prefrontal cortex (DLPFC) for implicit task sequence learning and consolidation.

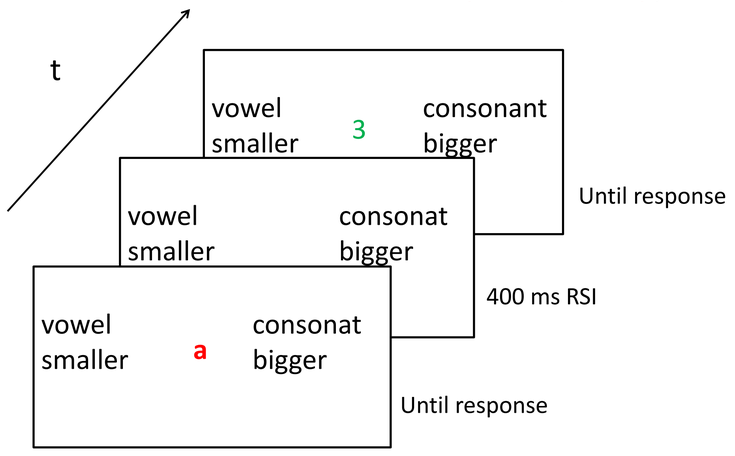
We conducted two experiments with different transcranial direct current stimulation (tDCS) protocols. tDCS can affect cortical excitability, specifically anodal tDCS produces cortical excitation while cathodal tDCS produces cortical inhibition.

We expected that tDCS over the DLPFC would affect implicit task sequence learning and consolidation compared to simulated (sham) tDCS condition.

Method

Task sequence learning (TSL)

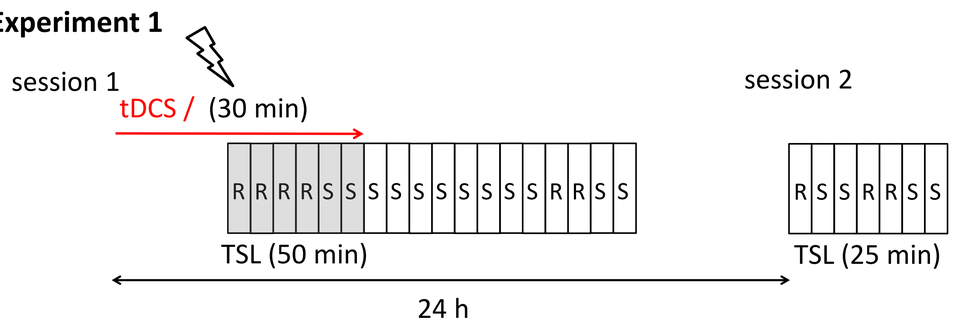
- Task
  - Letter (L): Vowel or consonant
  - Number (N): < 5 or > 5
- Response mapping
  - Compatible (Comp)
  - Incompatible (Incomp)



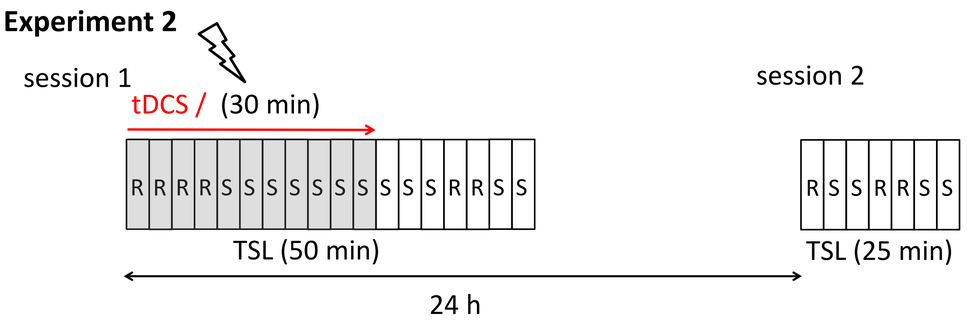
Trial	1	2	3	4	5	6	7	8
Task	N	L	N	N	N	L	L	L
Response mapping	Comp	Comp	Incomp	Incomp	Comp	Incomp	Incomp	Comp

Correlated Task and Response mapping sequences with random motor responses.

Experiment 1



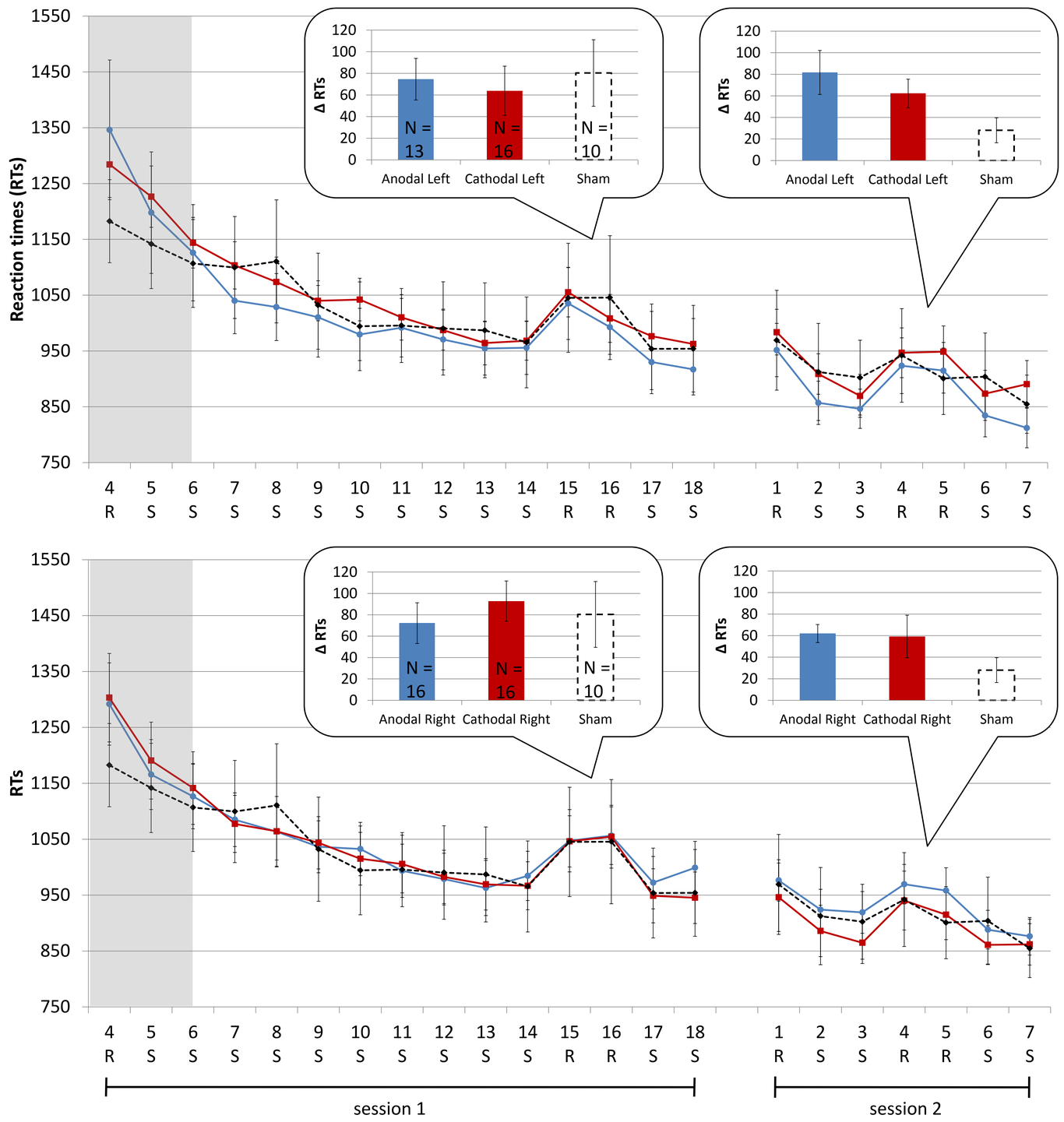
Experiment 2



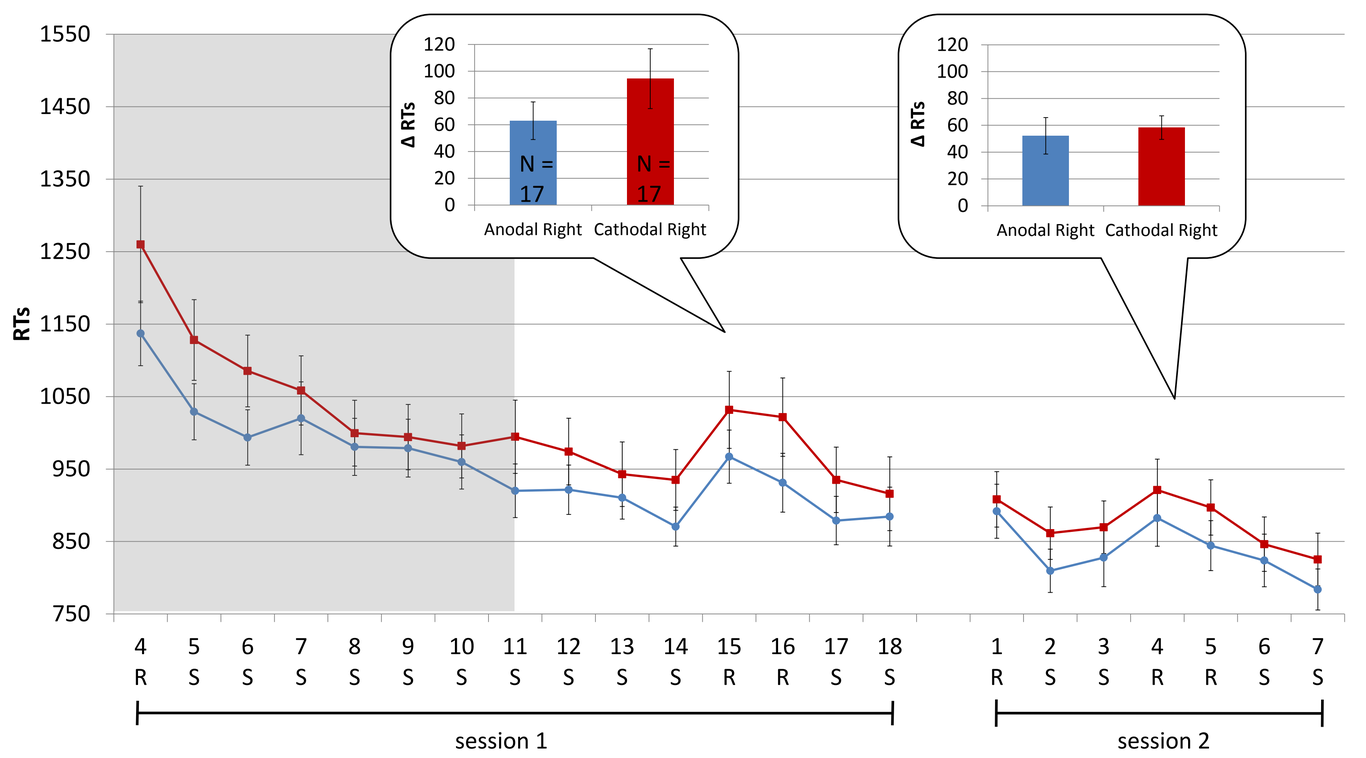
tDCS was applied at 1 milliampere (mA) for 30 minutes. The active electrode was placed over the left or the right DLPFC, the reference electrode over the controlateral supraorbital region. Stimulation was applied only during session 1.

Results

Experiment 1



Experiment 2



Mean reaction times per block for each stimulation condition for session 1 (left) and session 2 (right). Inserted are the disruption scores (RT difference between the random blocks and the adjacent sequenced blocks) for each session and each condition.

Results: (1) In all groups there was a decrease in RTs during the sequenced blocks, indicating general learning. (2) When the sequence was switched to random RTs increased, indicating sequence-specific learning. (3) Disruption scores did not differ across sessions. (4) Finally, in both experiments there was no significant difference between the groups, indicating no influence of tDCS stimulation.

Conclusions

Across two experiments we showed robust implicit task sequence learning. However tDCS did not influence performance. Thus, it seems that the two tDCS protocols are not suitable to affect implicit sequence learning.

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Reference

Weiermann, B., Cock, J., & Meier, B. (2010). What matters in implicit task sequence learning: Perceptual stimulus features, task-sets, or correlated streams of information? *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *36*, 1492-1509. doi:10.1037/a0021038

Meier, B., Weiermann, B., Gutbrod, K., Stephan, M.A., Cock, J., Müri, M.R., & Kaelin-Lang, A. (2013). Implicit task sequence learning in patients with Parkinson's disease, frontal lesions and amnesia: The critical role of fronto-striatal loops. *Neuropsychologia*, *51*, 3014-3024. doi: 10.1016/j.neuropsychologia.2013.10.009