Dose response of high-intensity transcranial electric stimulation on cortical excitability and motor learning

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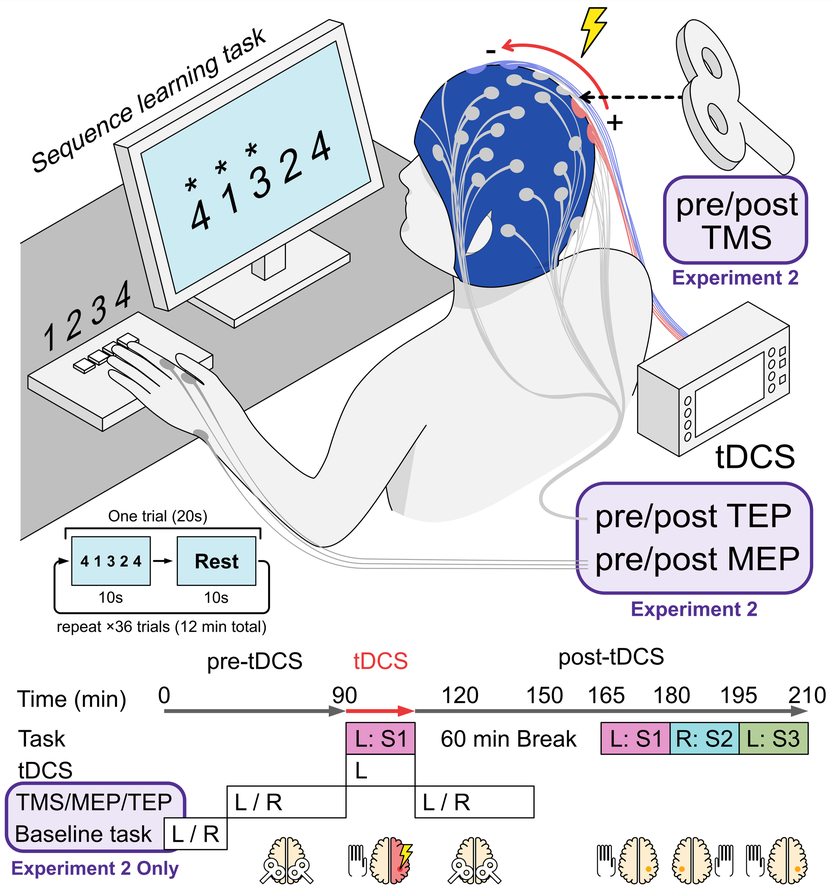
Introduction

Transcranial direct current stimulation (tDCS) shows promising effects on motor behavior and corticospinal excitability, but results are mixed.

Typical *in vivo* stimulation intensities (up to 2 mA) are much lower than those used *in vitro* to demonstrate modulation of synaptic plasticity.

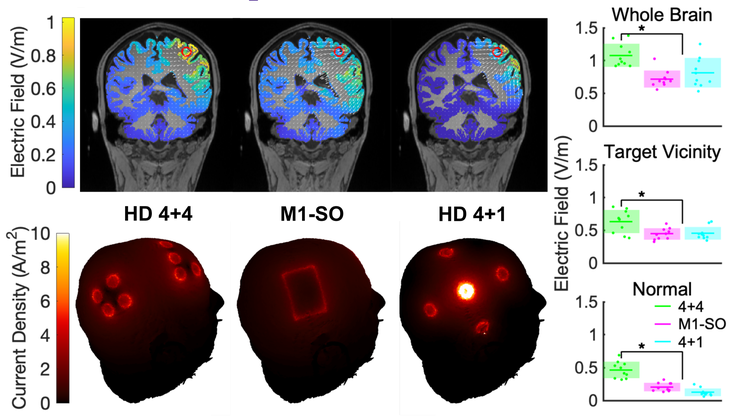
We hypothesize a monotonic effect of increasing tDCS intensity above 4 mA on cortical excitability and motor learning.

Methods



Experiments 1 and 2 use the same setup and sequence learning task. tDCS is applied concurrently with the first task (S1). Different sequences (S2, S3) are used as follow-ups.

Experiment 1



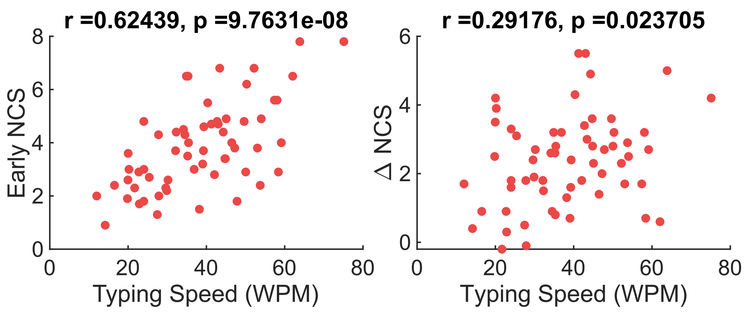
High-definition 4+4 tDCS was used to optimize targeting and minimize skin sensation effects. Electrode layout determined using MRI-based current flow modeling.

-4	0	+4	+6
n = 36	n = 36	n = 36	n = 32

In a parallel design, subjects received -4, 0, or +4 mA tDCS (n=36 each). A +6 mA group (n=32) was added later.

Experiment 2

Experiment 2 is a partial replication of Experiment 1 that also measures changes in corticospinal and cortical excitability through MEPs and TEPs.

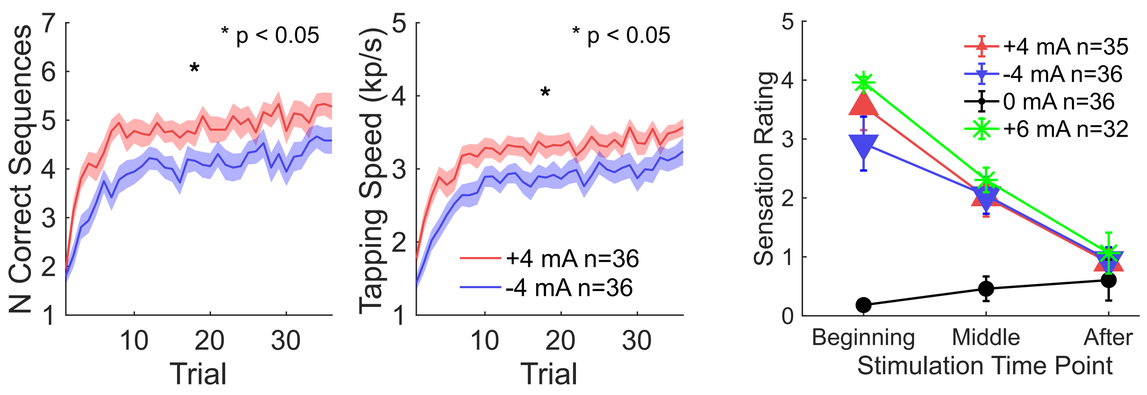


A baseline typing task will be used to counterbalance group assignments against variability in learning ability.

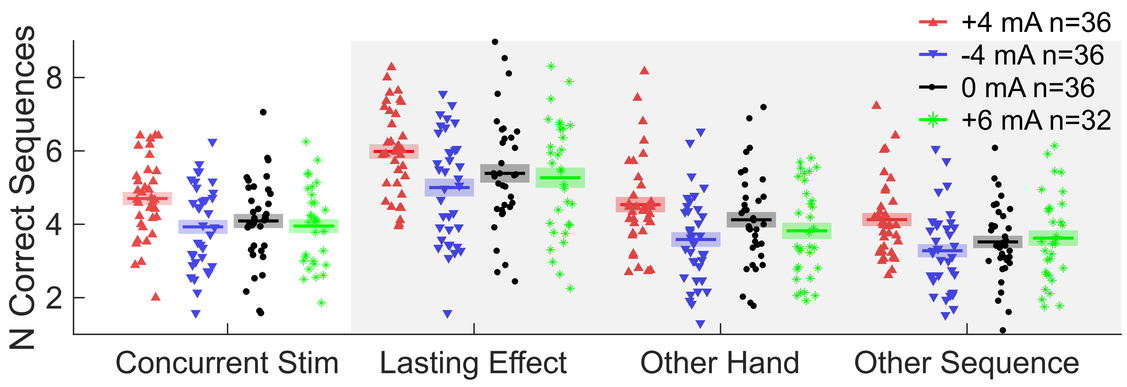
0	+4	+6
n = 40	n = 40	n = 40

Similar to Experiment 1, subjects will receive 0, +4, or +6 mA tDCS (n=40 each). Sample size is powered at 80%.

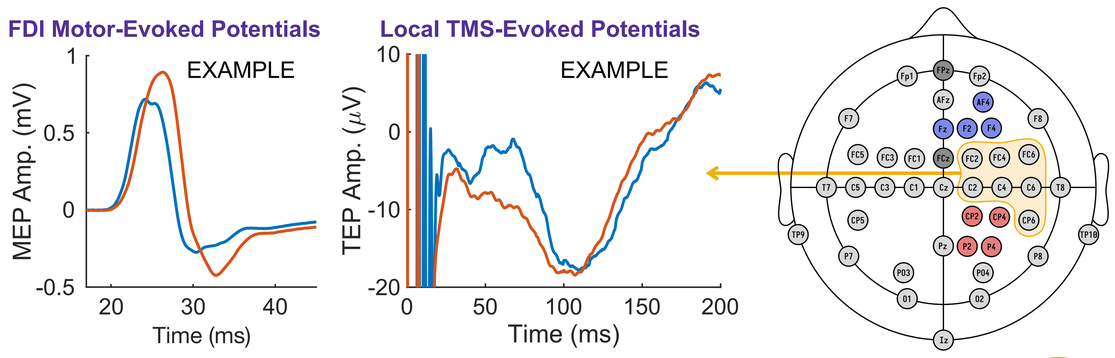
Results (Experiment 1)



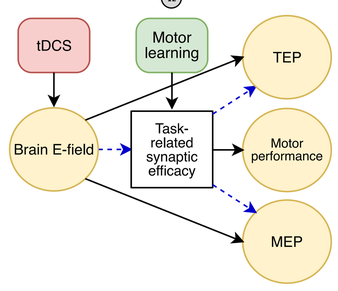
+4 mA group outperformed all other groups. Boosting effect lasted after 1 hour and carried over to the other hand and sequence. 4 mA and 6 mA tDCS were well tolerated.



Summary + Expected Outcomes



We have demonstrated the feasibility of applying high-intensity tDCS at 4 mA and above. This work will inform us whether more current is better, and help determine the utility of corticospinal and cortical excitability as correlates of motor learning.



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Some Experiment 1 figures were sourced from:

Hsu G, Shereen AD, Cohen LG, Parra LC. Robust enhancement of motor sequence learning with 4 mA transcranial electric stimulation. Brain Stimulat. 2023;16(1):56-67. doi:10.1016/j.brs.2022.12.011

Disclosure of Conflict of Interest

Name of first author: Gavin Hsu

I have no COI with regard to the presentation.