A Cautionary Tale About the Importance of Taking Individual Differences into Account When Examining Whether tDCS can Enhance Cognitive Control

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INTRODUCTION

Cognitive control: Ability to disregard irrelevant information while attending to relevant information, supported by the prefrontal cortex (PFC) (Miller & Cohen, 2001).

Can this important ability be enhanced?

Transcranial direct current stimulation (tDCS): Weak electrical current delivered to scalp, modulating likelihood of neuronal firing.

Recent meta-analysis suggests anodal tDCS over PFC may enhance cognitive control, with some setups (small anodes, extra-cranial cathodes; Imburgio & Orr, 2018)

- But even using these setups, results vary.
- Baseline individual differences in cognitive control may account for some variability in results across studies
- Most studies have fewer than 20 SS/group and do not examine whether tDCS modulates changes from pre-test to post-test

When baseline differences in cognitive control are accounted for: Does anodal tDCS over PFC (applied using a common montage: F3-RSO) enhance cognitive control in Flanker or Stroop tasks?

RESULTS (N = 52)

**Flanker:** No tDCS induced changes from pre- to post- test:

- Baseline Flanker effects not equivalent across Sham and Anodal participants!

**Stroop:** No tDCS induced changes from pre- to post- test:

- **Baseline differences in Flanker** unsurprising given broad range of pre-test scores across participants: (and modest N)
  - By chance, more sham participants (blue dots) drawn from left side of distribution

- **Despite broad range of Flanker scores,** test-retest reliability was relatively good… Suggesting that, had it existed, an effect of tDCS on Flanker should have been detectable (after controlling for baseline differences)

**DISCUSSION**

Data collection may(?) resume (target was 60/condition)

Currently...

- No effect of anodal tDCS over PFC on cognitive control (i.e., Flanker or Stroop incongruency effects) …with our montage and stimulation parameters
- Results highlight importance of taking individual differences into account: *If we had only compared post-test performance, we would have erroneously concluded that anodal tDCS produces a highly significant (7%) detriment in cognitive control in Flanker!*
- Reminders:
  - When using tasks with large individual differences, test large sample and/or use pre- vs. post-test design
  - Also consider test-retest reliability (not great for Stroop)

Future

- Test montage which current modeling suggests may better stimulate PFC: anode placed posterior to PFC, so midpoint of current is over PFC (Data et al., 2012)

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**METHODS**

**Anodal tDCS:**

- Montage: F3-RSO
- 5x7cm saline-soaked sponges
- 1.5 mA stimulation begins 3 min before tasks, and continues throughout tasks

**Stroop Task**

- 5 Colors: Blue, Red, Green, Yellow, Black
- 50% Incongruent
- Respond to ink color – not text

**Flanker Task**

Respond to central arrow

- Congruent
- Incongruent

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