

Bifocal tDCS Stimulation of the Dorsolateral Prefrontal Cortex leads to asymmetries in judgement and decision making

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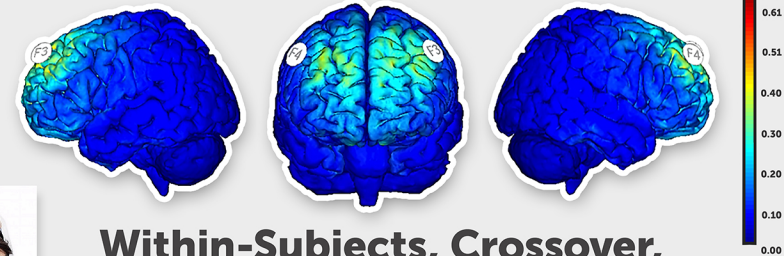
INTRODUCTION

- This study uses transcranial direct current stimulation (tDCS) to explore a potential asymmetry between right and left dorsolateral prefrontal cortex (DLPFC) in facilitating reflective processing.
- Previous studies have revealed the importance of the DLPFC in attentional control and regulating impulsivity.^{1,2}
- Edgcombe et al. (2019) found that tDCS stimulation of the right, but not the left, DLPFC facilitated performance on the cognitive reflection task (CRT), a common marker of reflective processing.³
- We hypothesized that stimulation of the right DLPFC will replicate the Edgcombe (2019) findings on CRT performance, and will reduce impulsivity as measured by a stop-signal task while reducing context-driven bias as measured by a financial risk framing task.

PARTICIPANTS: We collected pilot data from 9 male participants in a series of randomized, within-subjects trials at the University of Texas at Dallas. All participants were right-handed, native English speakers.

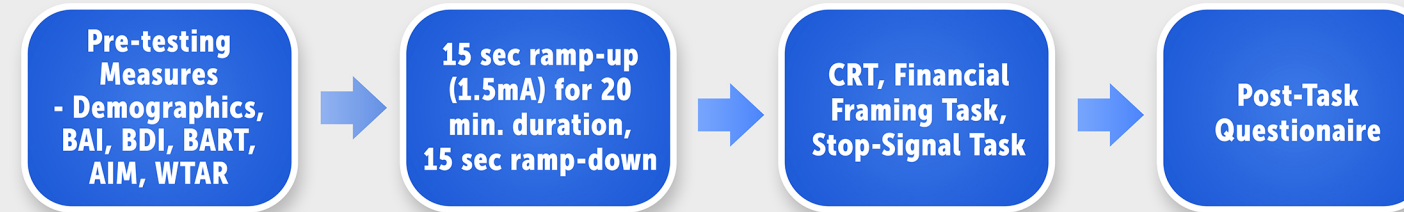
METHODOLOGY, DESIGN & PROCEDURE

- A Neuroelectrics STARSTIM 8 device (Barcelona, Spain) was used to implement a bifocal electrode montage placed at 10-10 electrode sites F3 and F4 over the dorsolateral prefrontal cortex.
- tDCS induces temporary shifts in resting membrane potentials during task performance.⁴
- Each stimulation condition was counterbalanced and spaced at least one week apart on each data collection visit to attenuate residual effects of prior tDCS stimulation.



Within-Subjects, Crossover, Sham-controlled design

Stimulation Groups:
• Right DLPFC • Left DLPFC • SHAM



Timeline of Experiment

DISCUSSION & CONCLUSIONS

- These pilot data findings provide evidence for both the potential benefits and hinderances of using tDCS to enhance reflective processing by modulating activity in the DLPFC.
- A follow-up study will assess the role of norepinephrine (NE) in modulating attention during tDCS stimulation. Biomarkers for NE modulation will include salivary alpha-amylase and the P300 event-related potential (ERP) derived from EEG.

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EXPERIMENTAL TASKS & RESULTS

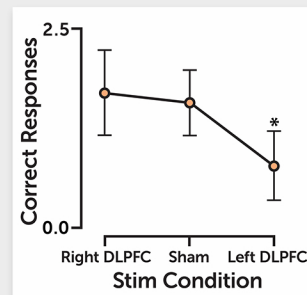
Cognitive Reflection Test (CRT)

- CRT assesses reflective processing
- Each questionnaire comprises of 6 questions: 3 quantitative and 3 verbal

- A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost? _____ cents
- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
- In a lake, there is a patch of lily pads. every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days

Fig. 1 Effect of tDCS Stimulation on Quant CRT Accuracy (with 95% CI)

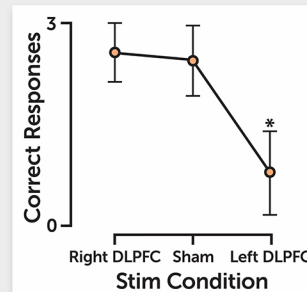
- Stimulation of the left DLPFC significantly reduced accuracy on the quantitative CRT in comparison to right DLPFC and sham stimulation conditions.



- Within-subjects ANOVA indicates Stim condition had significant effect on CRT Quant accuracy, $F(2, 16) = 5.85, p = .012, \eta^2 p = .42$

Fig. 2 Effect of tDCS Stimulation on Verbal CRT Accuracy (with 95% CI)

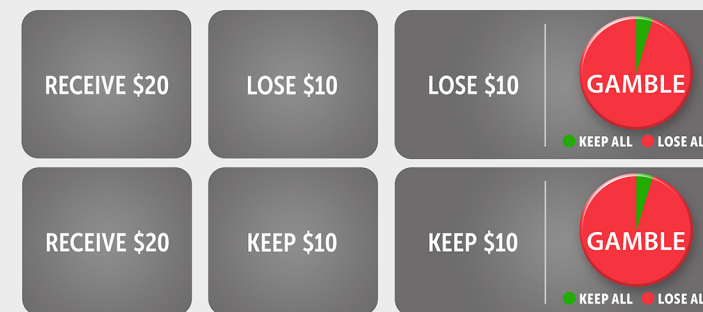
- Stimulation of the left DLPFC significantly reduced accuracy on the verbal CRT in comparison to right DLPFC and sham stimulation conditions.



- Within-Subjects ANOVA indicates Stim condition had significant effect on verbal CRT accuracy, $F(2, 16) = 19.09, p < .001, \eta^2 p = .72$

Financial Risk Framing Task

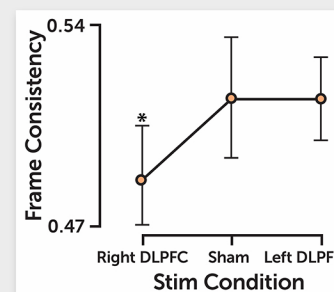
- Measures tendency to engage in context-driven decision making ...
- 4 blocks of 20 items each
- Counterbalanced keep/lose amounts
- Counterbalanced gamble win/loss probabilities



- Frame Consistency Index (FCI) denotes frame consistent judgements such that FCI is positively correlated with frame susceptibility:
 - Selecting risk-averse option during positive framing (e.g., "keep \$X")
 - Selecting risk-seeking option during negative framing (e.g. "lose \$X")

Fig. 3 Effect of tDCS Stimulation on FCI (with 95% CI)

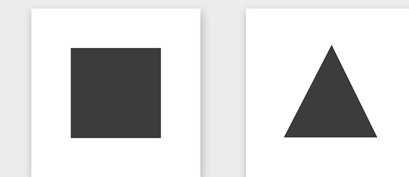
- Stimulation of the right DLPFC significantly reduced frame susceptibility in comparison to left DLPFC and sham stimulation conditions.



- Within-Subjects ANOVA indicates stimulation condition had a significant effect on FCI scores, $F(2, 14) = 4.30, p = .035, \eta^2 p = .38$

Visual Stop-Signal Task

- Measures ability to inhibit motor response and detects lapses in attention
- 4 blocks of 50 items each,
- 10 out of 50 items (20%) contain stop signal
- Participant presses ← on square, Press → on triangle



- Participant must inhibit motor response during stop signal.

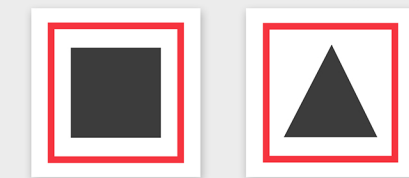
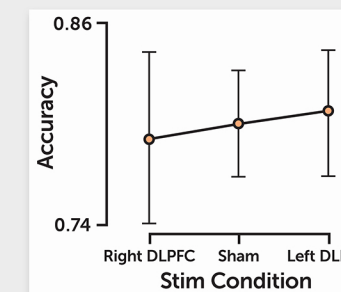


Fig. 4 Effect of tDCS Stimulation on Visual Stop-Signal Accuracy (with 95% CI)



- Within-Subjects ANOVA indicates Stim condition had no significant effect on Stop Signal accuracy, $F(2, 16) = .19, p = .83$