

What Can You Expect from Boosting Prefrontal Cortex?

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Background

- Paying selective attention to a word in an utterance increases accuracy on that word, and decreases accuracy on other words (Nozari & Dell., 2012) → cost and benefit of selective attention.
- Anodal Transcranial Direct Current Stimulation (tDCS) of PFC reduces delta-band frequency and “boosts neuro-computational resources” (Wirth et al., 2011).

Question 1-

Will anodal stimulation of the left DLPFC ...

1) remove the cost by releasing more attentional resources?

OR

2) increase the cost by narrowing the focus of attention even more?

Question 2-

Does tDCS-induced improvement in one executive function predict improvement in another?

Methods

- **N = 24** (within-subject design)

- **Two tasks:**

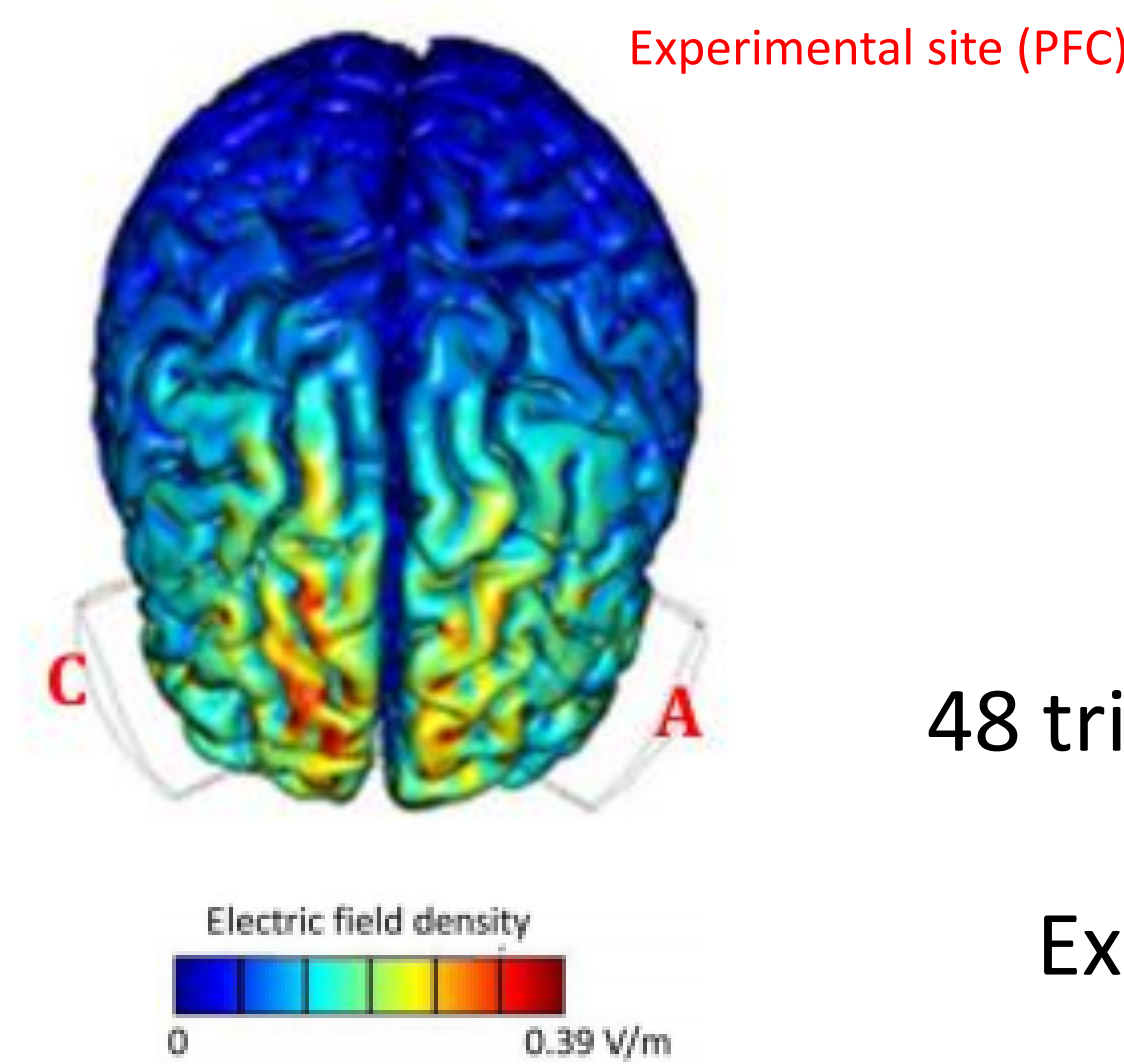
1) N-back (1-back, 2-back, and 3-back) during tDCS

2) Tongue-twisters (post-tDCS)

- **Two stimulation sites:**

Experimental site (PFC); Control site (M1).

Session's procedure: Instructions → N-back → Tongue-twister → Tongue-twister
(training block) (experimental blocks)

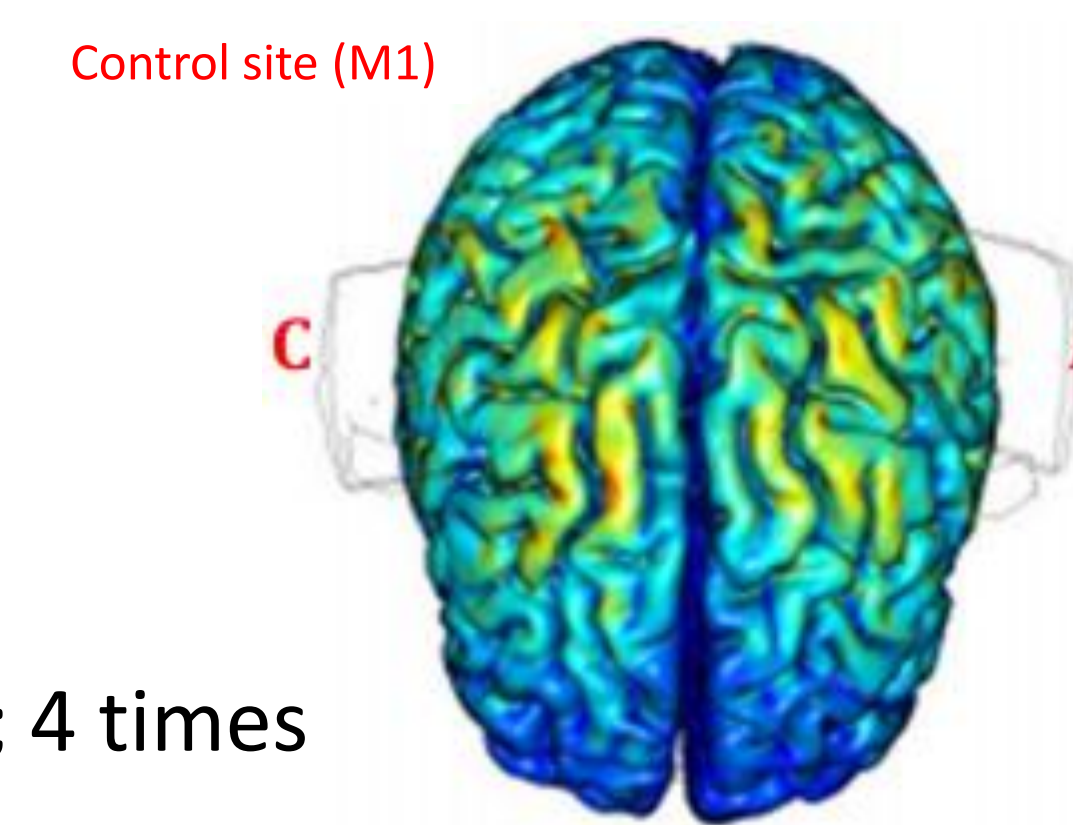


The tongue-twister task

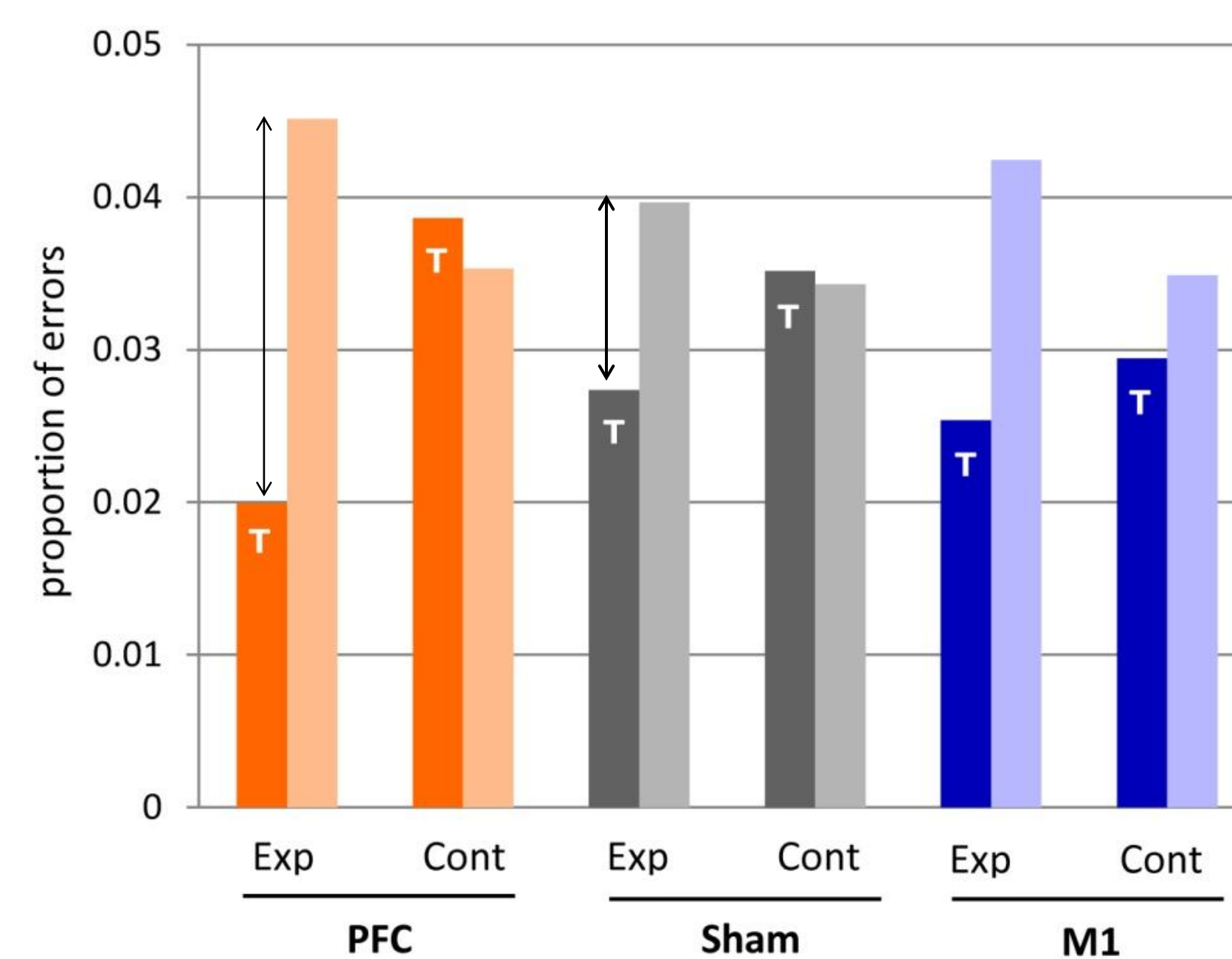
experimental: WRIST WING **WHIFF** RINK
control: MIST WING **WHIFF** MINK

48 trials, recited with a metronome 4 times at 2 beats/sec (practice); 4 times at 3 beats/sec (test). Errors were collected at test.

Experimental trials: one word in bold and underlined. Errors were to be avoided on ALL, but especially on that word.



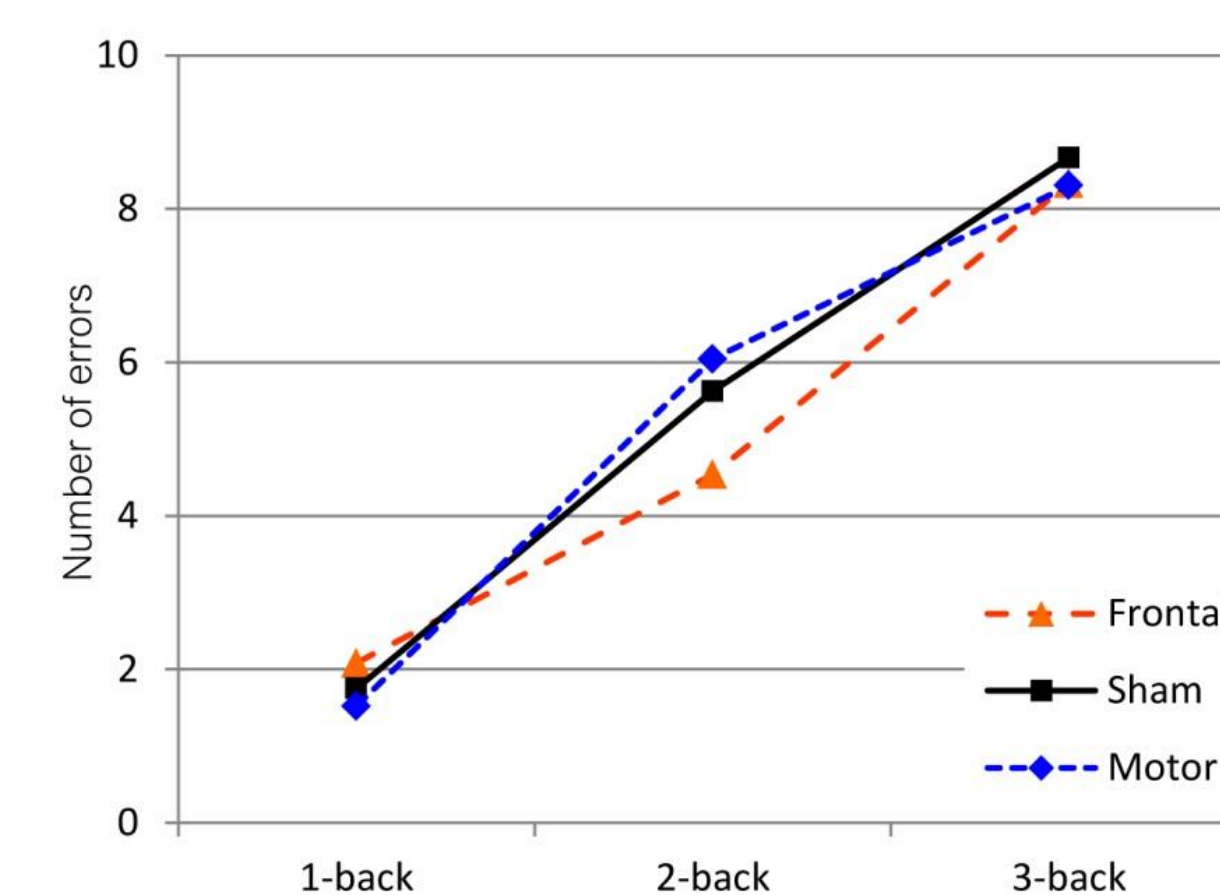
Results



Analysis: Multilevel mixed model with random effects of subjects and items.

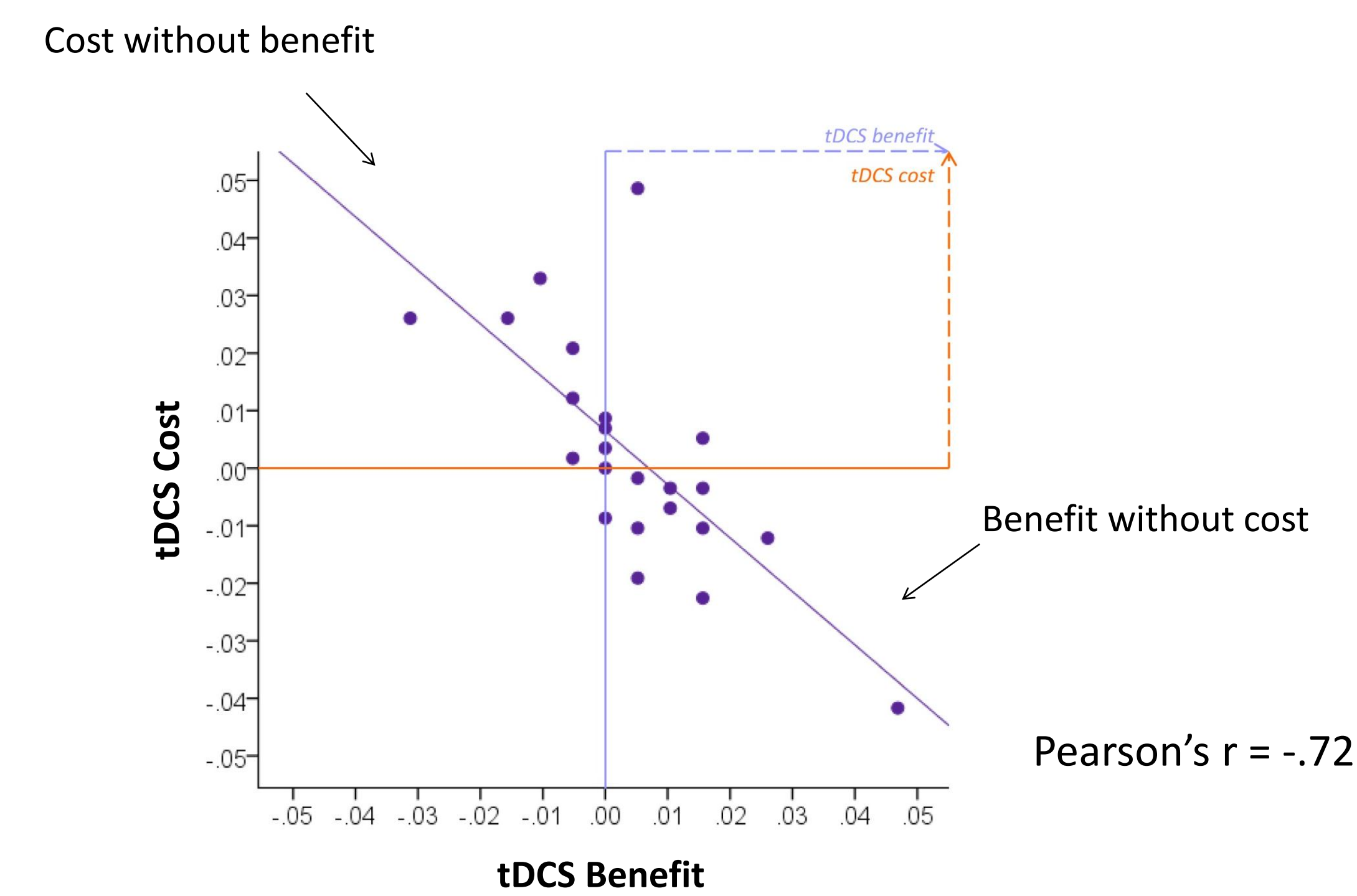
Critical interaction: Stimulation* Condition (Exp, Con)* WordType (Target, Nontarget)

- PFC vs. Sham: $z = 2.75$; $p = 0.01$
- PFC vs. M1: $z = 2.368$; $p = 0.018$ → This effect is site-specific.

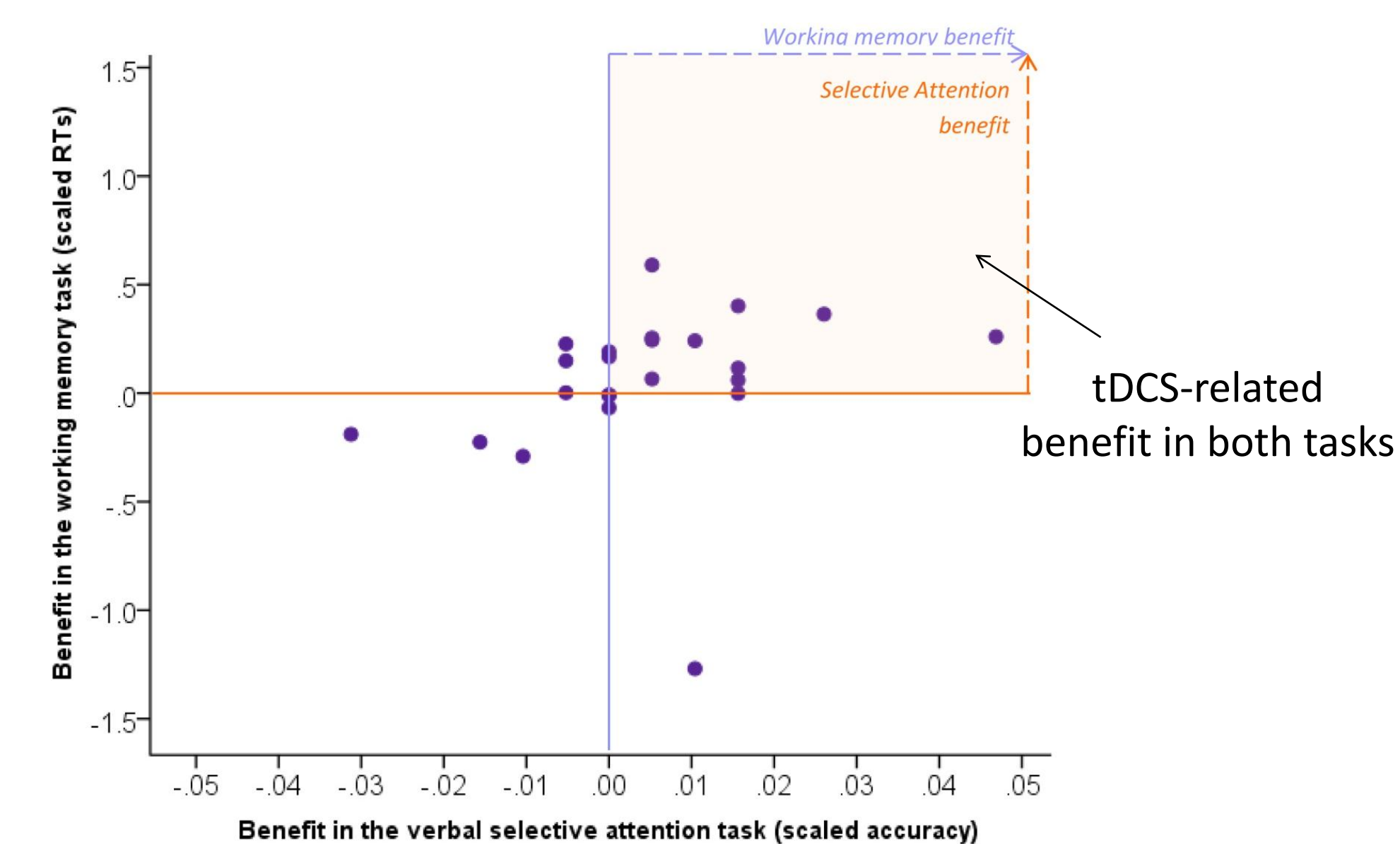


Critical interaction: Stimulation* N-back level

- PFC vs. Sham: $z = 2.03$; $p = 0.04$
- PFC vs. M1: $z = 2.05$; $p = 0.04$ → This effect is site-specific.



Also: benefit at baseline correlates negatively with cost at tDCS (Spearman's $\rho = -.49$, $p = 0.019$)



Summary

Group analysis:

- Anodal tDCS increased the benefit, but also the cost → Attentional focus was narrowed.

Analysis of individual differences:

- People who showed the benefit were UNLIKELY to show the cost. They were also people who started with better cognitive control.

- People who benefited from stimulation in one task, also benefited in the other task.

Conclusion

Answer 1-

Boosting the prefrontal cortex narrows the focus of attention. This manifests as cost or benefit depending on the person's attentional resources.

Answer 2-

Responsiveness to prefrontal stimulation is not task-specific.

References

1. Nozari N, & Dell GS, (2012) Feature migration in time: Reflection of selective attention on speech errors. *J Exp Psychol Learn Mem Cogn* 38(4): 1084-1090.
2. Wirth M, et al (2011) Effects of transcranial direct current stimulation (tDCS) on behaviour and electrophysiology of language production. *Neuropsychologia* 49: 3989-3998.

Acknowledgment

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