Spatial processing mediates the effect of electrical stimulation over posterior parietal cortex on visual short-term memory

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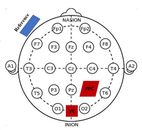
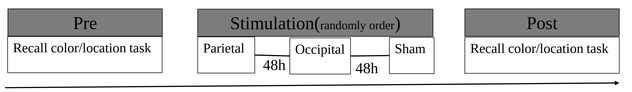
Introduction

- Posterior parietal cortex (PPC) is critical for information storage in visual short-term memory (VSTM), but the causality between PPC and VSTM is still controversy(Wang, 2019; Robinson, 2017).
- The functional role of PPC during spatial processing is well established (Xu, 2018). In this study, we focused on the question ***whether spatial processing mediates the function of PPC in VSTM.***

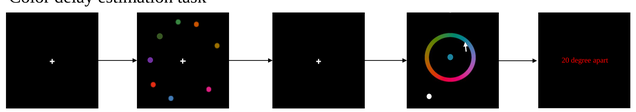
Methods

- **Task**: Before and after stimulation, subjects completed delay estimation tasks for colors and locations (block design). The set size was 6 or 8 (120 trial/set size).
- **tDCS Stimulation**: Each subject completed three transcranial direct current stimulation (tDCS) sessions: Posterior parietal cortex (P4, 2mA, 20min) , Occipital cortex(Oz, 2mA, 20min) and Sham (half on Oz, 2mA, 30s).
- **Subjects**: N=34(female =20). Subjects with poor memory performance (memory capacity <1) or memory performance beyond 3SD were excluded.

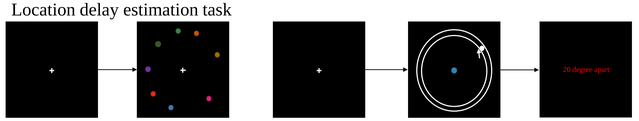




Color delay estimation task



Location delay estimation task

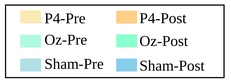


Fixation: 500ms Sample: 200ms Delay :1000ms Response<8000ms Feedback :500ms

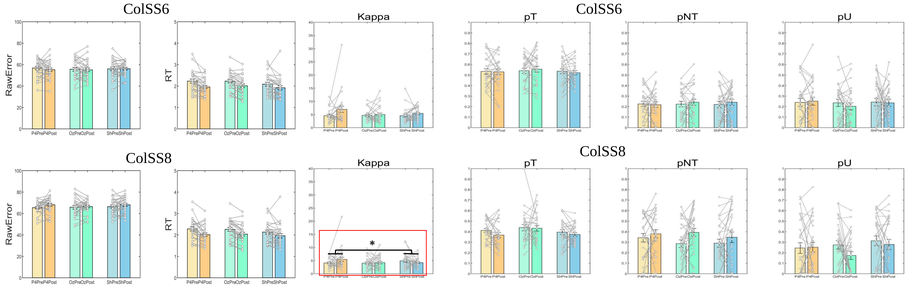
- **Model fitting:** Raw error distance between response and target were recorded. The error distribution was fitted by the 3-factor mixture model and we estimated the memory precision(kappa), the response probability for target (pT), nontarget (pNT), and random guessing(pU) separately, (Bays, 2009).

Results

Color delayed estimation task (N=27)

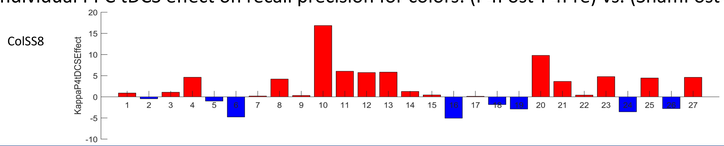


➢ Raw Error & RT ➢ 3-factor mixture model



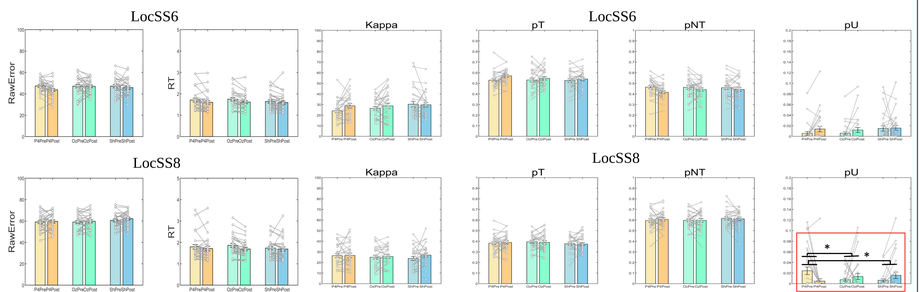
◆**PPC stimulation specifically increased the recall precision for colors in SS8 condition (*$p<0.05$).**

➢ The individual PPC tDCS effect on recall precision for colors: (P4Post-P4Pre) vs. (ShamPost-ShamPre)



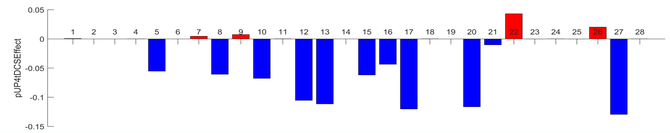
Location delayed estimation task (N=28)

➢ Raw Error & RT ➢ 3-factor mixture model

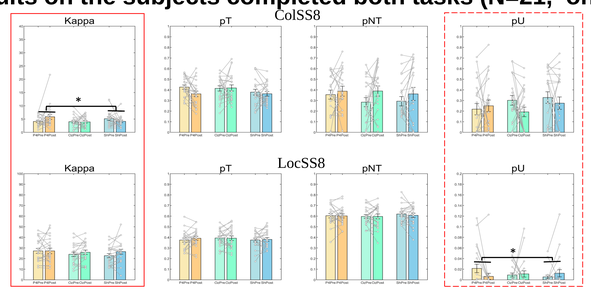


◆**PPC stimulation specifically decreased the guessing rate of recall location task in SS8 condition(*$p<0.05$)**

➢ The individual PPC tDCS effect on guessing rate for locations: (P4Post-P4Pre) vs. (ShamPost-ShamPre)

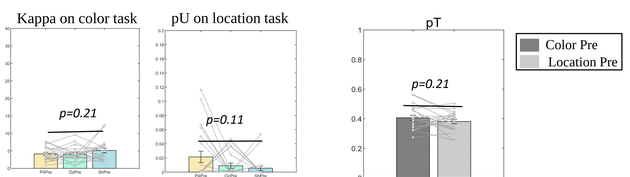


Results on the subjects completed both tasks (N=21, only for SS8 conditions)

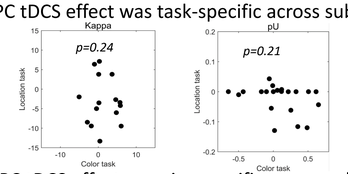


➢PPC effects were not caused by Pre-stimulation performance difference.

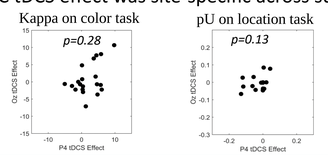
➢Task difficulty cannot explain the different tDCS effect(averaged across three sessions)



➢PPC tDCS effect was task-specific across subjects



➢PPC tDCS effect was site-specific across subjects



◆ **The interaction effect between task and stimulation were significant (solid red line: *$p<0.05$*, dash line: *$p=0.08$*)**

Conclusion

PPC stimulation improve color recall precision, while PPC decreased random guessing during location recall.

Our results suggested PPC plays a general casual role in VSTM, but its specific function is mediated by spatial processing.

More future neural imaging studies were needed to explore the underlying mechanism.

Reference

1. Wang, S., Ithipuripat, S., & Ku, Y. (2019). Electrical stimulation over human posterior parietal cortex selectively enhances the capacity of visual short-term memory. *Journal of Neuroscience*, *39*(3), 528-536.
2. Robison, M. K., McGuirk, W. P., & Unsworth, N. (2017). No evidence for enhancements to visual working memory with transcranial direct current stimulation to prefrontal or posterior parietal cortices. *Behavioral neuroscience*, *131*(4), 277.
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4. Bays PM, Catalao RFG & Husain M.(2009). The precision of visual working memory is set by allocation of a shared resource. *Journal of Vision* 9(10): 7, 1-11.

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