



Research Plan: Using Neuromodulation to Attenuate the Negative Impact of High Task Load on Memory

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Background

- Neuromodulation over left dorsolateral prefrontal cortex (dlPFC) can improve memory encoding (Javadi & Walsh, 2012) and performance in working memory tasks (Brunoni & Vanderhasselt, 2014)
- However, past research has yet to:
 - Compare the effectiveness of different stimulation protocols, e.g., direct current (DC) vs. alternating current (AC) stimulation (Abellaneda-Pérez et al., 2020)
 - Show consistent polarity effect in cognitive studies (Jacobson et al., 2012)
 - Examine the effect of stimulation during processing (vs. encoding) intervals

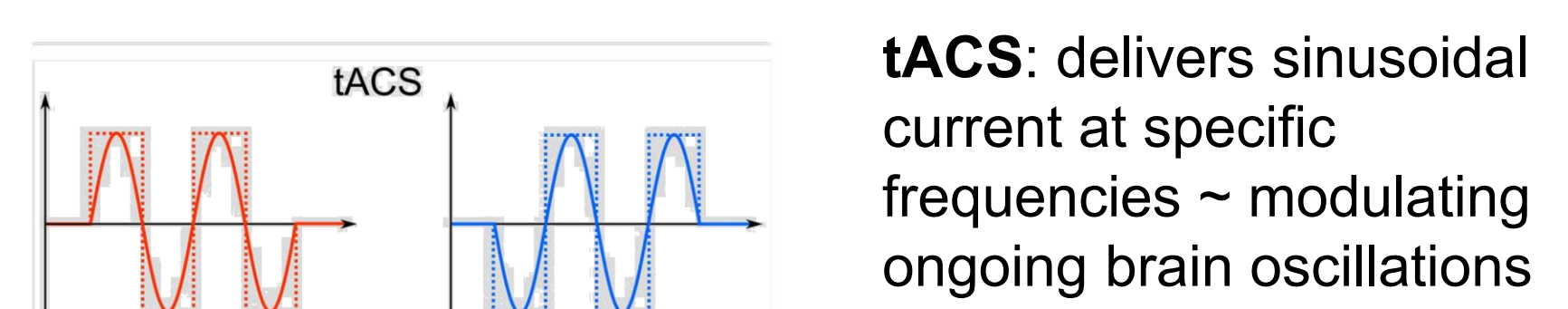
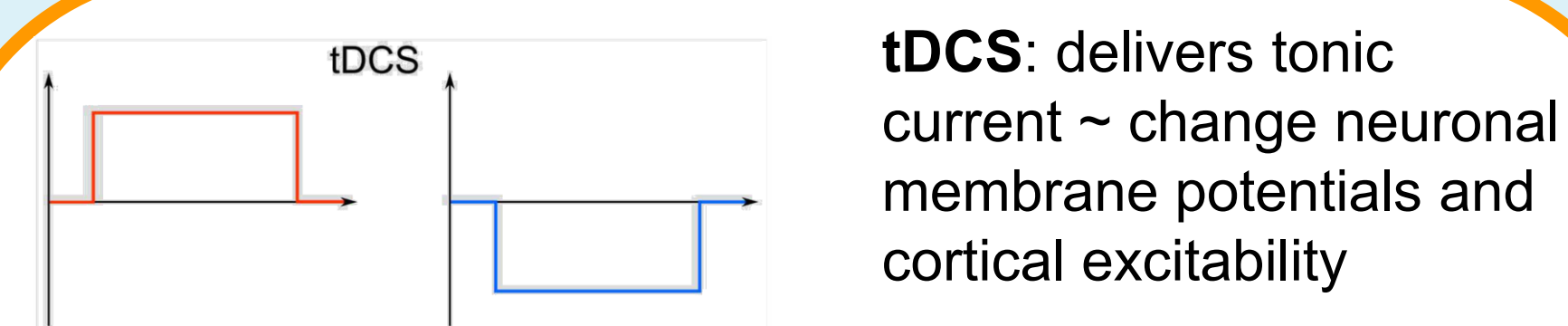
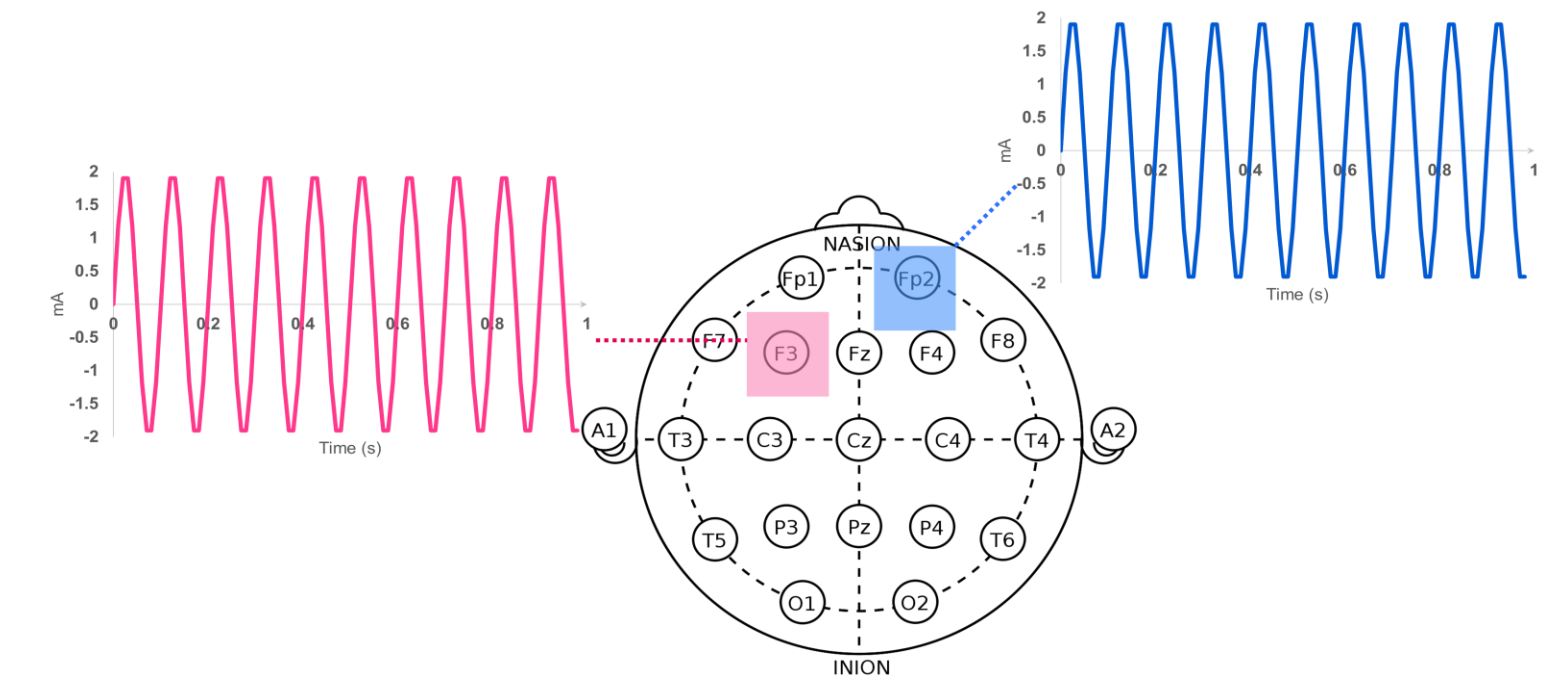


Figure reproduced from Herrmann et al. (2013) Fig. 1



Aims:

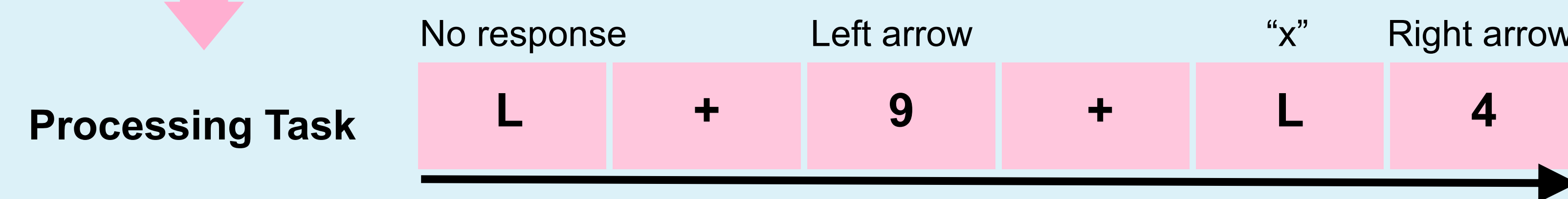
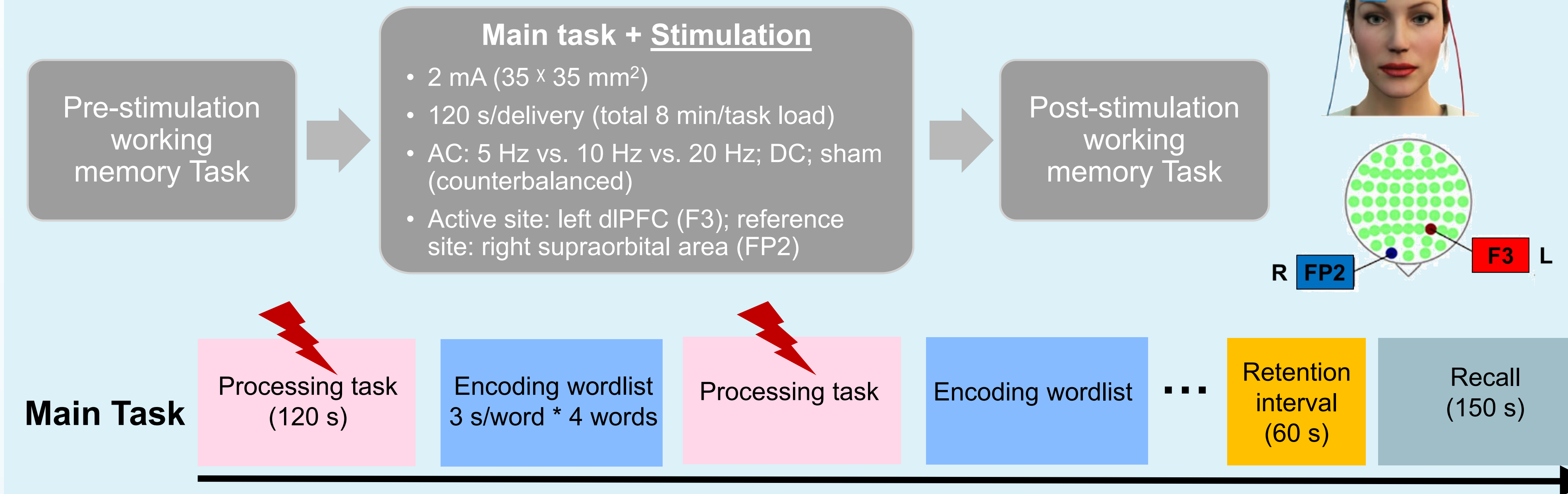
- Compare the effects of different stimulation protocols (AC, DC, Sham)
- Explore the effects of short, repeated pulses at processing intervals

References

- Abellaneda-Pérez et al. (2020). *Frontiers in Neuroscience*, 13:1440
 Borragán, et al. (2017). *Cortex*, 89, 71–84.
 Borragán, et al. (2016). *Frontiers in Human Neuroscience*, 10:86.
 Brunoni & Vanderhasselt (2014). *Brain and Cognition*, 86(1), 1–9.
 Herrmann, et al. (2013). *Frontiers in Human Neuroscience*, 7:279.
 Jacobson, et al. (2012). *Experimental Brain Research*, 216(1), 1–10.
 Javadi & Walsh (2012). *Brain Stimulation*, 5(3), 231–241.
 Scott et al. (2018). *Behavior Research Methods*, 51, 1–13.

Methods

Overview of Experimental Procedure



- Time Load Dual-back task** (Borragán et al., 2016, 2017)
 - Low load ~ Slow presentation (1.25 s / stimulus)
 - High load ~ Fast presentation (0.8 s / stimulus)

Working Memory Task



- A modified operation span
- Recall either pet names or answers to multiplication problems in order (condition randomised)
- Two versions used in alternation to prevent practice
 - v1: pets ~ 3 s, multiplication ~ 2 s; v2: pets ~ 2 s; multiplications ~ 3 s

Design

- Within-subjects; each stimulation session scheduled at least a week apart
- In each session:
 - Processing task interleaved with encoding wordlist (~ 4 repeats)
 - Words selected from normative database (Scott et al., 2018)

Discussion & Future Plans

Discussion

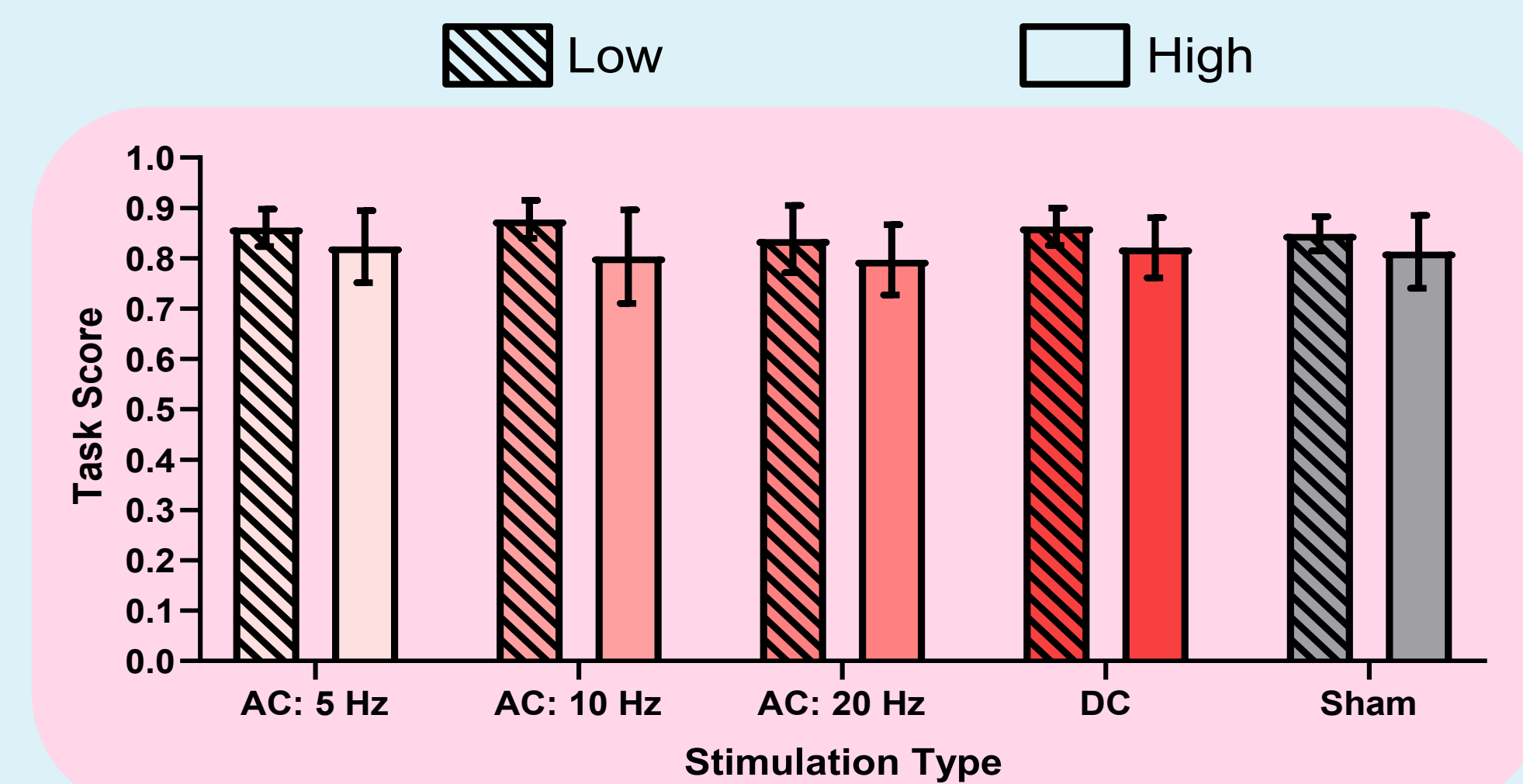
- Recall:** repeated short-pulse stimulation at 10 Hz may attenuate effect of high task load on memory
- Processing task:** AC Stimulation at higher frequency (10/20 Hz) influence subtasks differently; RTs slowing may be related to enhanced task monitoring

Future Plans

- Compare the effects of different stimulation types (AC: 10 Hz vs. DC), relative to sham, over dlPFC

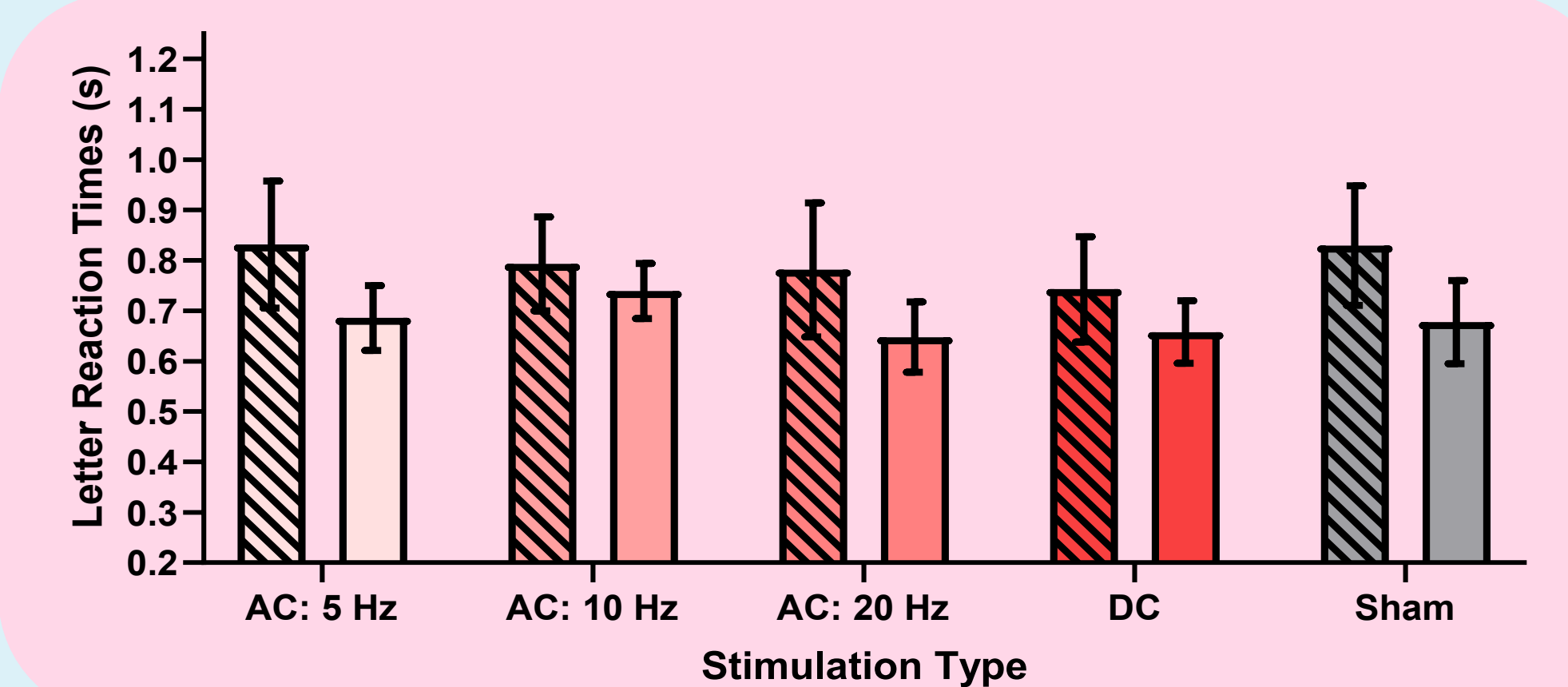
Pilot Results

Processing Task – Accuracy (65% Letter + 35% Number)

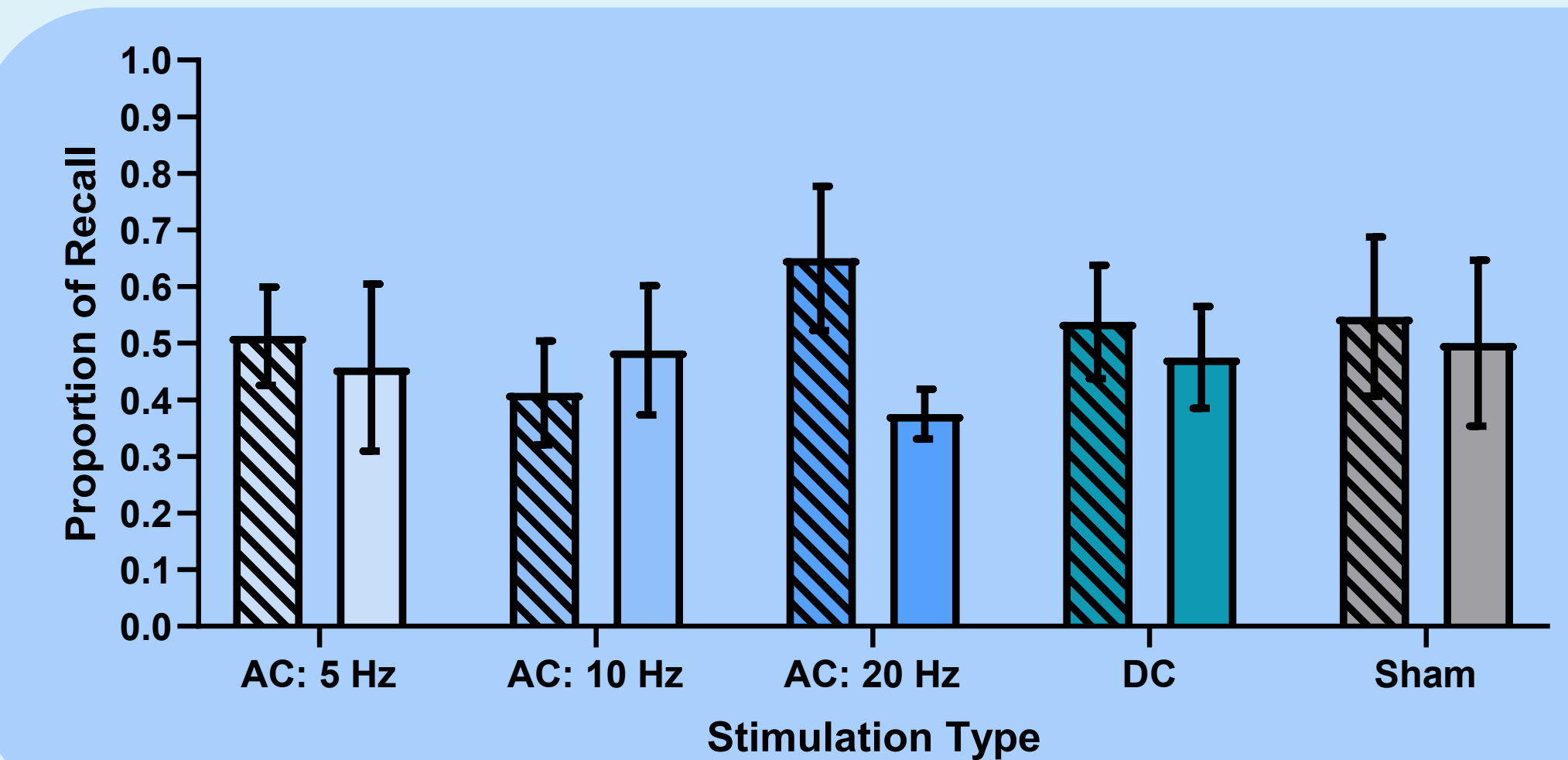


- Stimulation at 10 and 20 Hz slightly improved letter accuracy under low load, relative to sham
- Stimulation at 10 Hz slightly improved number accuracy under high load, relative to sham

Processing Task – Reaction Times



Recall



Working Memory Task

