Temporal Interference Affects Visual Field in Stimulus-Onset Asynchrony Task in Non-Human Primates

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INTRODUCTION

- Temporal interference stimulation (TIS) was developed to modulate neural circuits deep in the human brain noninvasively
- TIS leverages two "carrier" frequencies offset by a small frequency difference that produces a neuromodulatory "beat" pattern at the difference frequency [1].
- This beat field can be steered into specific regions by adjusting the relative intensities of the carrier fields.
- Learning how to utilize this technique with the right set of parameters is critical to the future of the field and its utilization in real world applications.

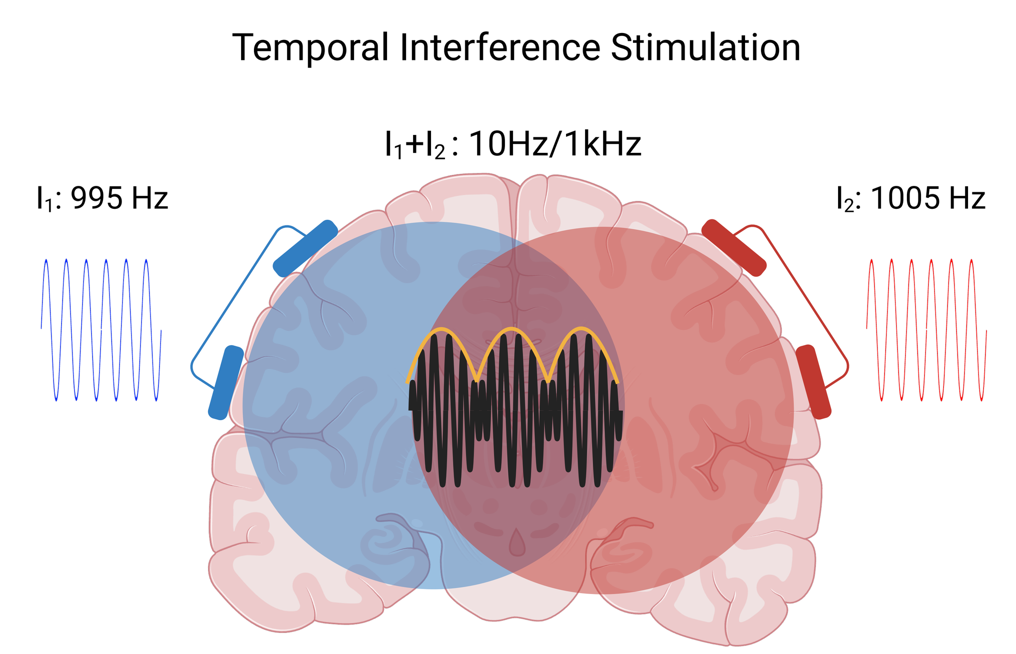
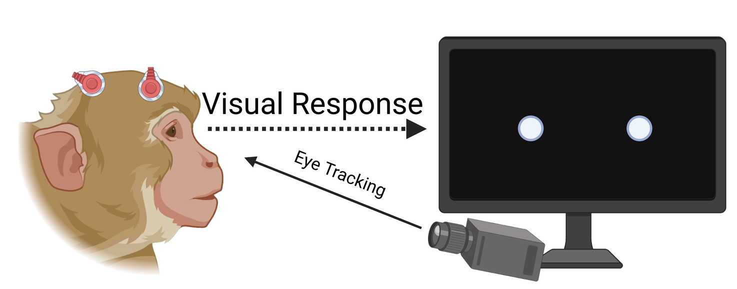


Figure 1: Two pairs of scalp electrodes (I_1 and I_2) apply high-frequency currents at a small frequency difference that generate oscillating electric fields within the brain. The resulting field is a signal of the carrier frequency with an envelope at the difference between the two inputs (I_1+I_2)

METHODS

Stimulus Onset Asynchrony (SOA) Task

- Eye-tracking of which dot appears first
- Stimulus is delivered
- Track visual bias and selection



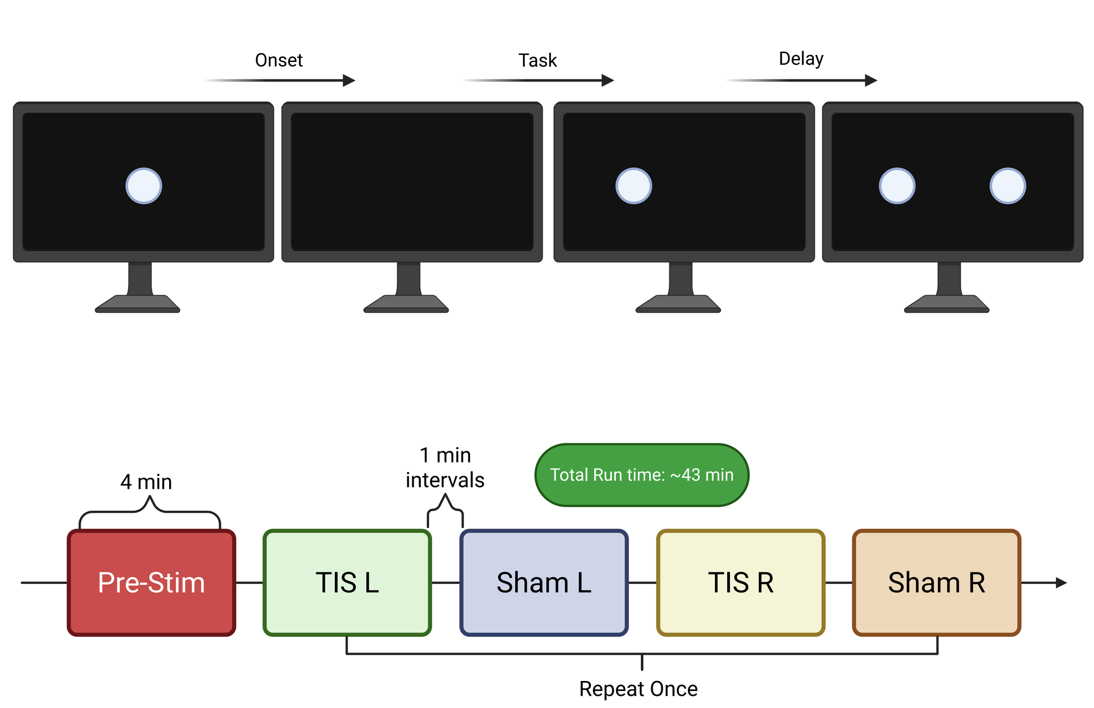


Figure 2: SOA task description. The block order is chosen randomly for a total of two periods for each parameter setting.

RESULTS

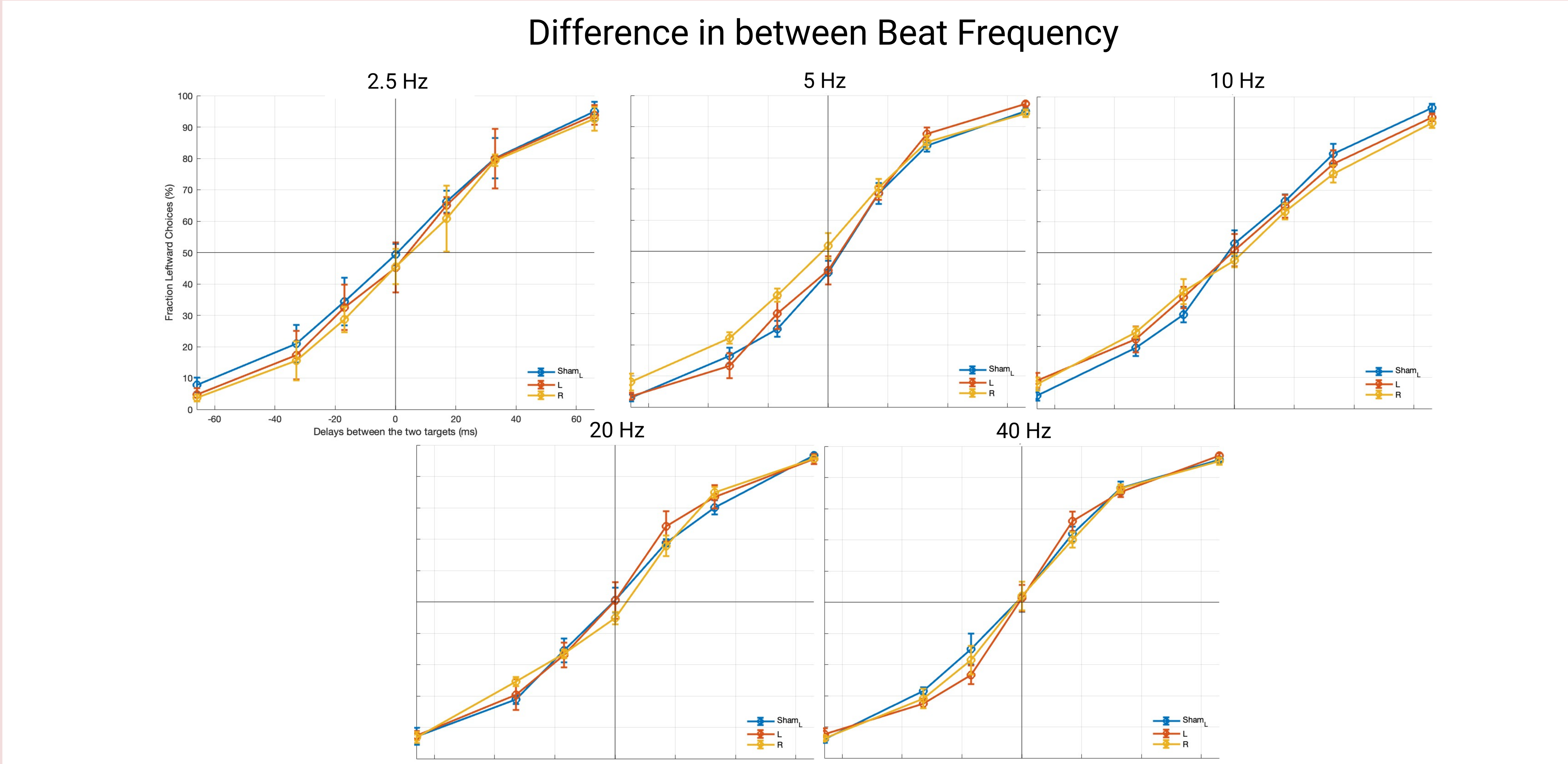


Figure 3: Beat Frequency sweep from 2.5 - 40 Hz at a 0.8 current ratio (1.75 vs 1.4 mA) in task for NHP. 5 Hz showed the biggest difference in left-right stimulation therefore indicating a possible effect needing further investigation.

Different Current Ratios impact Targeting

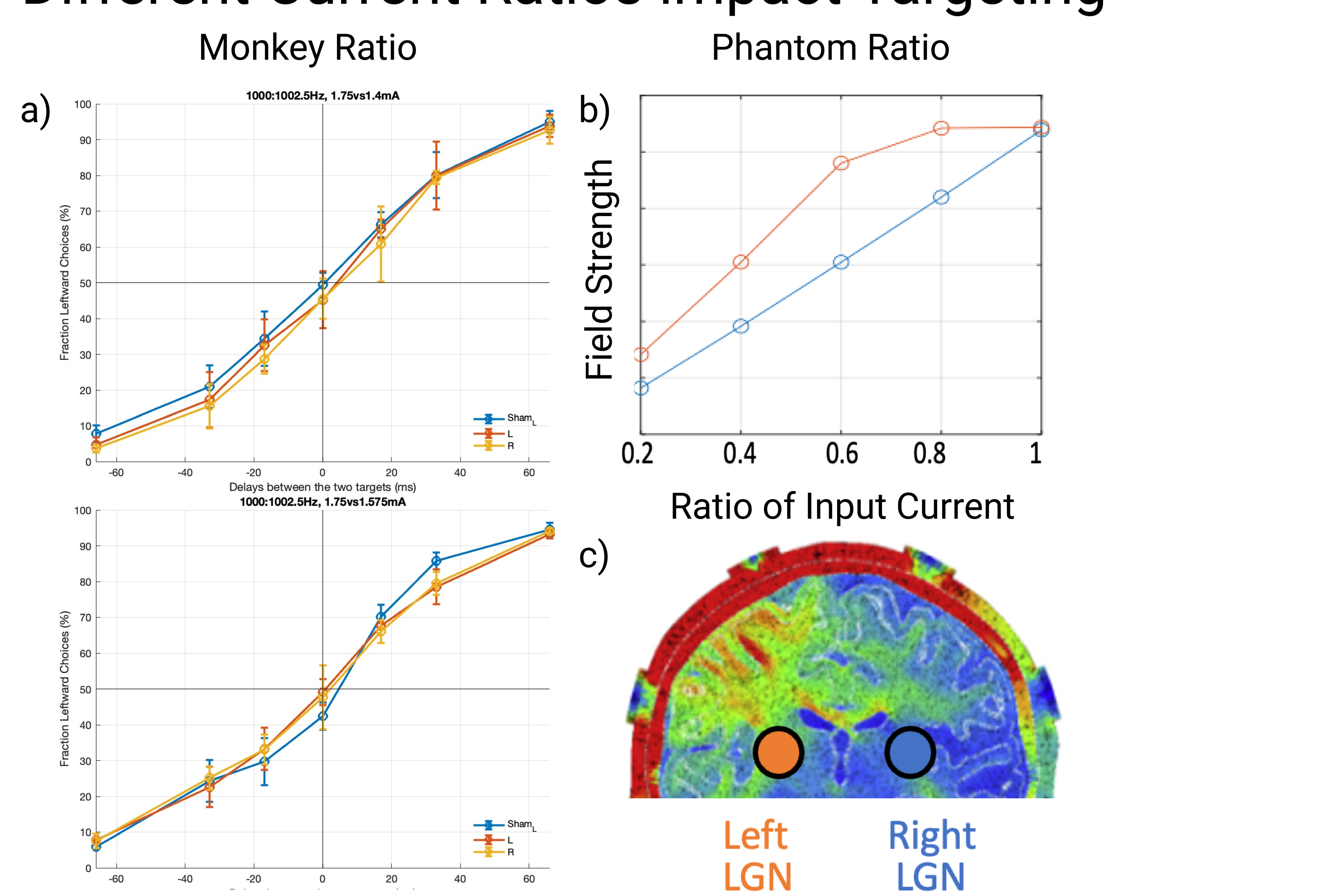


Figure 4: a) Example data of a 0.8 (top) and 0.9 (bottom) ratios in NHP data. b) Optimal ratio of currents, where 1is both are equal and 0.2 is 1:0.2, measured in agar phantom setup with skull where 0.6 offers highest difference in field strength. c) Visualization of a leftward bias in stimulation. Red and green hotspots indicated higher activation in the targeted area [2].

DISCUSSION

- This study employed a sigmoidal psychometric function to analyze leftward choice behavior
- Under ideal circumstances, a 0 ms delay would be expected to yield a 50% success rate, reflecting chance-level performance.
- Left and right-sham are where the frequency of the two signals have no difference ie 1000:1000 Hz
- Small effects in very deep brain regions can occur from superficial electrodes and can be significant towards understanding TI's behavior
- The psychometric curves for 2.5 Hz stimulation exhibited no significant differences in slope or accuracy.
- At certain frequencies (5 Hz and 10 Hz), preliminary evidence suggests that the sigmoidal function flattened compared to both sham and pre-trial conditions.
- This observation suggests that TIS may impair NHPs' visual perception and/or disrupt their ability to perform the task effectively.

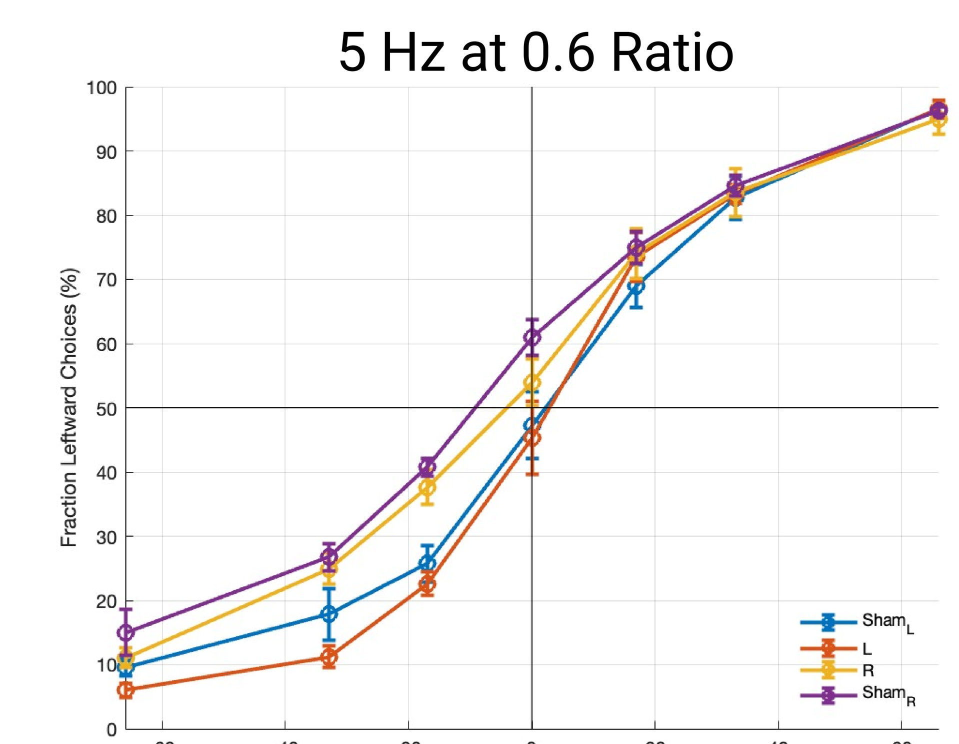


Figure 5: Trials of two optimal parameters (0.6 ratio with 5 Hz) show possible effect and require further investigation.

- To further elucidate the effects of TIS on targeted neural regions, additional investigations are warranted
- Amplitude modulation studies, exploration of different frequency parameters and exploring the effects of AC are future focus points.
- Such research would provide a more comprehensive understanding of TIS-induced behavioral and perceptual modifications.

ACKNOWLEDGEMENTS

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[2] S. Rampersad *et al.*, "Prospects for transcranial temporal interference stimulation in humans: A computational study," *NeuroImage*, vol. 202, p. 116124, Nov. 2019, doi: 10.1016/j.neuroimage.2019.116124.