The Effects of Behavioral Preference and Transcranial Magnetic Stimulation on Episodic Memory

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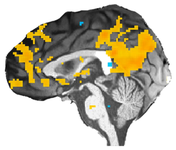
Introduction

- The hippocampus is an important brain region that plays an **extensive role in memory** and imagination[1].



- Studies have tried to understand how exactly memory retrieval works, and how temporal context (or the state of the brain) affects it. Studies have found that when an individual attempts to remember something, their brain is brought back to the same temporal context of when they first created the memory[2].

- Researchers have been attempting to manipulate the hippocampus/memory processes and have found that **non-invasive stimulation using transcranial magnetic stimulation (TMS) can improve the function of the hippocampus**[4].

- As the use of TMS became broadened, other studies found conclusive evidence that the stimulation had a **short-term improvement on episodic and associative memory**[3,5].

- Work done prior in our lab, has shown that the posterior hippocampus (associated with detail memory) is better stimulated by fast TMS, when compared to the anterior hippocampus (gist memory) which is better stimulated by slow TMS

Research Question:

How does the use of TMS and behavioral variables affect an individual's ability to remember visual scenes?

Hypothesis:

Individuals will have the greatest memory of a visual scene that they both enjoyed and were stimulated for

Methods

A **concurrent TMS/fMRI task** was performed by young, healthy participants (N=9), where they were shown outdoor scenes, asked to create a vivid mental image, and then had to mark whether they wanted to **visit or skip**

While viewing these scenes in the scanner, the participants received 10 bursts of theta burst TMS before the viewing each scene.

- **39 trials w/ 2.2-Hz TBS**
- **39 trials w/ no stimulation**
- **39 trials w/ 6.5-Hz stimulation**

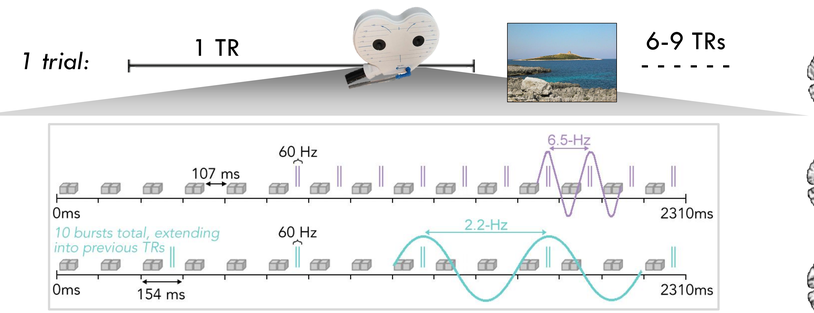
Study Timeline

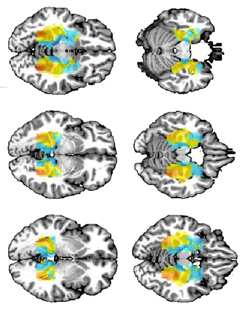
This stimulation occurred in a unique placement for **each participant**

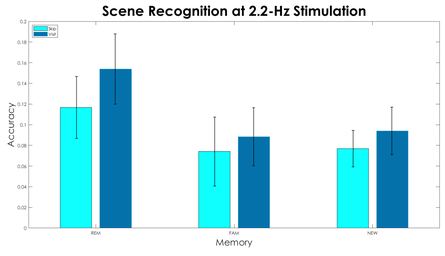
A baseline fMRI was used to identify both the **Hippocampal target** for the 2.2Hz and 6.5Hz stim

Interleaved TMS-fMRI

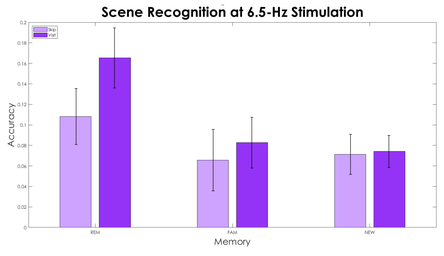
Each trial w/ stim included 10 bursts of 60-Hz stimulation - this occurred either every 2.2-Hz (slow) or every 6.5-Hz (fast). This stimulation was interleaved with the acquisition of an MRI slice (protocol below)



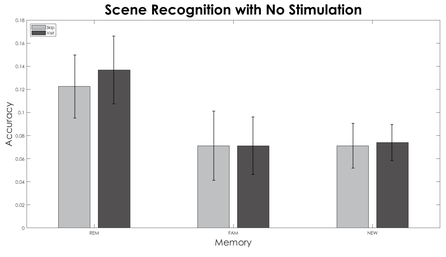


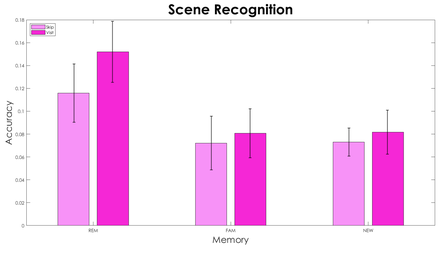


- 74% hit rate w/ 2.2-Hz stimulation



- 71% hit rate w/ 6.5-Hz stimulation





Conclusions

- Our work is adding to the literature on TMS, as well behavioral preferences – showing that in certain conditions (6.5Hz stimulation) that **enjoyment can improve memory**
- We also continued to grow our understanding of fast vs. slow TMS, with **detail memory being improved by the fast TMS**, which is consistent with the literature
- Continually, while our work did provide significant results, we did have **a low sample size**, which is a limiting factor
- Understanding this connection on a broader scale has **medical implications, specifically regarding memory loss conditions**, like Alzheimer's

Future Directions

- Creating treatment plans that implement tasks the patient finds enjoyable could help **slow the neurodegeneration** they are facing
- In the future, running an altered version of the task with more participants could **help strengthen the correlation** we are finding
- Furthermore, conducting future studies with 6.5Hz TMS, with a **closer focus on the boundaries of enjoyment**, might be able to further the correlations we have began
- Creating systematic techniques to both define enjoyment and utilize it in memory retention is a long-term goal of this research

Results

We calculated a **paired t-test** (grouped and by stimulation type) to compare scene recognition among photos individuals chose to "visit" and photos individuals chose to "skip"

There is a **significant difference** in full scene recognition when stimulated individuals (6.5Hz) chose to visit (M = .1652, SD = .0293) versus chose to skip (M = .1083, SD = .0273); t(8) = 2.8571, p = .0212.

- 74% hit rate w/ no stimulation
- 74% hit rate among all trials

References

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4. Thakral, P.P., et al. (2020). *Proceedings of the National Academy of Sciences*

5. Wang, J. X., et al. (2014). *Science*