Effect of Transcranial Magnetic Stimulation on the Hippocampus Shown in Delayed-Nonmatch-to-Sample Performance

Rita Mei, Wenxuan Jiang, Dong Song Ph.D.

USC Neural Modeling and Interface Lab, Dept of Biomedical Engineering, Bridge Institute, University of Southern California, Los Angeles, CA , USA

Bridge UnderGrad Science (BUGS) ***Summer Research Program***

USC University of Southern California

Abstract

Brain damage can come from injuries or diseases. It can be devastating from people as it inhibits the ability to function correctly like speech or mobility impairment. Brain injury in younger people can be repaired through other parts of the brain making up for damaged tissue. However, destroyed or damaged brain cells will not regenerate. Therefore, people can never truly heal from injuring the brain

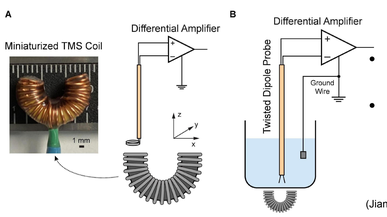
Transcranial magnetic stimulation is a way to improve the functions of the brain and might help people with damage to the brain. It will stimulate a part of the brain noninvasively and increase activity in that part.

Objectives

- Determine the potential benefits this may have on treating cognitive disorders or injuries

Method

Miniature TMS coil for rodents



- 5mm out diameter with a C-shaped iron powder core.
- Copper wires coated with silicone were wound around the core 30 times

(Jiang et al., 2022)

- The magnetic field of the coil was measured using a two-loop search coil.

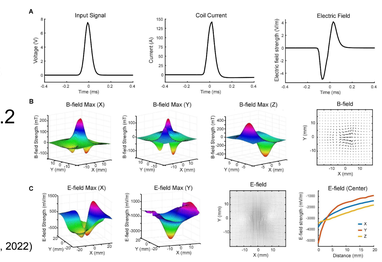
$$B_x = -\frac{1}{Nr^2\pi}\int V_x \cdot dt, B_y = -\frac{1}{Nr^2\pi}\int V_y \cdot dt, B_z = -\frac{1}{Nr^2\pi}\int V_z \cdot dt$$

- The induced electric field was measured using a dipole probe in saline

$$E_x = -\frac{\triangle V}{\triangle x}, E_y = -\frac{\triangle V}{\triangle y}, E_z = -\frac{\triangle V}{\triangle z}$$

(Jiang et al., 2022)

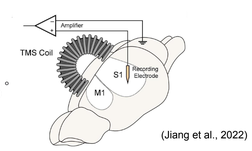
- Maximum magnetic field was 473 mT in the air
- Maximum electric field was 5.2 V/m at 3.5 mm in saline
- Electric field decays with distance along the z-axis



(Jiang et al., 2022)

Treatment

- Alternated TMS or Sham treatment between Rats: TMS1 and TMS2
- TMS coil placed parallel to midline tilted at 15°
- 1mm above the skull
- 5 minutes at 10 Hz

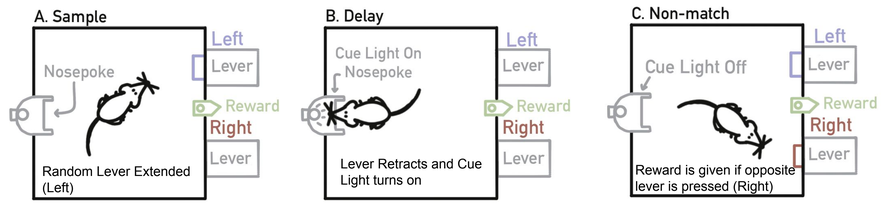


(Jiang et al., 2022)

Delayed Nonmatch to Sample Task Training Protocol

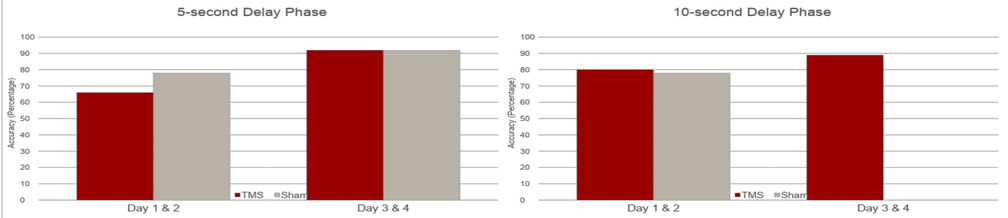
- 9 steps, 3 phases
- **Step 7 and 8**: introduction and shaping of nonmatch contingency. Punishment was added in step 8.
- **Step 9**: nose poke was integrated with natural delay to the touch bar nonmatch sample.
- **Step 10**: variable delays were added. It would be set to less than or equal to a certain variable. The rat would advance to next delay after 90% accuracy

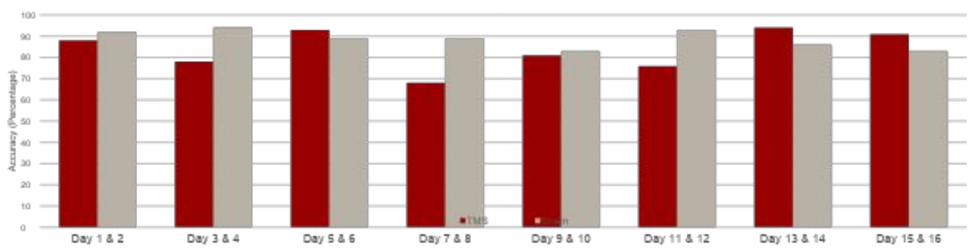
(Pace, 2022)



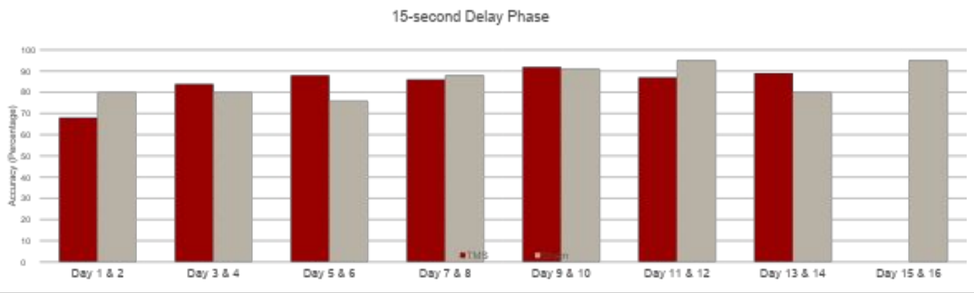
Results

TMS1 Performance



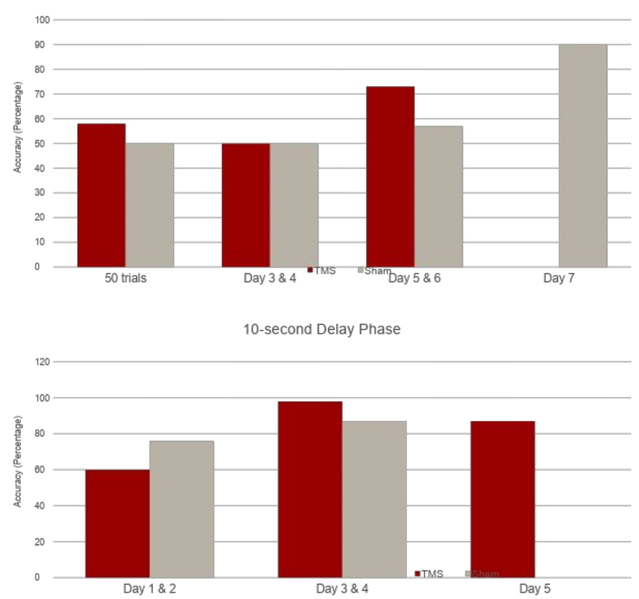


TMS2 Performance



Results

TMS2 Performance



- During each phase, the number of trials is increased from 25 to 50 to 100 trials after high accuracy is achieved for both TMS and Sham treatments
- Each rat moves on to the next phase after an accuracy of 90% or higher is achieved with 100 trials for both TMS and Sham treatments

Summary

From this experiment, there seems to be no correlation between TMS and the accuracy of the rats. For each phase, there have been similar results for both TMS and Sham treatments. At times, the rat that received Sham treatment seemed to do better than the one that received TMS treatment and vice versa.

Although this may indicate that TMS has no significant affects on the learning and cognitive functions of the rats immediately, there might be long term effects that improve the ability to learn. Further experiments will have to be performed.

CONTACT US

bridge.usc.edu/bugs