Testing network distinctions between face processing and memory

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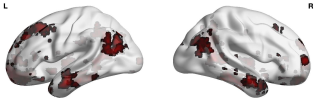
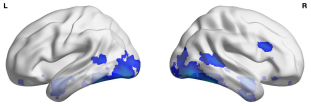
Introduction

- Episodic memory refers to the encoding (forming), consolidation (storing), & retrieval of details and experiences that are encountered in daily life, including associations between time, context, people, & emotions.
- These episodic memory processes rely on the Hippocampal-Cortical Network, a distributed set of brain regions that interact with the hippocampus. [1]



- The perceptual processing of faces is supported by another distributed network of brain regions., the Face-Processing Network.[2]



- These two networks have overlapping regions in the medial temporal lobe, including hippocampus, perirhinal, and anterior temporal lobe.
- The extent to how these two networks remain distinct are unknown.

RESEARCH QUESTION

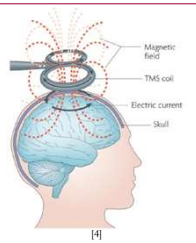
How distinct are the hippocampal cortical network and face processing network from each other during face perception and episodic memory formation?

HYPOTHESES

I. Pre-perceptual stimulation of the STS will modulate face-perceptual judgements but will not affect house-perceptual judgements.
II. Pre-perceptual stimulation of the HCN will have no affect on perceptual judgements.
III. Pre-encoding stimulation of the STS will not affect memory.
IV. Pre-encoding stimulation of the HCN will result improve memory formation for both face and house narratives.

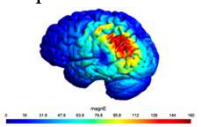
Brain Stimulation

- Transcranial Magnetic Stimulation (TMS) is a noninvasive brain stimulation method that modulates targeted brain networks. [3]
- We will deliver TMS to cortical nodes of the Hippocampal-Cortical Network (left parietal cortex) and to the Face-Processing Network (right posterior superior temporal sulcus) to affect network activity during memory formation and face perceptual processing, respectively.
- Cortical targets will be determined individually for each subject based on hippocampal-connectivity to left parietal cortex (HCN target) and peak task-evoked activity for faces (rSTS target)

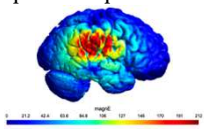


[4]

Hippocampal Cortical Network (HCN)



Right Superior Temporal Sulcus (rSTS)



- Previous work has shown that 2-sec volleys of theta-burst (TBS) patterned TMS delivered to the HCN immediately before stimulus encoding significantly improved later memory performance. [5]

Task Design

- Participants (N=30) from previous MRI study (use their scans for MRI-guided TMS navigation and target identification) will complete a two-day experimental design.
- **During Day 1**, subjects will complete a task where they perform perceptual judgements and learn a stimuli-narrative associates. Stimuli will consist of faces (90 total) and houses (90 total), presented in interleaved randomized order.

Example Face Trial:

Example House Trial:

- 2-sec theta-burst volleys will be delivered pre-perception for 1/3 trials, pre-encoding for 1/3 trials, or not at all for the remaining 1/3 trials.
- For the first half of the session, the stimulation coil will be placed at one location (i.e., HCN or STS), and then moved to other location for the second half.

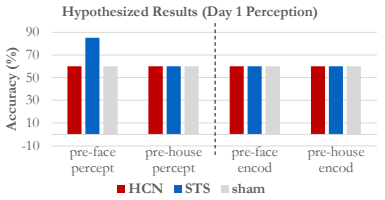
STS		HCN	
1/3 receive TMS before perceptual phase	30 trials	1/3 receive TMS before perceptual phase	30 trials
1/3 receive TMS before encoding phase	30 trials	1/3 receive TMS before encoding phase	30 trials
1/3 receive no TMS	30 trials	1/3 receive no TMS	30 trials

- **During Day 2**, subjects will be tested on their old/new recognition for old faces/houses and lures (Remember, Familiar, New response). For stimuli endorsed with a Remember or Familiar response, subjects will be asked to recall the associated name and quirk.

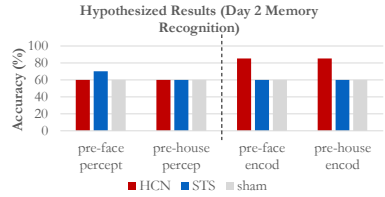
Example Task:

Expected Results

- We anticipate that results will support our hypotheses stating that the rSTS stimulation will specifically modulate facial perception processing , whereas HCN stimulation will enhance memory, supporting the idea that the two systems are distinct.
- Pre-perception rSTS stimulation will specifically modulate the perceptual judgement accuracy (measured during Day 1) for face trials.



- Pre-encoding HCN stimulation will enhance later memory performance (measured during Day 2) for both face and house stimuli.



Future Directions

- We will incorporate eye-tracking into the experiments to connect viewing behavior with perceptual and memory performance.
- This experiment will be performed with older adults to better understand how distinct brain with overlapping regions change over time; findings may be able to inform diagnoses and treatments of dementia and/or Alzheimer's disease.

References: 1. Buckner RL, Andrews-Hanna JR, Schacter DL. (2008) The brain's default network: anatomy, function, and relevance to disease. *Ann N Y Acad Sa.; 1124:1-38.* **2.** Pitcher D, Walsh V, Duchaine B. (2011) The role of the occipital face area in the cortical face perception network. *Exp Brain Res, 209(4), 481–493.* **3.** Rossi S, Hallett M, Rossini PM, Pascual-Leone A, & Safety of TMS Consensus Group (2009) Safety, ethical considerations, and application guidelines for the use of transcranial magnetic stimulation in clinical practice and research. *Clinical Neurophysiology 120(12), 2008–2039.* **4.** Ridding MC, Rothwell JC (2007) Is there a future for therapeutic use of transcranial magnetic stimulation? *Nature Reviews Neuroscience, 8(7), 559–567.* **5.** Hermiller MS. Chen YF, Parrish TB, Voss JL (2020) Evidence for Immediate Enhancement of Hippocampal Memory Encoding by Network-Targeted Theta-Burst Stimulation during Concurrent fMRI. *J of Neuroscience 40(37), 7155–7168.*