

# Enhanced neural reinstatement and memory for naturalistic episodes following hippocampal-targeted noninvasive stimulation



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## Background

- Episodic memory depends on a widespread network of regions including the hippocampus and posterior parietal lobe
- Transcranial magnetic stimulation (TMS) of lateral parietal regions with high functional connectivity to hippocampus can alter episodic memory and its neural correlates<sup>1</sup>
  - Stimulation-induced improvements reported in paired-associates, word-list, and spatial precision tests of episodic memory<sup>2,3,4</sup>
  - Associated improvements in resting state functional connectivity
- It is currently unclear whether the effects of hippocampal-targeted stimulation generalize to more naturalistic forms of episodic memory, which involve distinct neural mechanisms<sup>5</sup>
  - Parietal stimulation has been shown to alter autobiographical memory<sup>6,7</sup>, but findings are inconsistent perhaps due to lack of experimental control over such memories
- Effects of stimulation on memory-related neural activity are also unclear
  - Neural reinstatement is thought to underlie episodic memory

## Present Study

The current study investigated the effects of hippocampal-targeted parietal stimulation on memory for naturalistic video-clip episodes.

- Does hippocampal-targeted stimulation affect memory for naturalistic, complex events?
- What are the effects of hippocampal network-targeted stimulation on large-scale, multivariate memory-related neural activity?

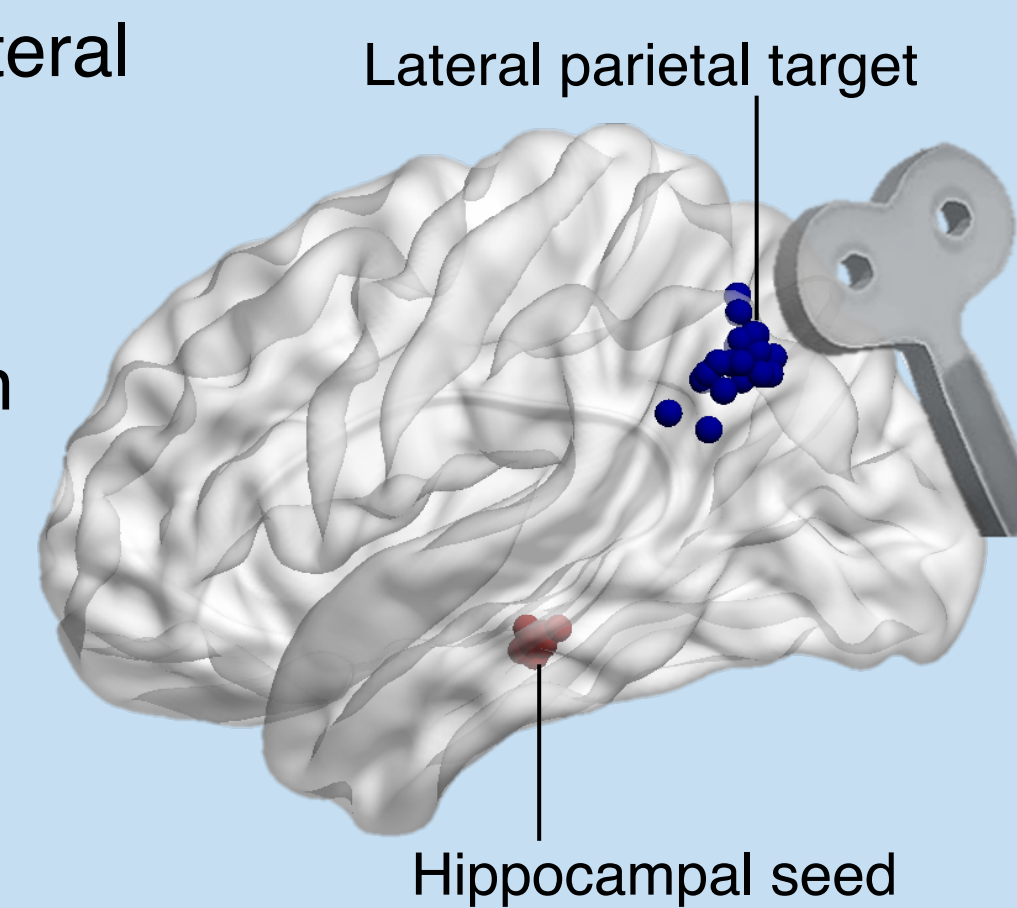
## Methods

### Study design

- 40s of TMS immediately followed by 45 min episodic memory task with fMRI (n=20)

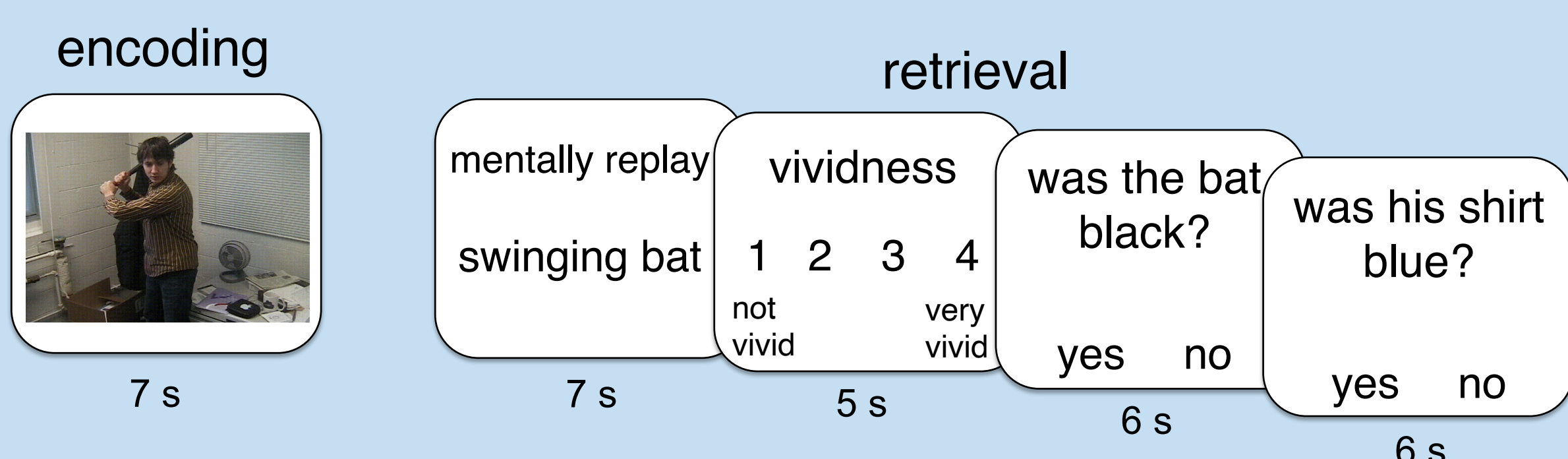
### TMS methods

- Active stimulation:** subject-specific lateral parietal target with high functional connectivity to hippocampus
- Control stimulation:** vertex stimulation (low connectivity to hippocampus)
- Continuous theta burst stimulation (cTBS) – bursts of 3 50 Hz pulses delivered at 5 Hz

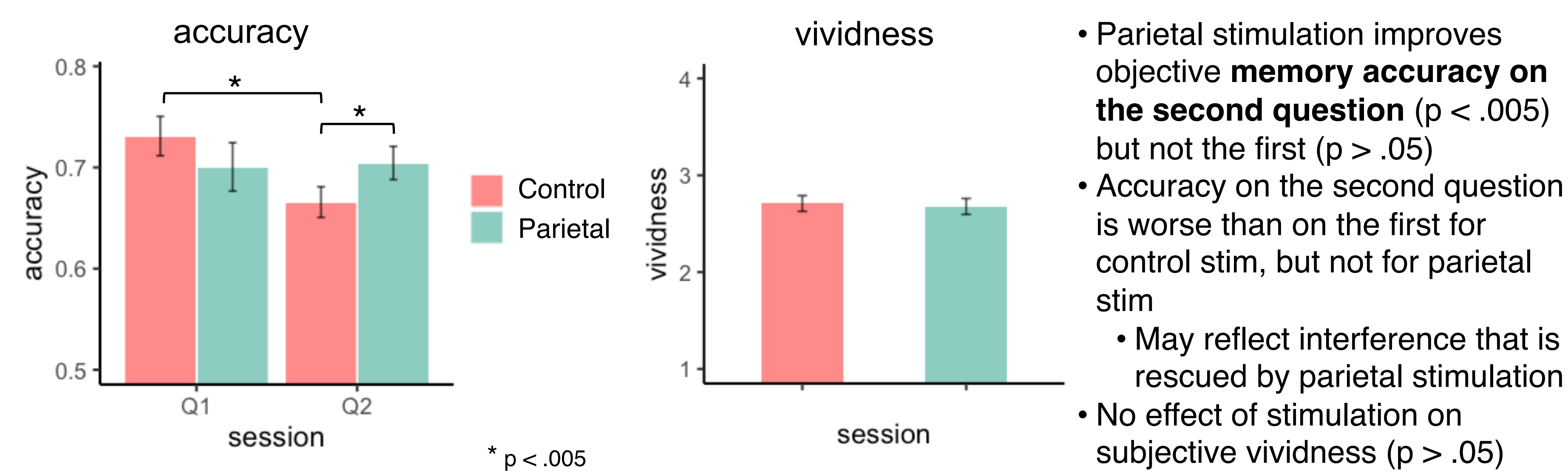


### Episodic memory task

- Encoding: 50 short videos depicting everyday events per session
  - High overlap between characters and locations in videos
- Retrieval: subjective and objective memory measures



## Behavioral Results

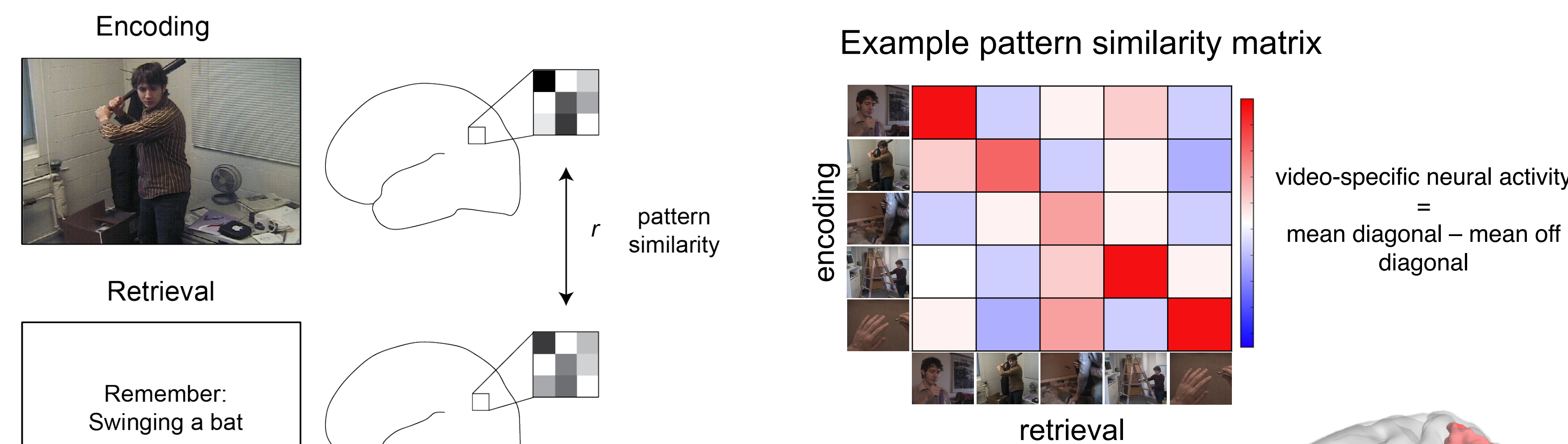


- Parietal stimulation improves objective **memory accuracy on the second question** ( $p < .005$ ) but not the first ( $p > .05$ )
- Accuracy on the second question is worse than on the first for control stim, but not for parietal stim
  - May reflect interference that is rescued by parietal stimulation
- No effect of stimulation on subjective vividness ( $p > .05$ )

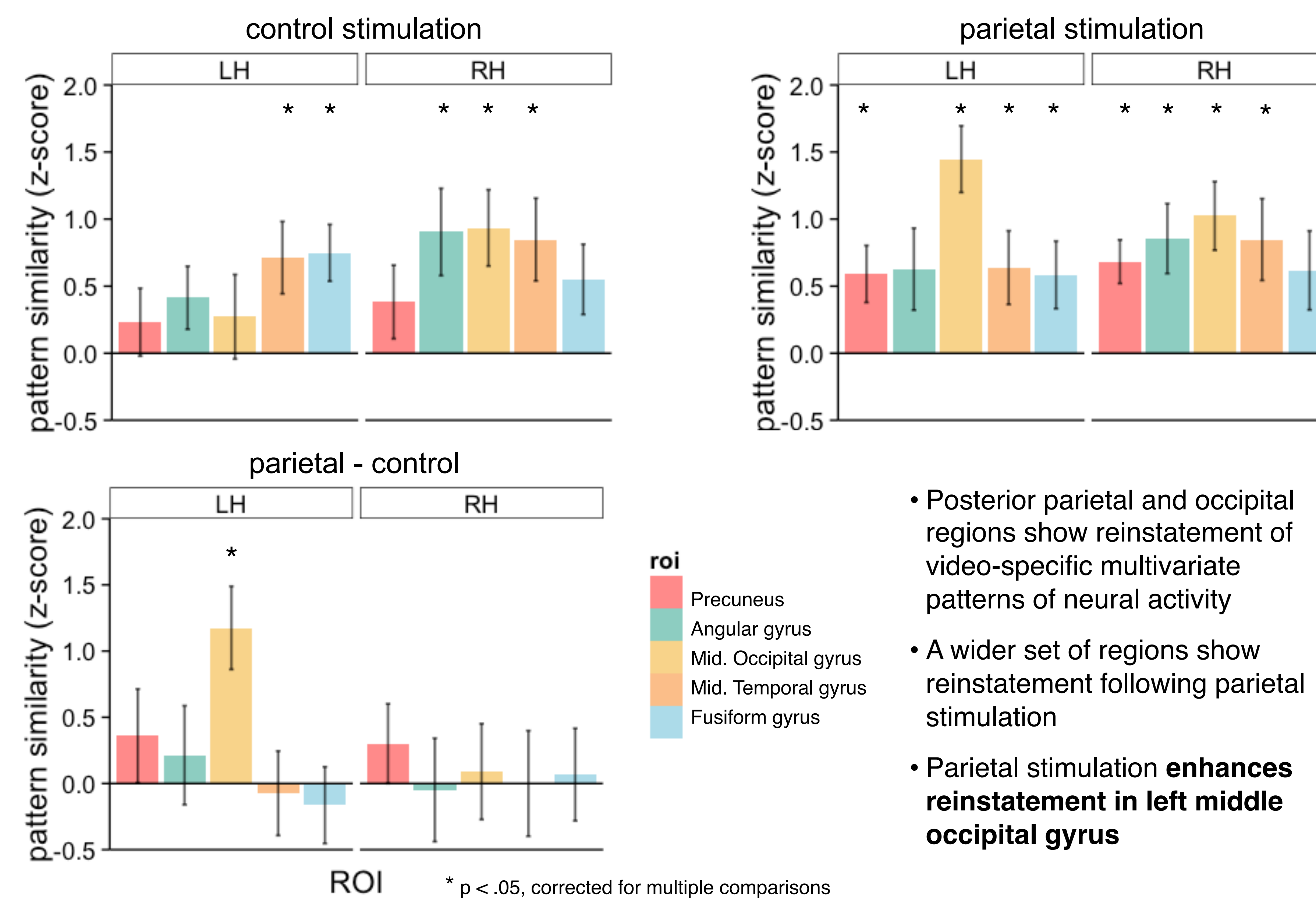
## Neural Reinstatement

### Pattern similarity analysis

- We examined encoding-retrieval similarity between videos to assess reinstatement of memories



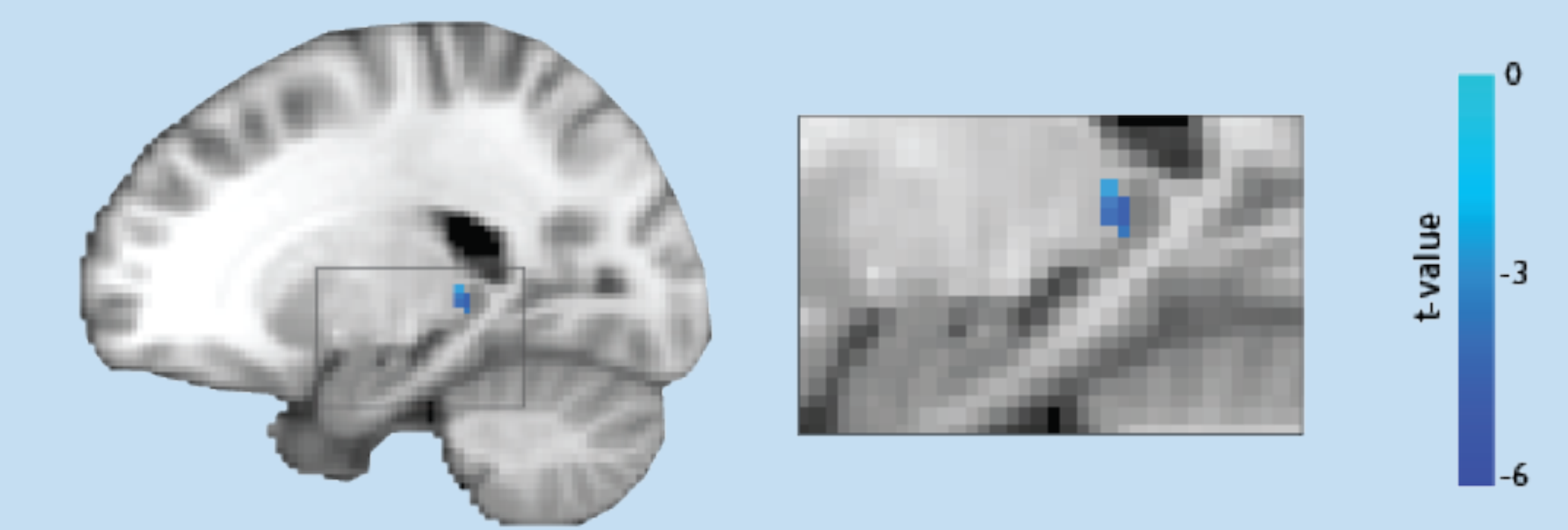
### Pattern similarity results



- Posterior parietal and occipital regions show reinstatement of video-specific multivariate patterns of neural activity
- A wider set of regions show reinstatement following parietal stimulation
- Parietal stimulation **enhances reinstatement in left middle occipital gyrus**

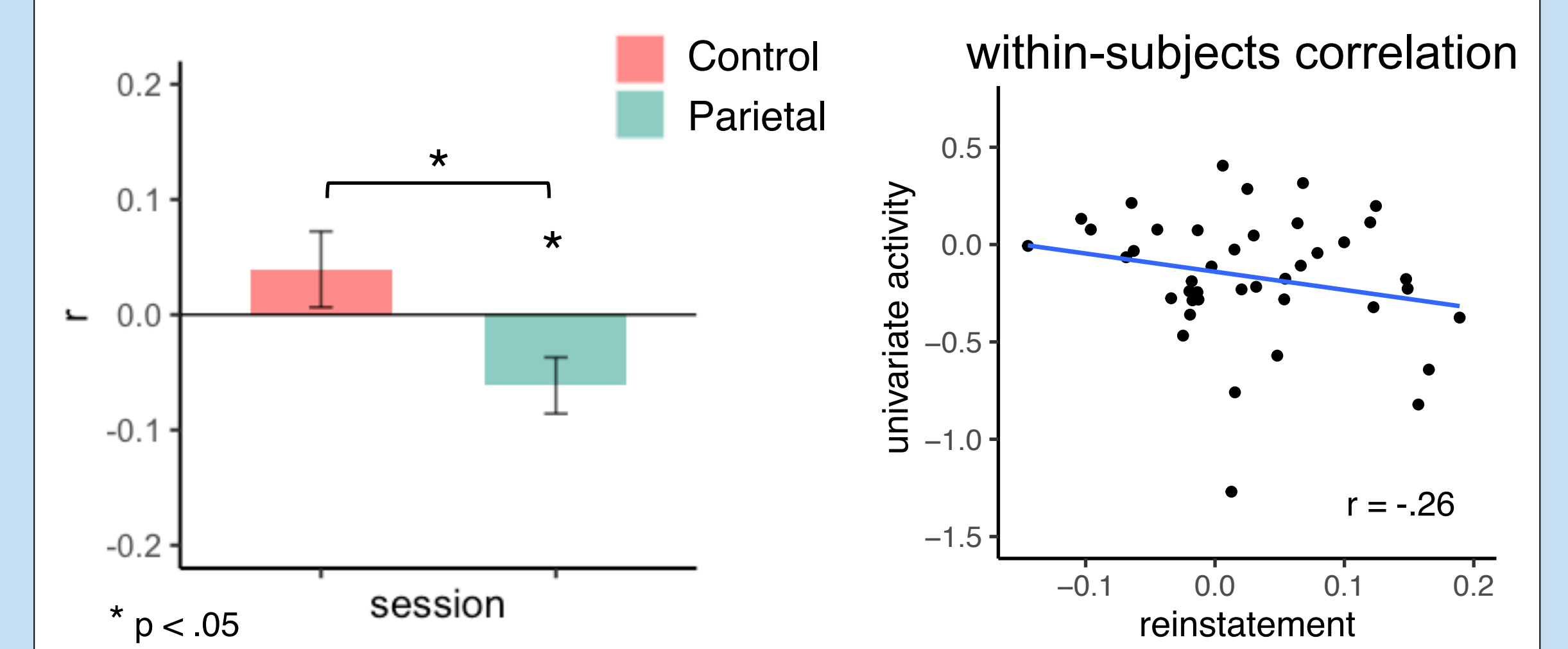
## Univariate Results

parietal > control stimulation



- Parietal stimulation leads to **decreased left posterior hippocampal activity** during memory encoding (cluster corrected threshold  $p < .005$ )

### Correlation between hippocampal activity and reinstatement



- Stimulation leads to a negative within-subjects correlation between **univariate left posterior hippocampal activity** at encoding and **reinstatement in left medial occipital gyrus**

## Conclusions

- Lateral parietal stimulation alters objective but not subjective memory for naturalistic episodes
  - Accuracy improved on the second question only, perhaps due to reduced interference in shifting between details retrieved to answer separate questions
- Memory for lifelike events is supported by reinstatement of event-specific patterns of neural activity in posterior midline regions
- Lateral parietal stimulation alters reinstatement of event-specific multivariate activity
- Stimulation decreases posterior hippocampal univariate activity during memory encoding
- Stimulation leads to a negative within-subject correlation between univariate hippocampal activity and medial occipital reinstatement
- Hippocampal-targeted stimulation alters large-scale, event-specific multivariate patterns of neural activity and objective memory for naturalistic episodes

## References

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