

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 correlates¹
 - Stimulation-induced improvements reported in paired-associates, word-list, and spatial precision tests of episodic memory^{2,3,4}
 - 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 mechanisms⁵
 - Parietal stimulation has been shown to alter autobiographical memory^{6,7}, 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?

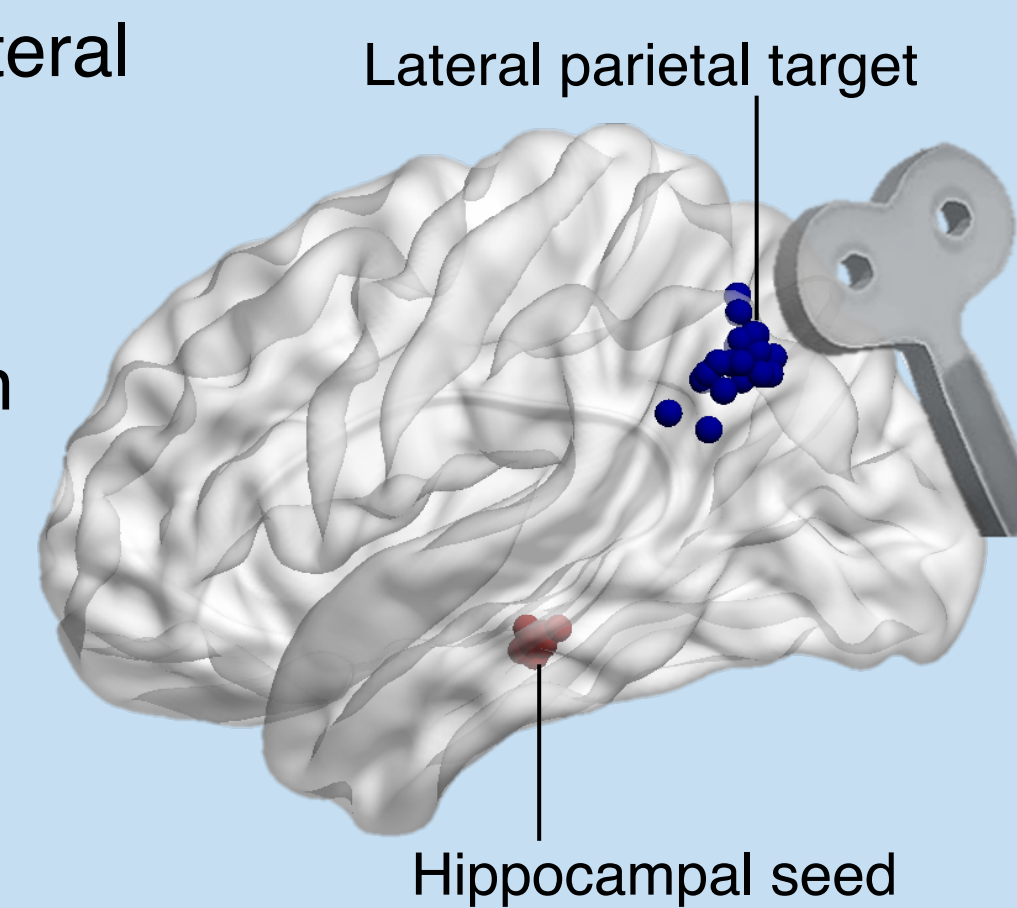
Methods

Study design

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

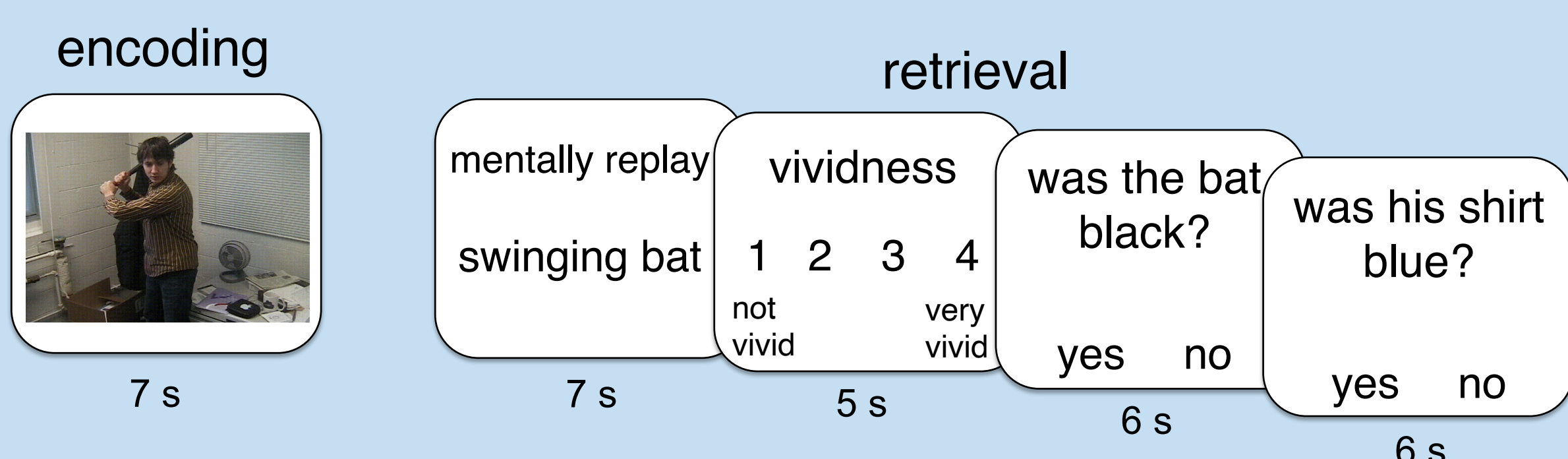
TMS methods

- 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

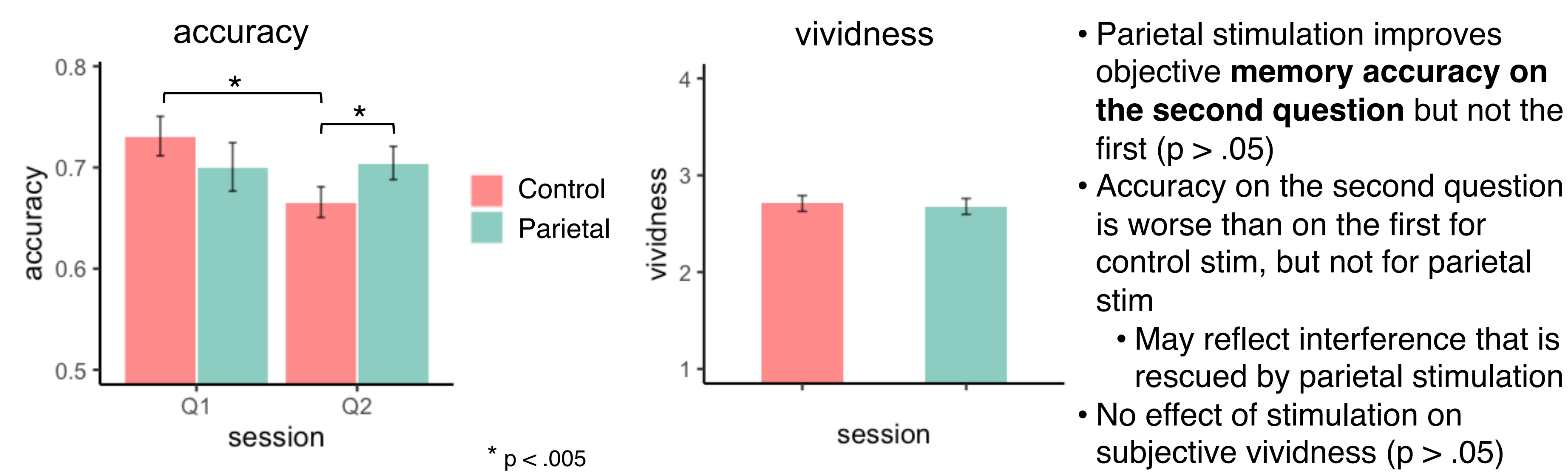


Episodic memory task

- 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

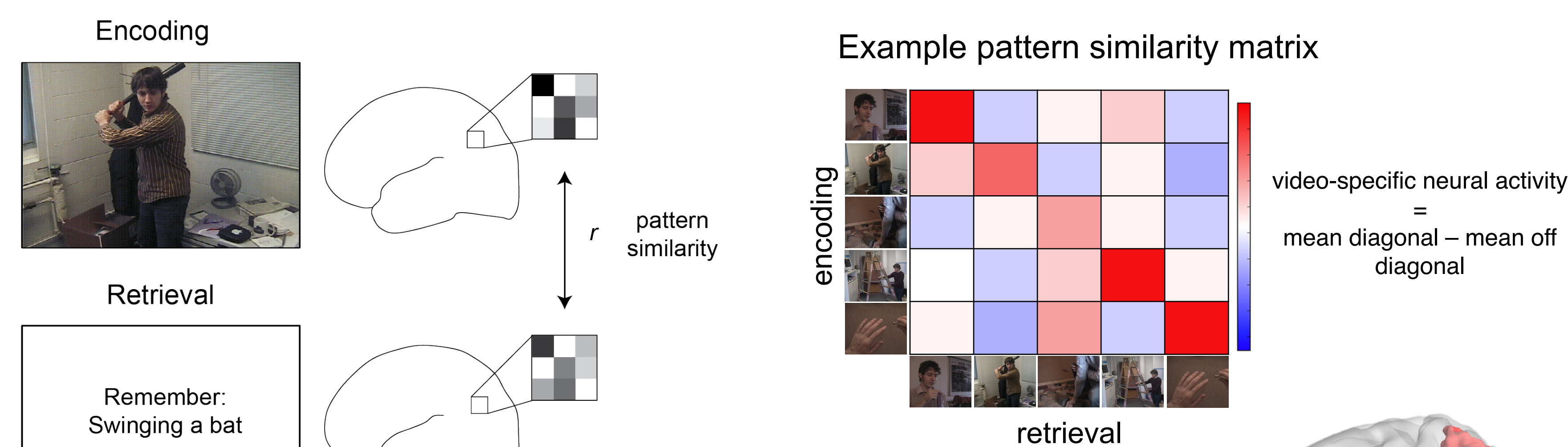


- Parietal stimulation improves objective **memory accuracy on the second question** but not the first (p > .05)
- Accuracy on the second question is worse than on the first for control stim, but not for parietal stim
 - May reflect interference that is rescued by parietal stimulation
- No effect of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

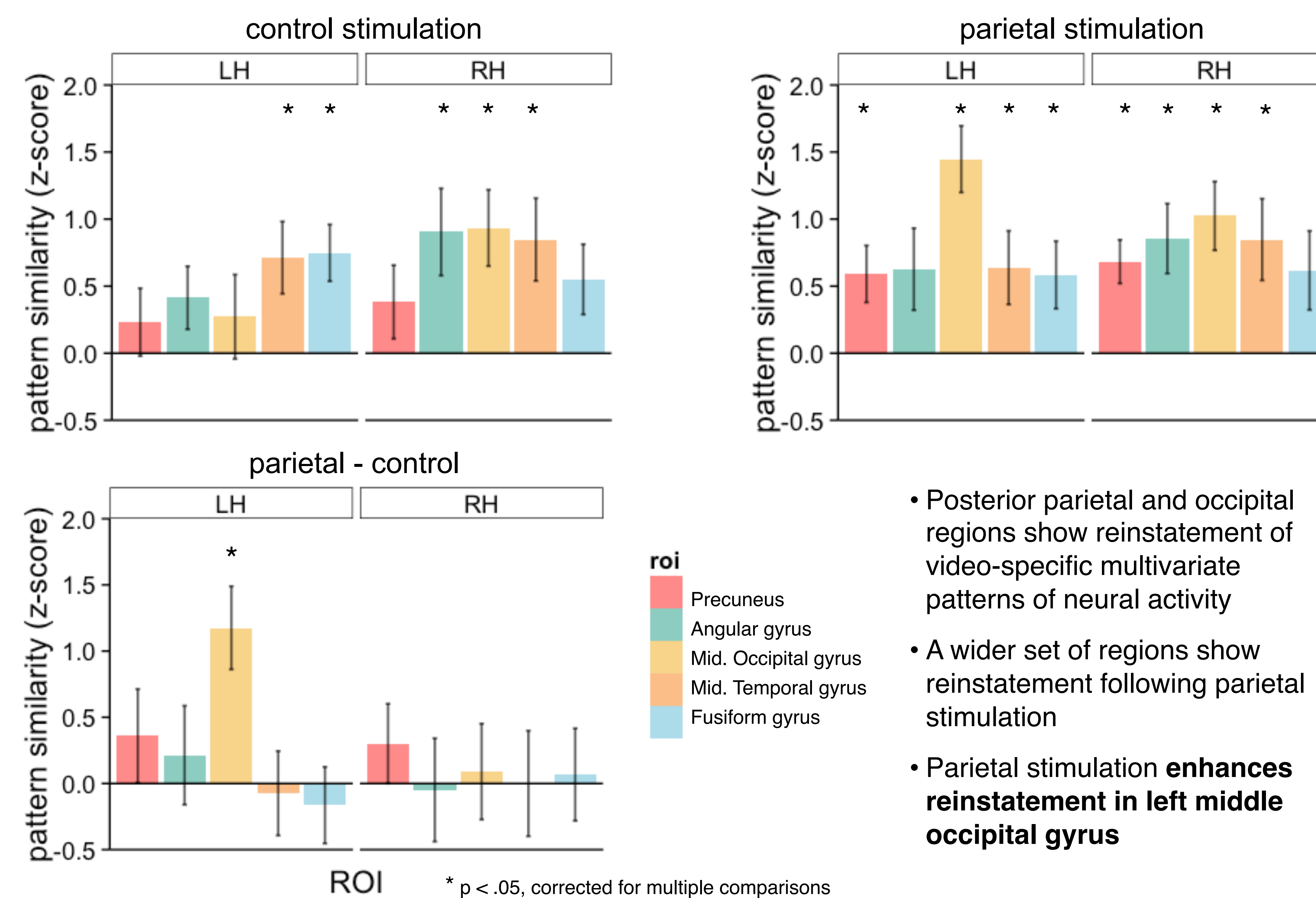
Neural Reinstatement

Pattern similarity analysis

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



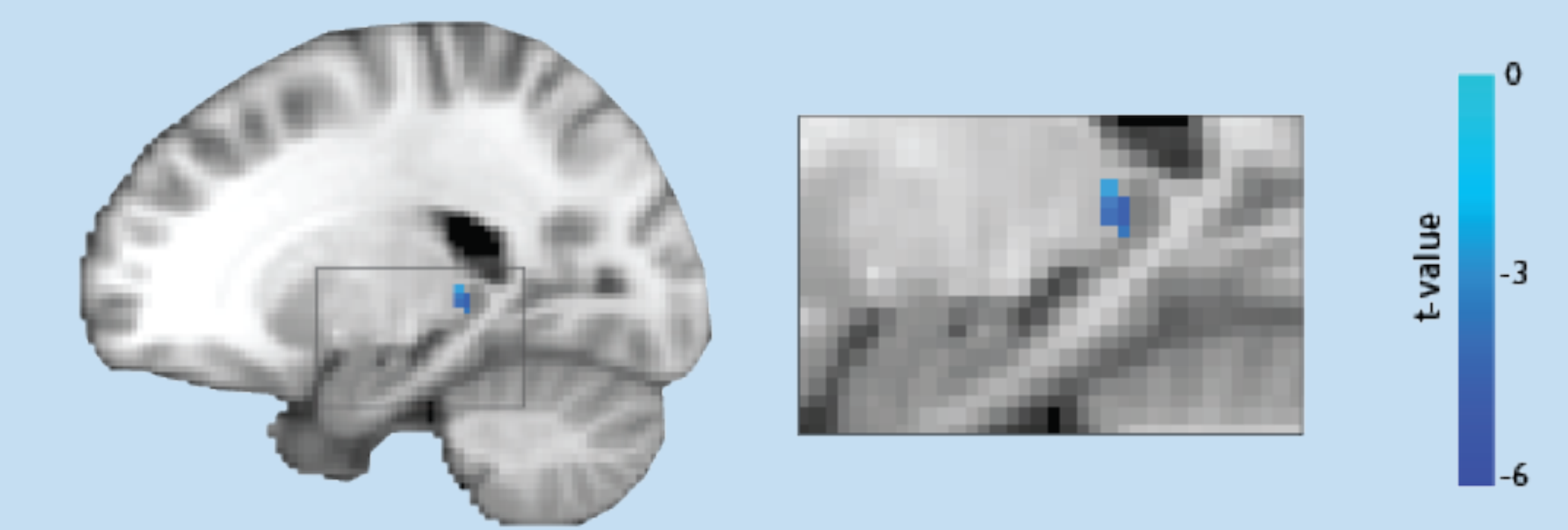
Pattern similarity results



- 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**

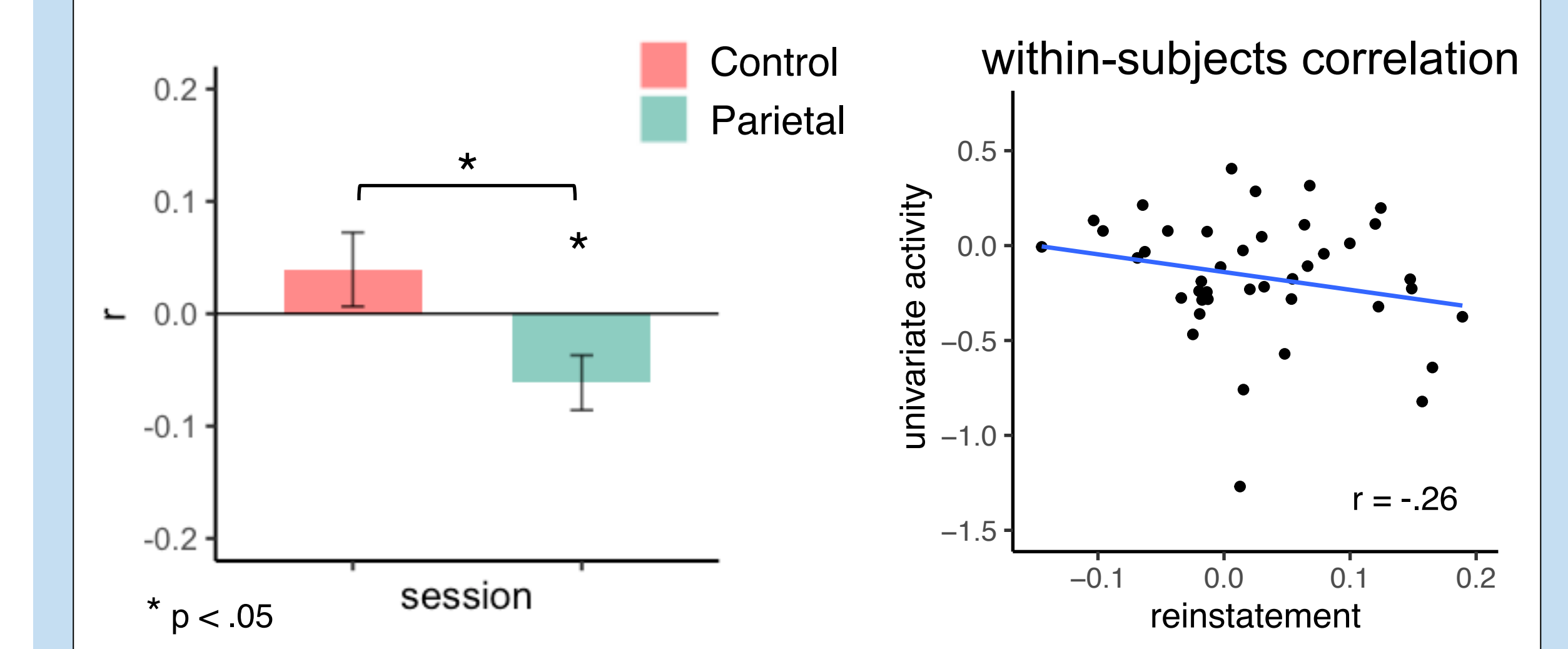
Univariate Results

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 increases reinstatement** of event-specific multivariate activity and **decreases posterior hippocampal univariate activity** during memory encoding
- Stimulation leads to a **negative within-subject correlation** between univariate hippocampal activity and occipital reinstatement, consistent with group-level univariate and reinstatement effects
- Hippocampal-targeted stimulation alters large-scale, event-specific multivariate patterns of neural activity and objective memory for naturalistic episodes

References

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