

# Hippocampus involvement in a dual-retrocue working memory task

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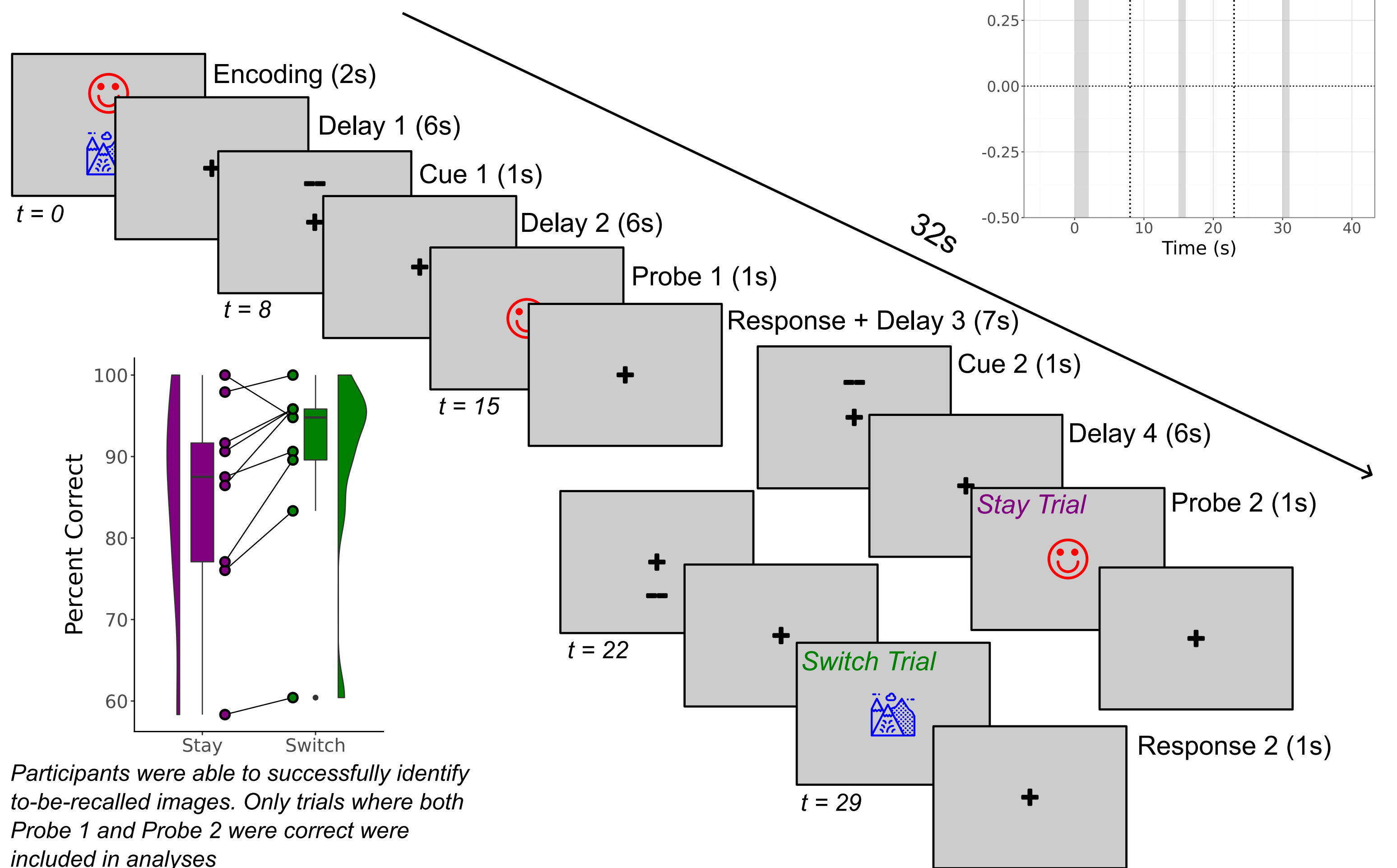
## Introduction

- Work in both human and non-human primates has shown evidence that the maintenance of task-relevant information during working memory comes from persistent neural activity in the lateral prefrontal cortex<sup>1</sup>
- Recent work has shown that information may also be maintained in the face of interruptions to persistent activity, a phenomenon known as activity silent working memory (ASWM)<sup>2</sup>
  - While task-relevant information is maintained via recurrent activation in parietal and prefrontal regions, information that is not task-relevant (but may later become so) can be stored in an activated long-term memory state through sub-threshold patterns of reinforced synaptic weights
- In the present work, we use a dual retrocue paradigm<sup>3</sup> to test the hypothesis that information stored in ASWM processes are brought into an active supra-threshold state when it becomes relevant by medial temporal lobe structures, including the hippocampus

## Methods

### Dual Retrocue Task

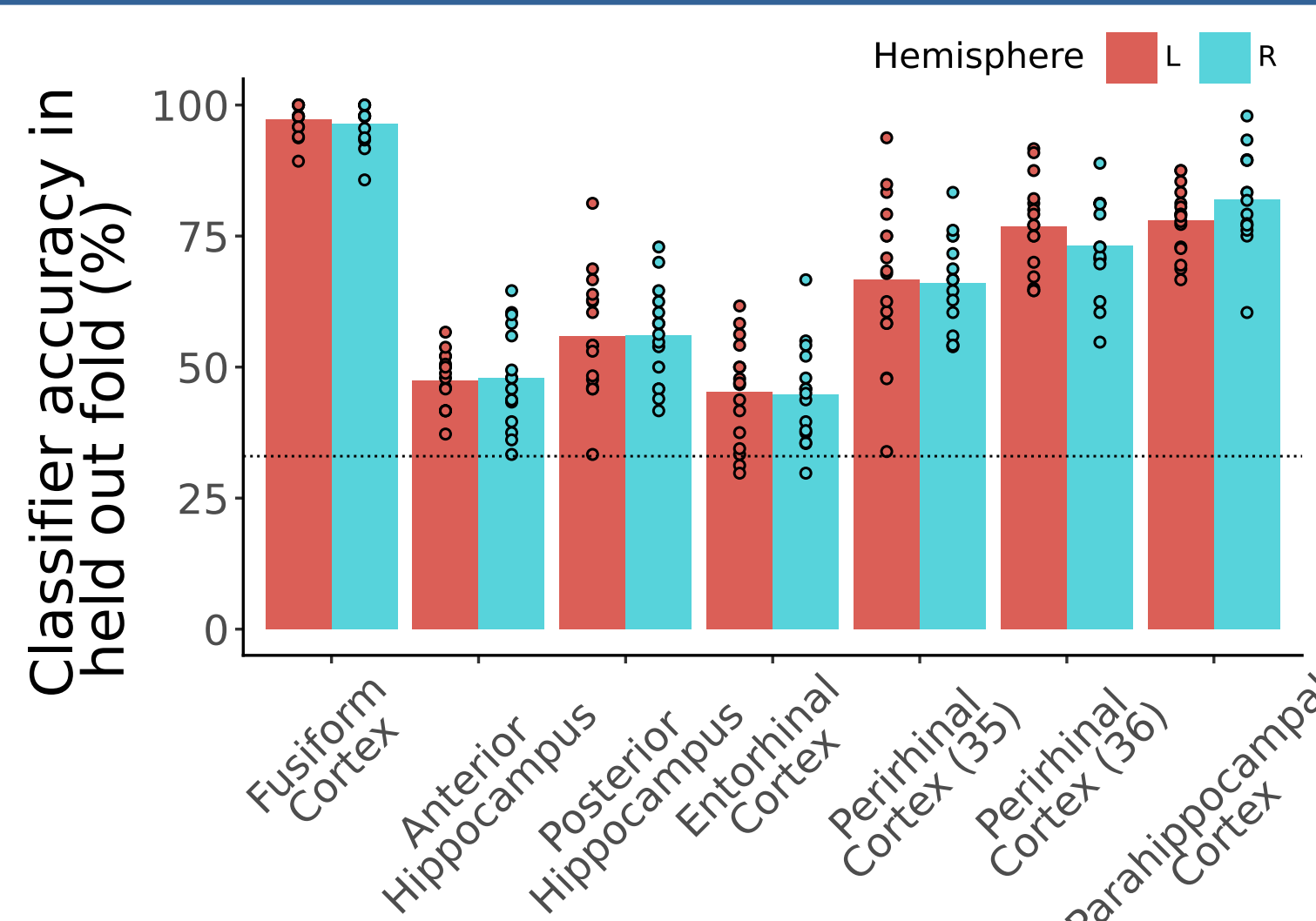
96 trials (50% stay, 50% switch), split across 2 sessions



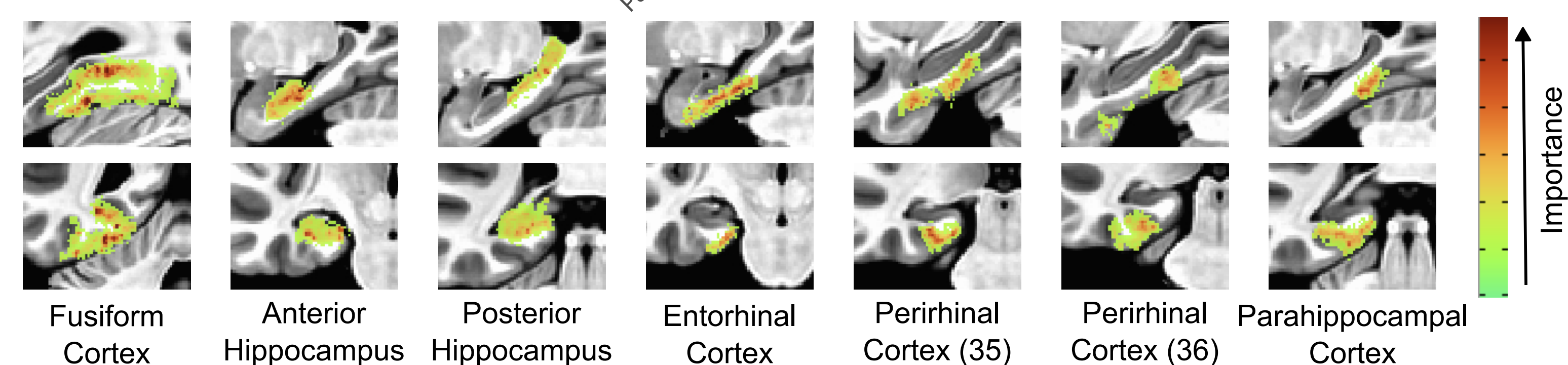
### fMRI Data & Preprocessing

- Participants: N = 9 (5 F; mean age = 29.3 yrs; SD = 11.56 yrs)
- fMRI data collected on a 7T Siemens Terra scanner (3D EPI BOLD sequence; 1.3mm<sup>3</sup> voxels, TR=1s, TE=10ms); data denoised using NORDIC<sup>4</sup> and preprocessed using afni\_proc.py<sup>5</sup>, including aCompCor
- Bilateral hippocampal ROIs extracted from high-resolution T1w image using hippunfold<sup>6</sup> and manually split into anterior and posterior hippocampus segments using the uncus apex as an anatomical landmark; medial temporal lobe segmented into entorhinal cortex, perirhinal cortex and parahippocampal cortex ROIs using ASHS software<sup>7</sup> with the Magdeburg 7T atlas<sup>8</sup>
- All preprocessing and analysis code is publicly available at <https://github.com/nimh-sfm/fastWM>

## Decoding Performance on Localizer Task



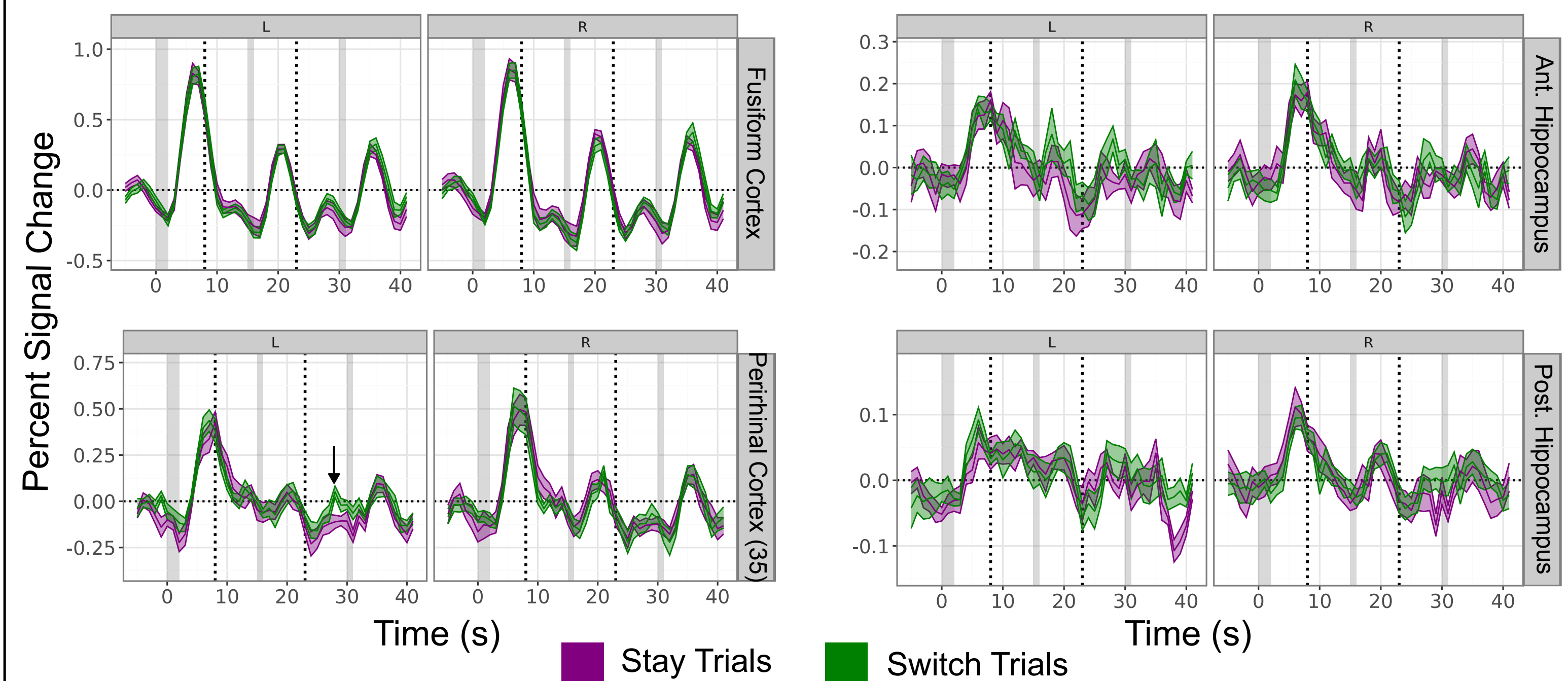
- Cross-validated regularized logistic regression decoder was trained on data from an independent functional localizer (16 blocks of a 1-back task for faces, scenes and objects; 16 images per block presented for 400ms with 600ms ISI). Each dot reflects one task session from each participant.
- Image category was able to be robustly decoded across the visual cortex and medial temporal lobe regions



Average L2 norm of classifier weights from each image category backprojected to volume space suggests varied spatial patterns of importance to classifier across participants

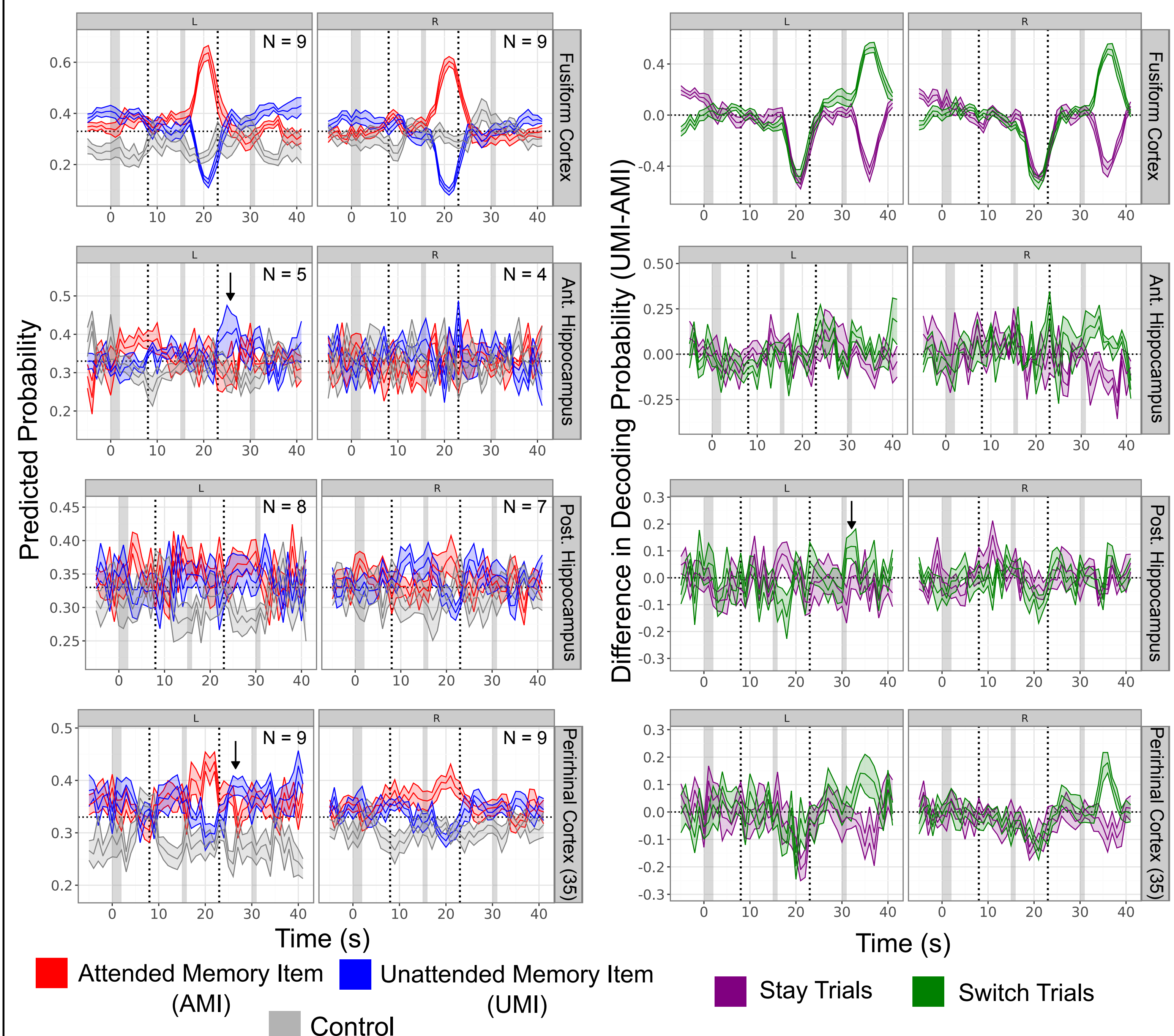
**References** 1. Fuster et al. (1971) *Science* 2. Stokes, MG. (2015) *Trends in Cognitive Science* 3. Rose et al. (2016) *Science*. 4. Vizioli et al., (2021) *Nature Communications* 5. Reynolds et al. (2024). *Imaging Neuroscience* 6. DeKraker et al (2023) *eLife* 7. Xie et al. (2018) *Journal of Alzheimer's Disease* 8. Berron et al (2017) *NeuroImage: Clinical*  
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## Univariate Activation Across Dual Retrocue Trials



- Activation averaged over trials shows trial-locked increases in activation, suggesting task engagement across memory-related regions
- Left perirhinal cortex shows a trend towards **increased activation on switch trials** after the second cue, suggesting it may be involved in bringing the **unattended memory item** into the focus of attention for retrieval during the second probe period

## Predicted Probabilities Across Dual Retrocue Trials



- A decoder trained on independent task data was applied to each time point of the dual retrocue task and provided a predicted probability for each category, reflecting the likelihood that this category was being maintained at a given timepoint
- Fusiform cortex and perirhinal cortex show robust representation of to-be-recalled image category during probe periods
- Left posterior hippocampus shows trend towards **increased UMI representation** after the second cue on **switch trials**, indicating it may transfer the UMI from an activated long-term memory state into a more active representation
- Left anterior hippocampus and left perirhinal cortex show **increased UMI representation**, regardless of trial type, suggesting these regions may bind to-be-recalled information together and the second cue "refreshes" the bound information prior to recall

## Conclusions and Future Directions

- Although the hippocampus and other medial temporal lobe structures do not show the pattern of sustained activation classically associated with working memory maintenance, preliminary evidence suggests that these regions may recruit processes typically associated with long-term memory to maintain information that is not initially task-relevant
- Future work includes assessing representations in hippocampal subfields, indexing category-agnostic processes in memory-related regions, and relating hippocampal activation and decoding performance to performance on a post-scan memory test