



The Hutchinson Lab of  
Cognitive Neuroscience

# Hippocampal and entorhinal pattern reinstatement mediates long-timescale temporal memory

Futing Zou<sup>1</sup>, Emily Allen<sup>2</sup>, Yihan Wu<sup>2</sup>, Ian Charest<sup>3</sup>,

Thomas Naselaris<sup>2</sup>, Kendrick Kay<sup>2</sup>, J. Benjamin Hutchinson<sup>1,\*</sup>, & Sarah DuBrow<sup>1,\*</sup>

<sup>1</sup>University of Oregon <sup>2</sup>University of Minnesota <sup>3</sup>University of Birmingham \*equal contribution



## Introduction

- Medial temporal lobe (MTL) plays an important role in encoding the time that events occur on the scales of seconds and minutes<sup>1,2,3</sup>.
- Hippocampal time signals carry information about time across seconds, minutes, and days<sup>4</sup>.
- However, it remains unclear whether and how temporal memory over longer real-world timescales (months) is supported by the MTL.
- Moreover, many of our experiences usually involve reoccurrences.

*What happens in the brain that allows us to remember when events occur over long timescales?*

*How does repeated study affect our memory for the when?*

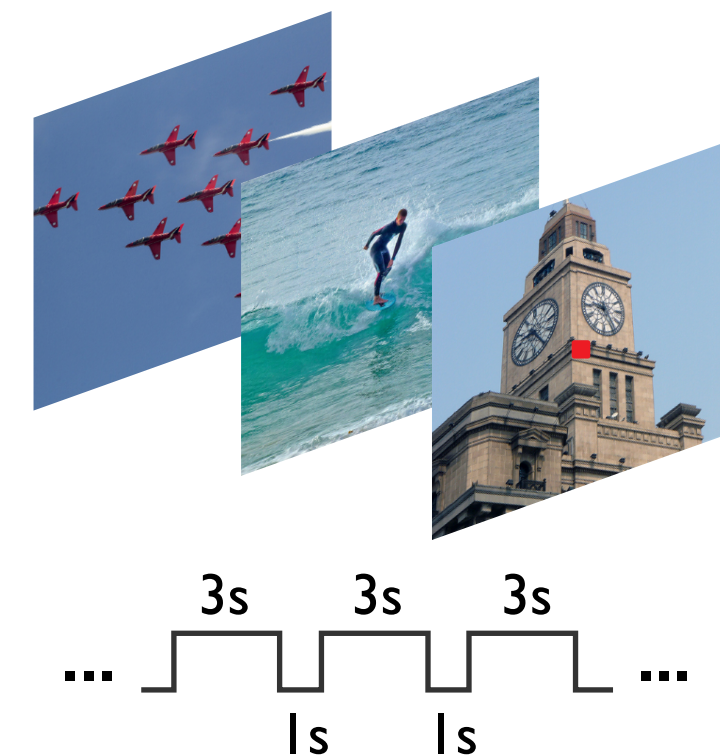
## Experimental design

### Continuous recognition phase

8-10 months

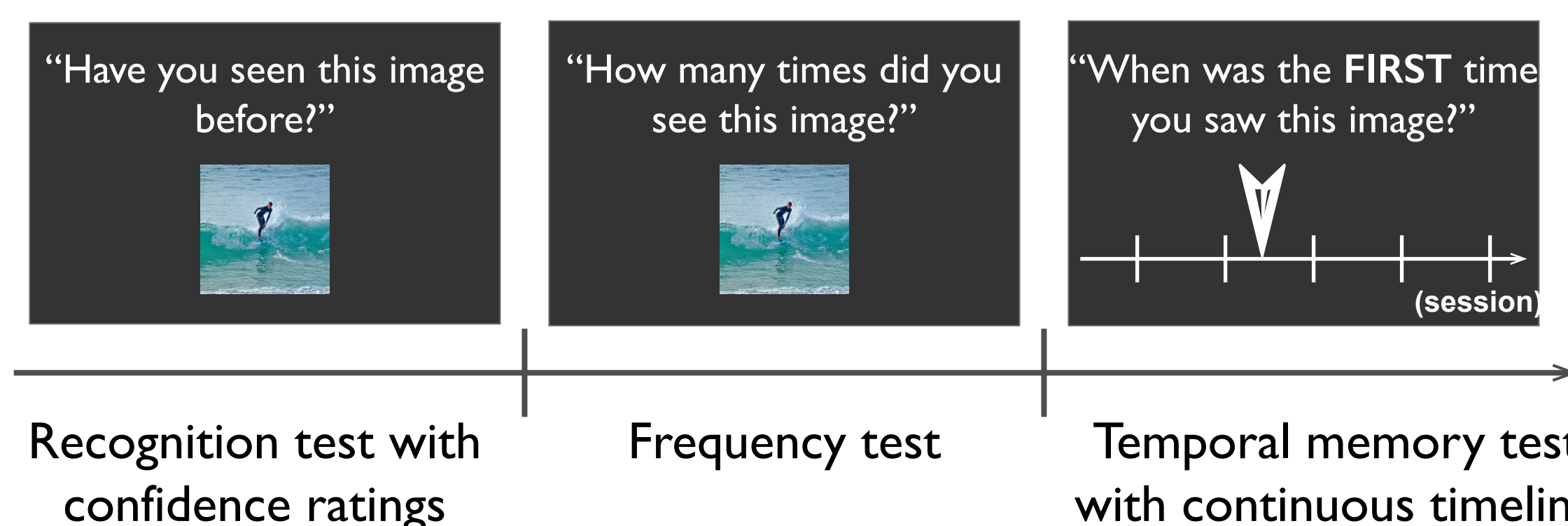
“Have you seen this image before?”

- N = 8
- 30-40 sessions of 7T fMRI
- ~30,000 trials per subject
- ~10,000 COCO images repeated up to 3 times



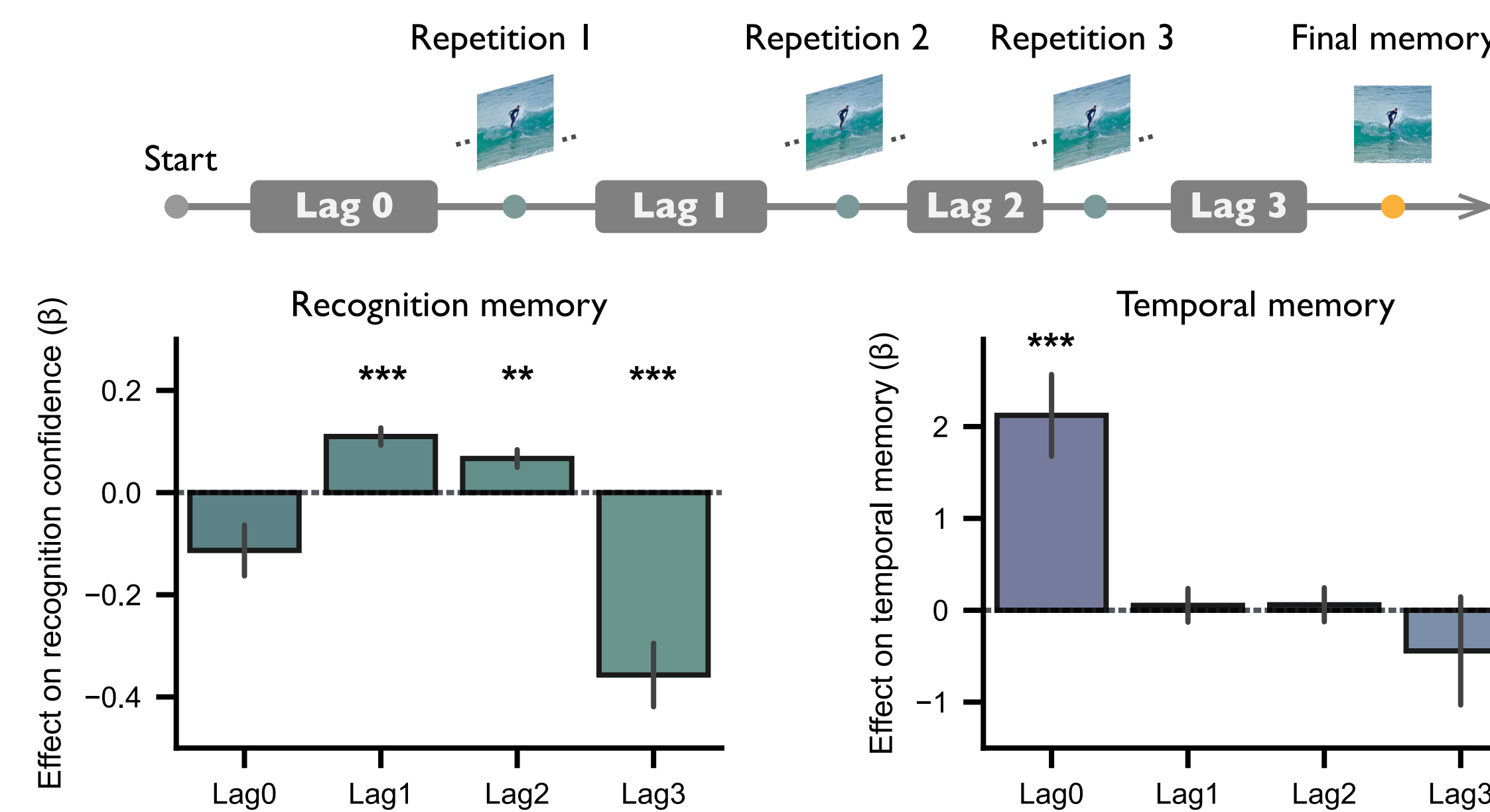
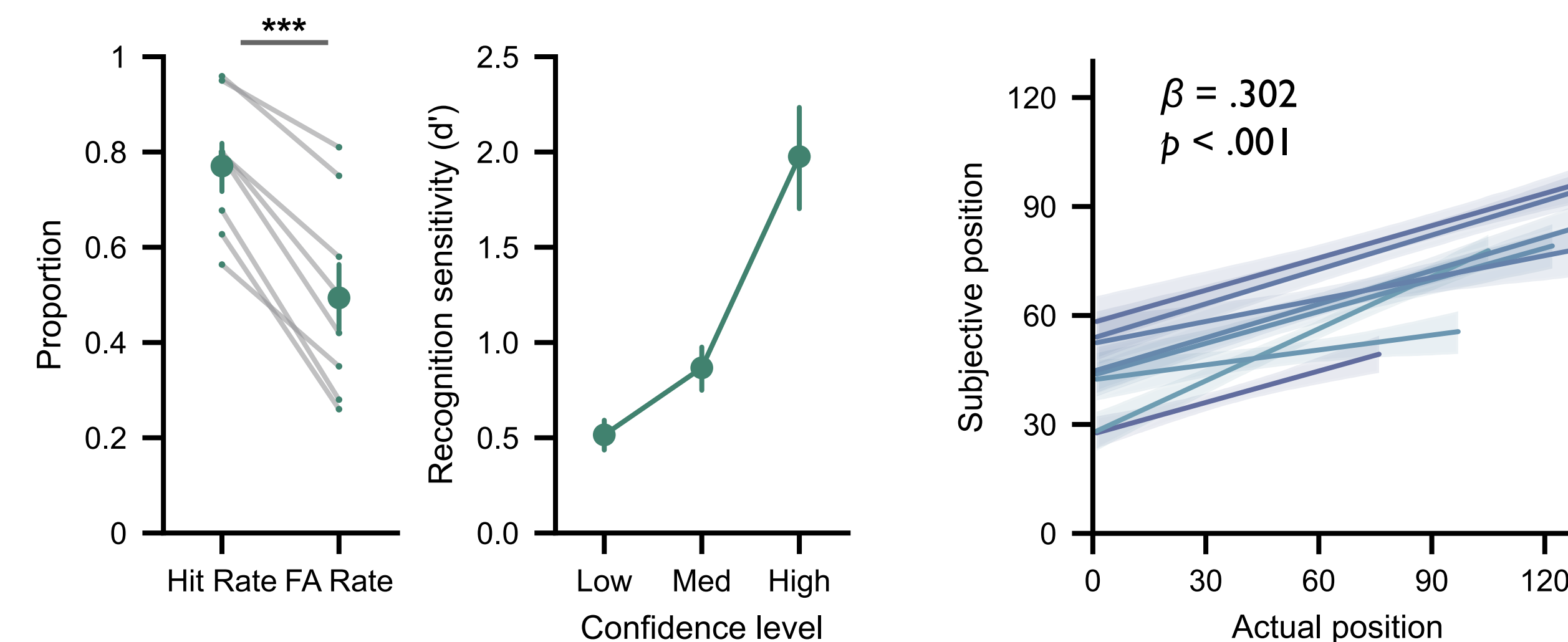
### Final memory phase

- 1 behavioral final memory test
- 320 images (220 old)



## Behavioral results

### Above-chance recognition and temporal memory performance

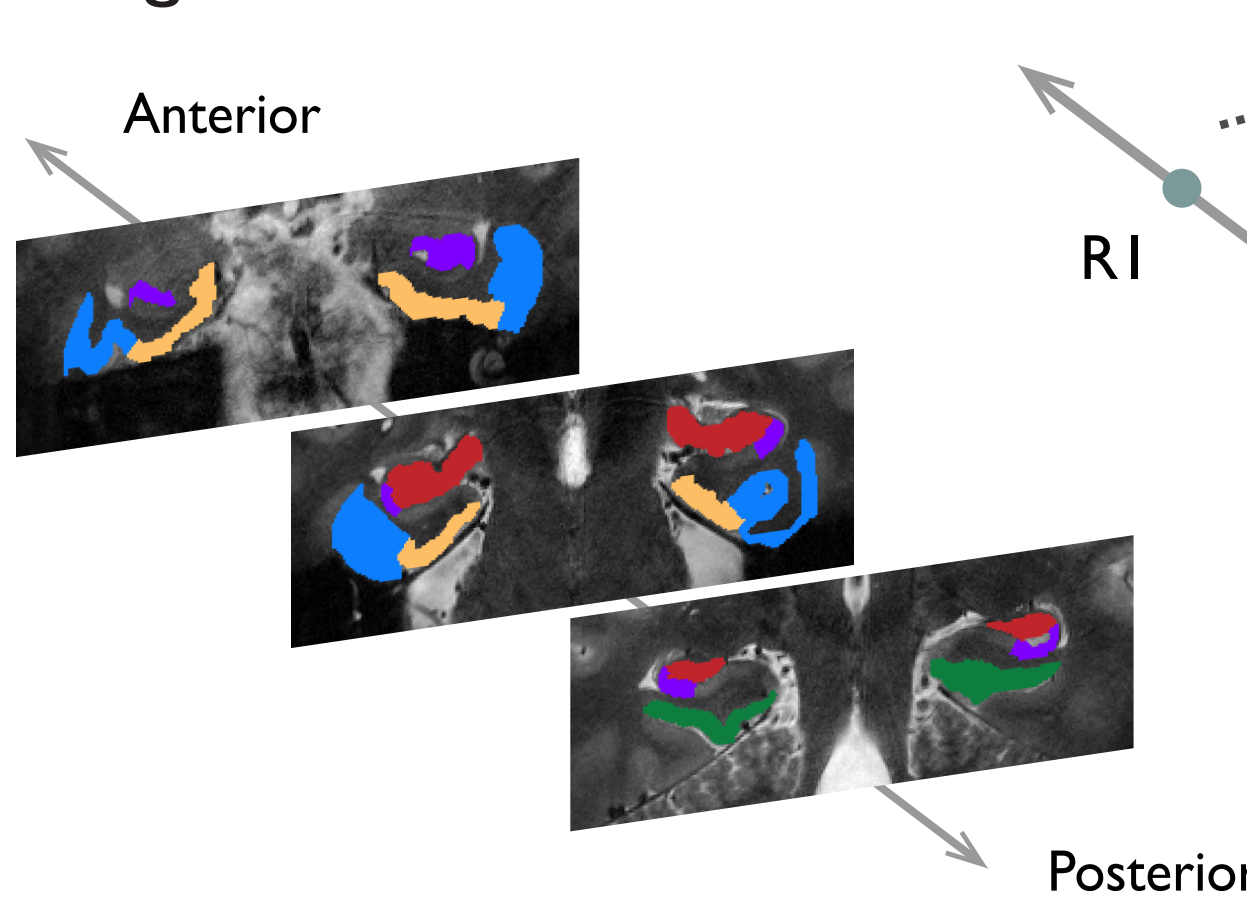


Spacing and forgetting effects in recognition memory;  
Recency effect in temporal memory.

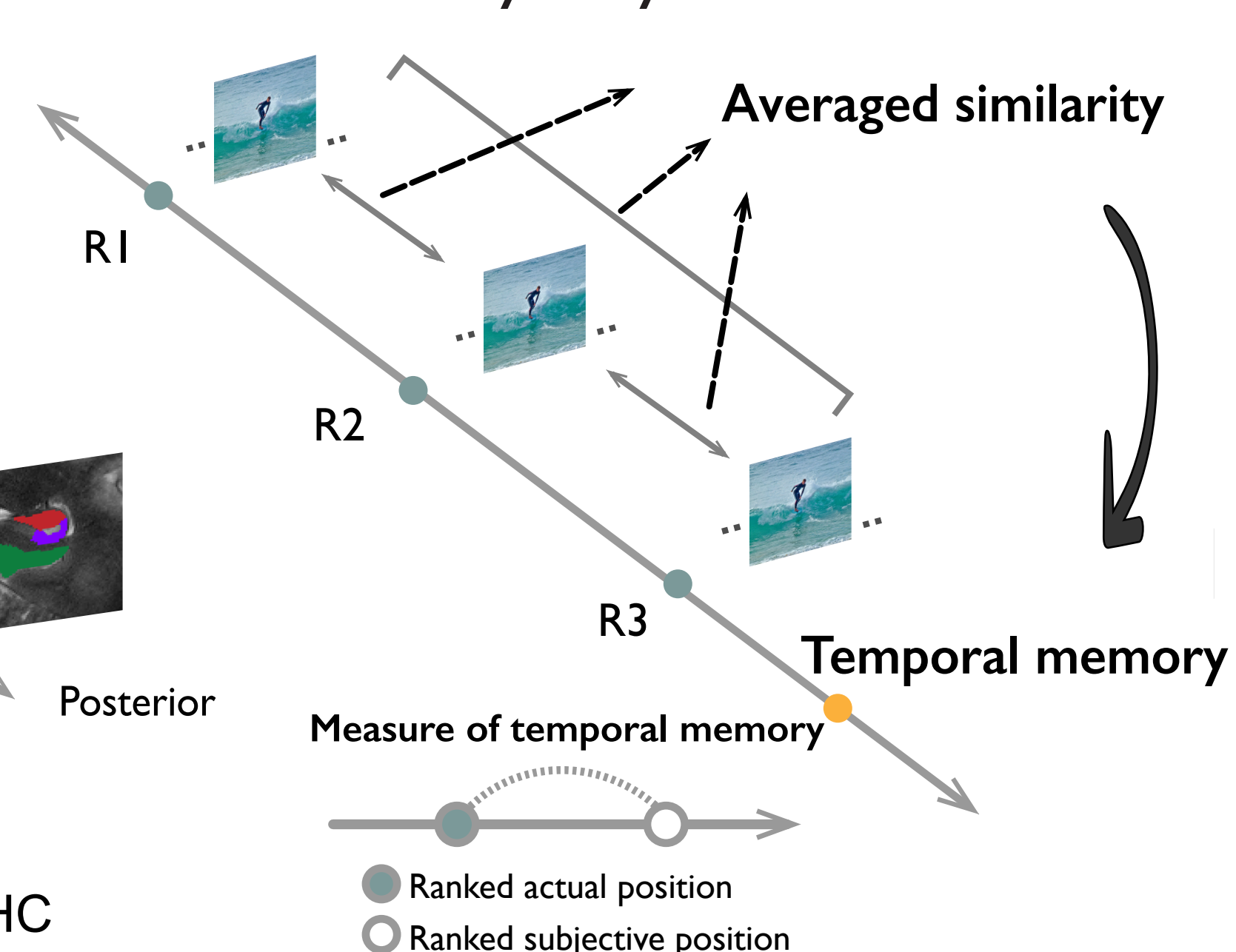
\*\*  $p < .010$   
\*\*\*  $p < .001$

## fMRI analysis

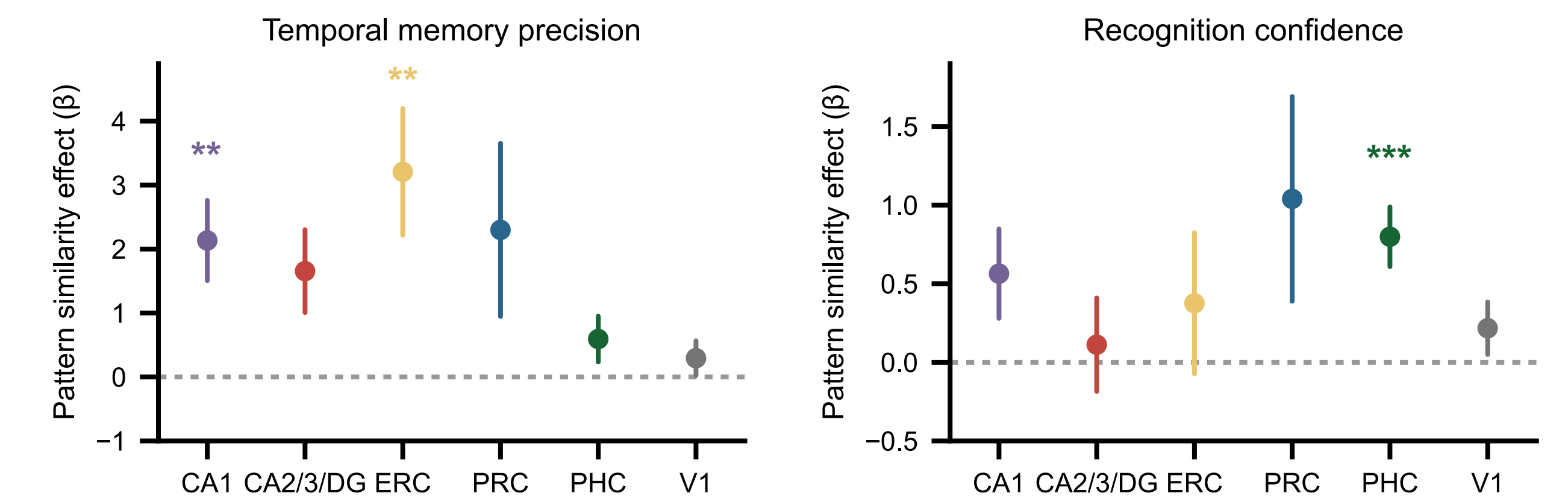
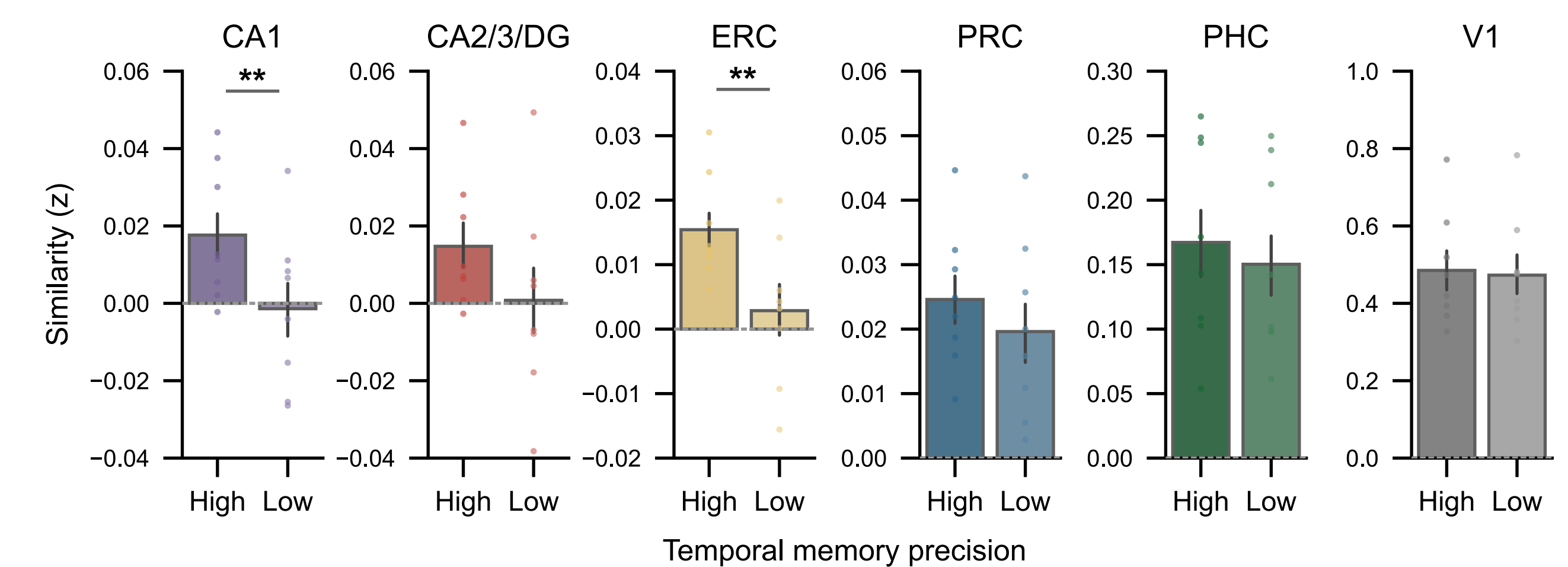
### Regions of interest



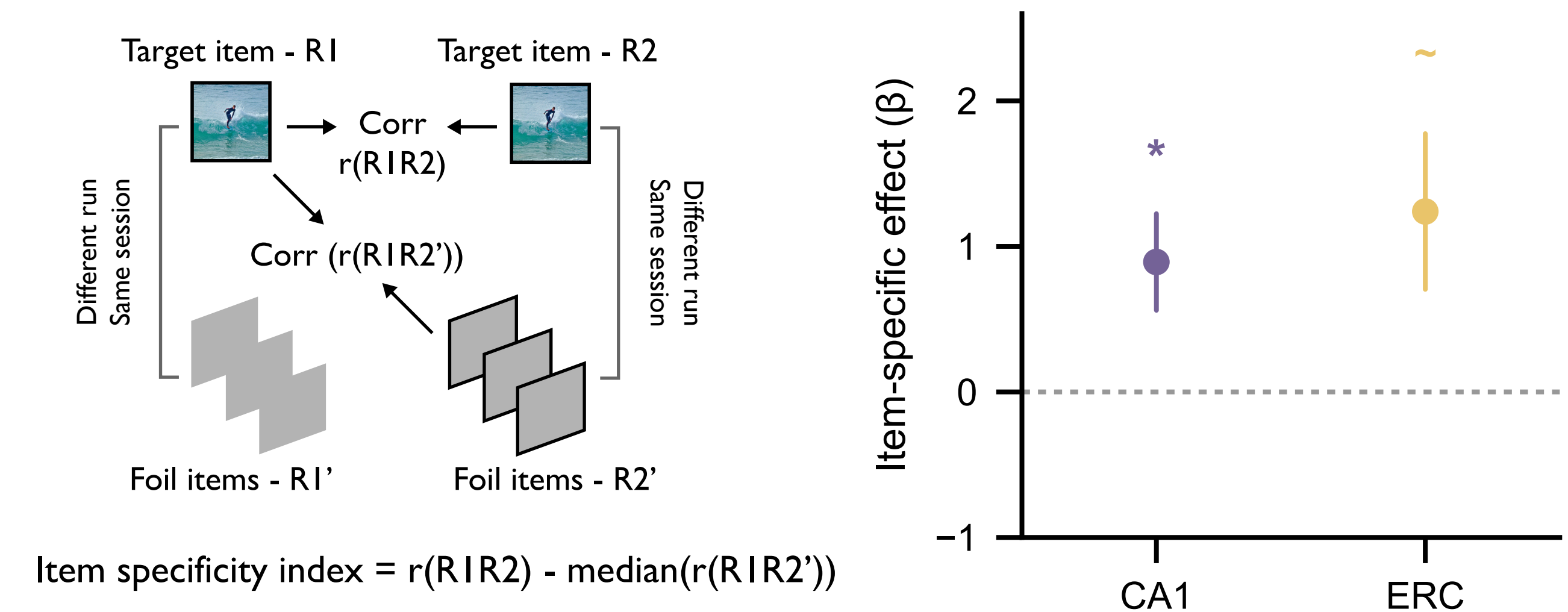
### Pattern similarity analysis



## fMRI results



Pattern similarity in CA1 and ERC across repetitions predicts  
temporal memory precision.



Pattern similarity in CA1 (and ERC) reflects reinstatement of  
item-specific temporal information.

~  $p < .10$   
\*  $p < .05$   
\*\*  $p < .010$   
\*\*\*  $p < .001$

## Summary

- Precise temporal memory persists across months.
  - Pattern reinstatement in CA1 and ERC predicts temporal memory precision irrespective of recognition confidence.
  - CA1 (and ERC) encodes item-specific temporal information.
- Hippocampal CA1 and ERC are involved in very long timescale temporal memory.*