

Shifting the balance between pattern separation and completion:

Recent memory retrieval increases people's subsequent ability to recall associations

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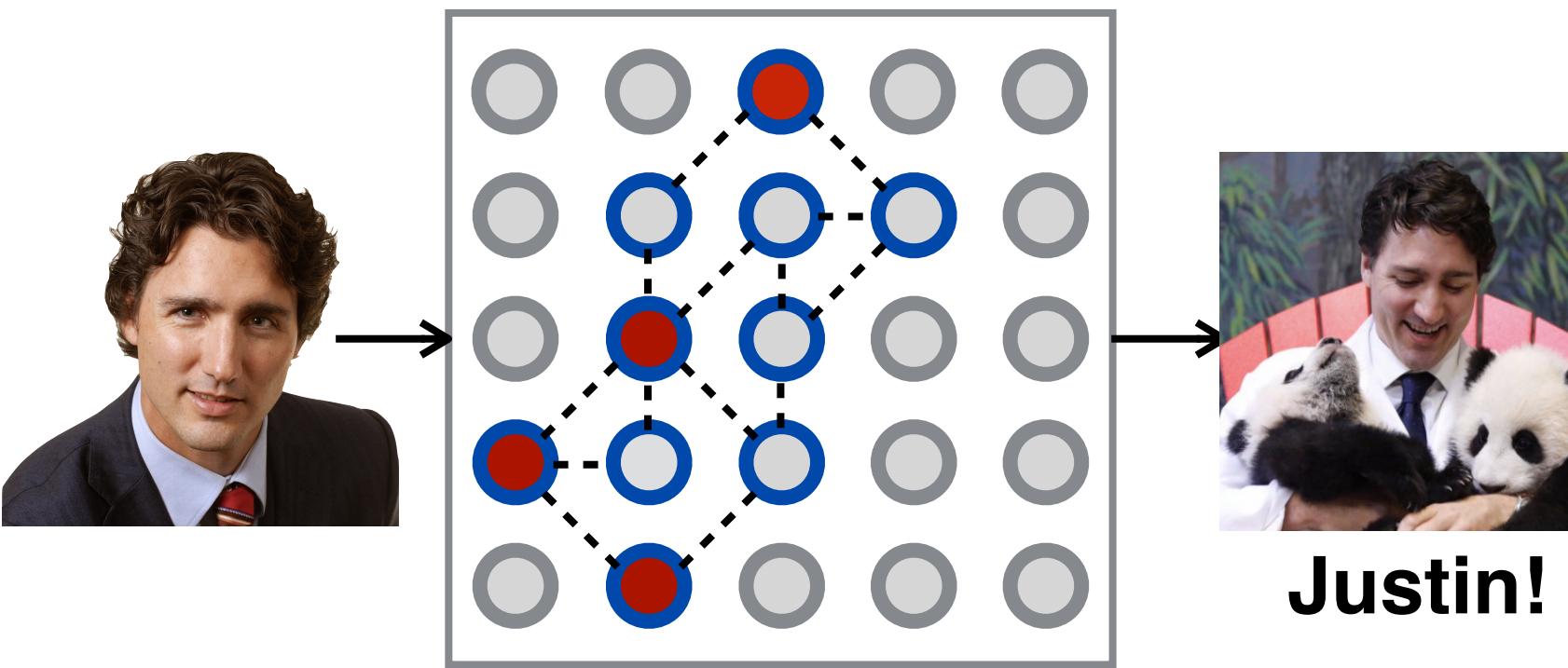
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Introduction

Recalling associations requires hippocampal **pattern completion**¹.



Lower cholinergic input in **familiar** contexts is thought to bias hippocampus towards pattern completion².

Cholinergic modulation is **slow-acting** so pattern completion biases could last for seconds³, influencing subsequent trials⁴.



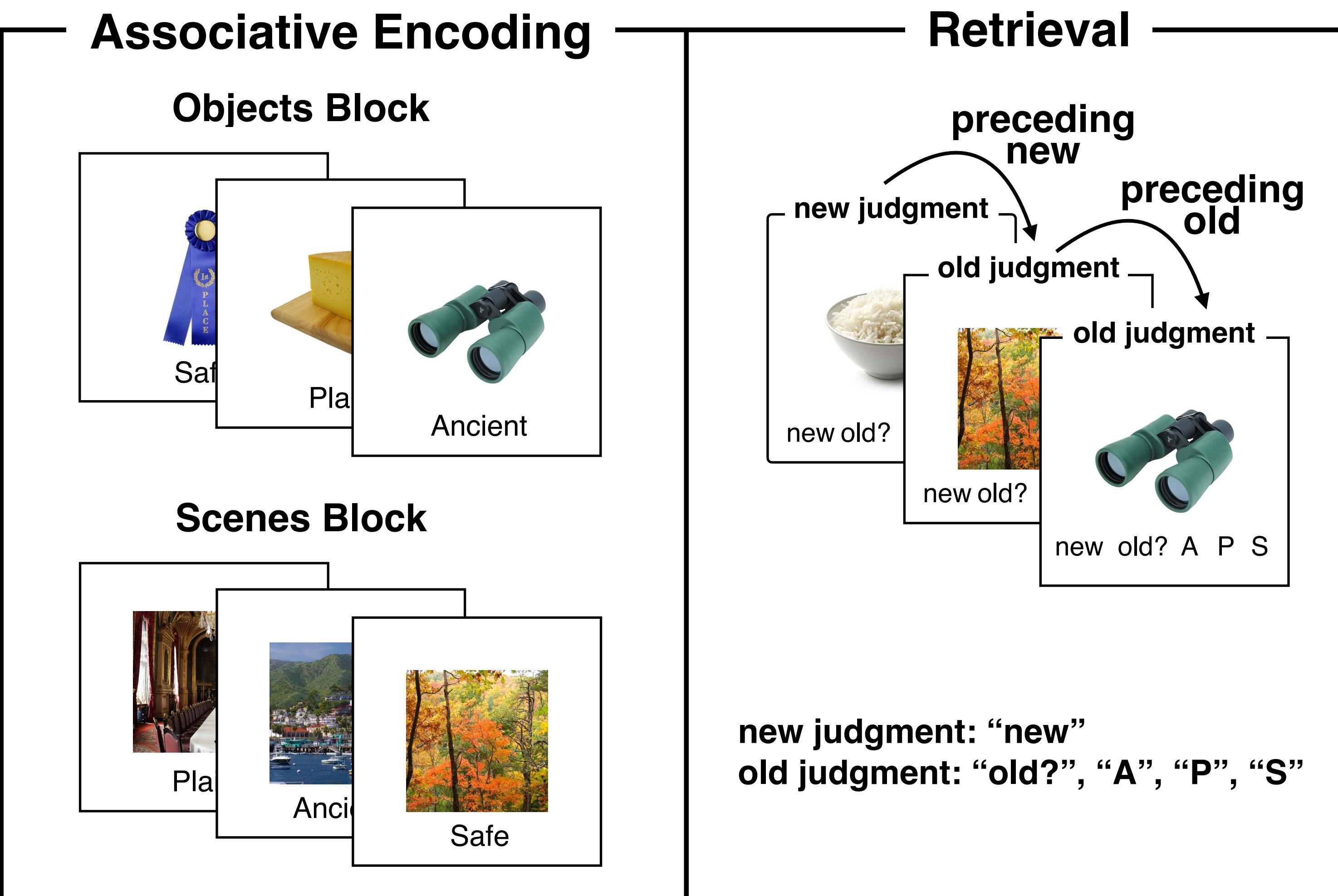
How do recent memory decisions affect associative memory (pattern completion-dependent) and item memory (pattern completion-independent)?

Experimental Design

Encoding session: Trial-unique images of scenes and objects paired with one of three words, presented in separate blocks

Retrieval session: Item and associative memory assessed simultaneously

Manipulation: Memory judgments were made after an unrelated novel or familiar image



Experiment 1

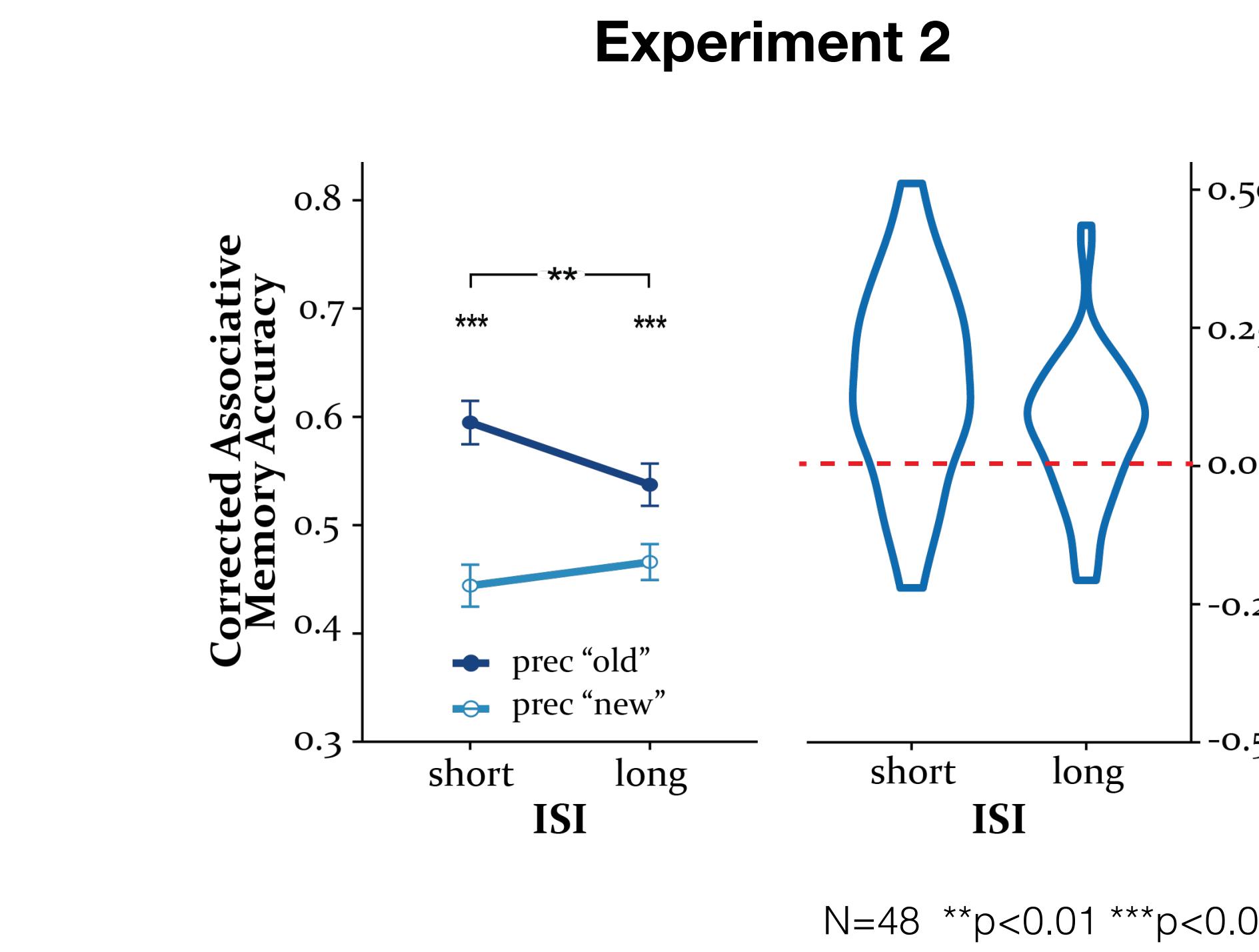
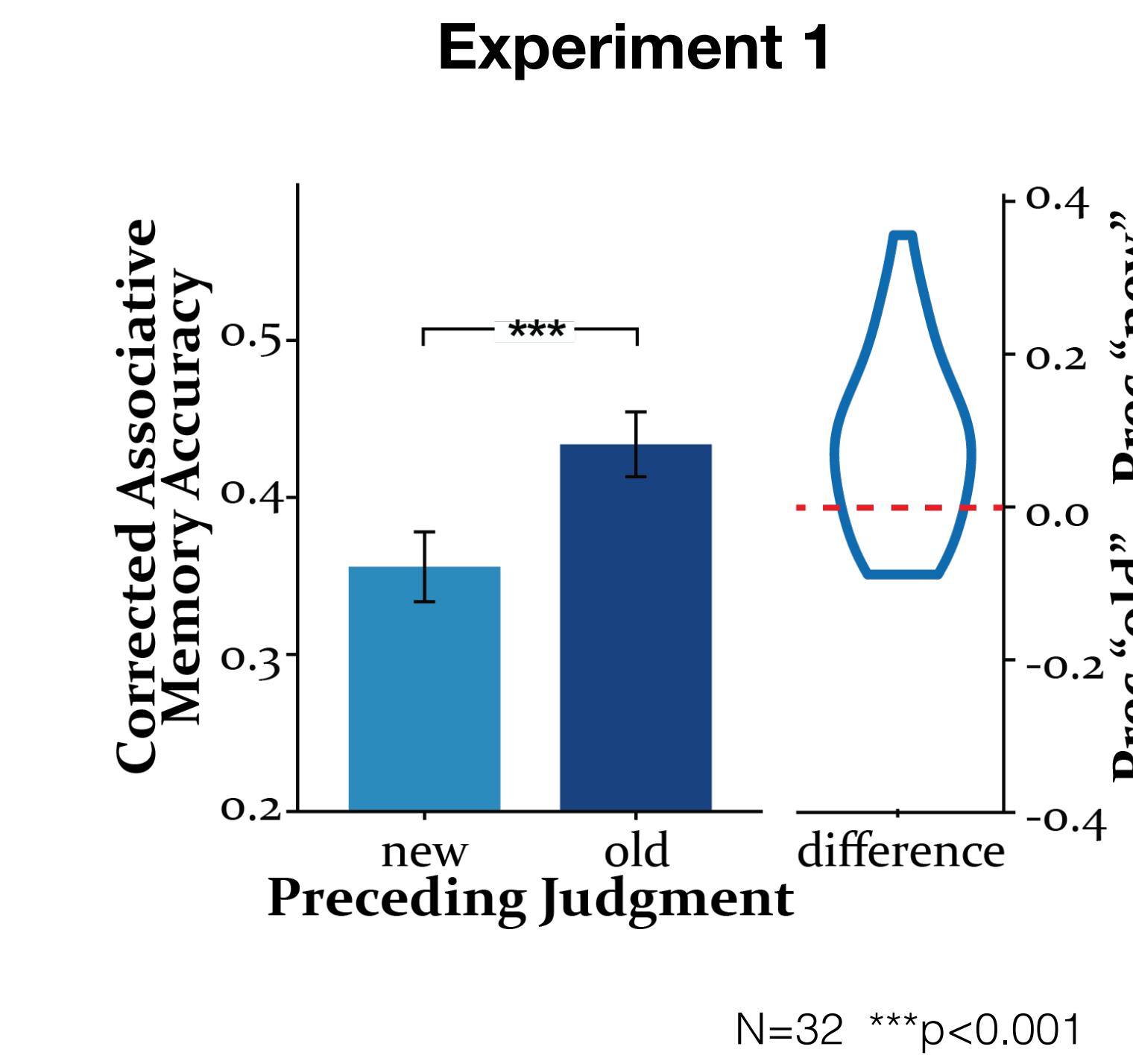
N = 32
Encoding: 242 trials
Retrieval:
484 trials
ISI = 1 s (short), 4 s (long)

Experiment 2

N = 48
Encoding: 196 trials
Retrieval:
392 trials
ISI = 1 s (short), 4 s (long)

Associative Memory

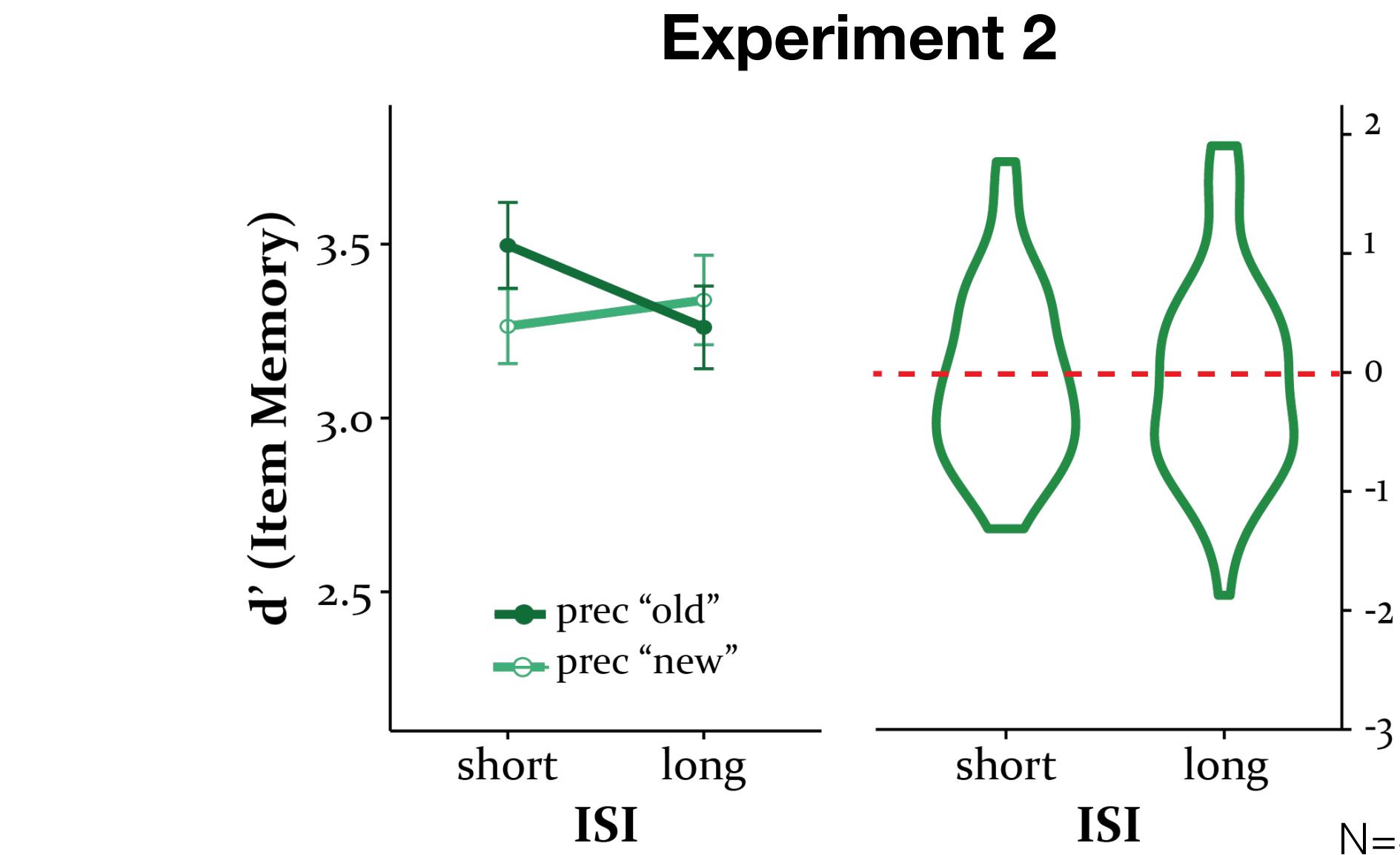
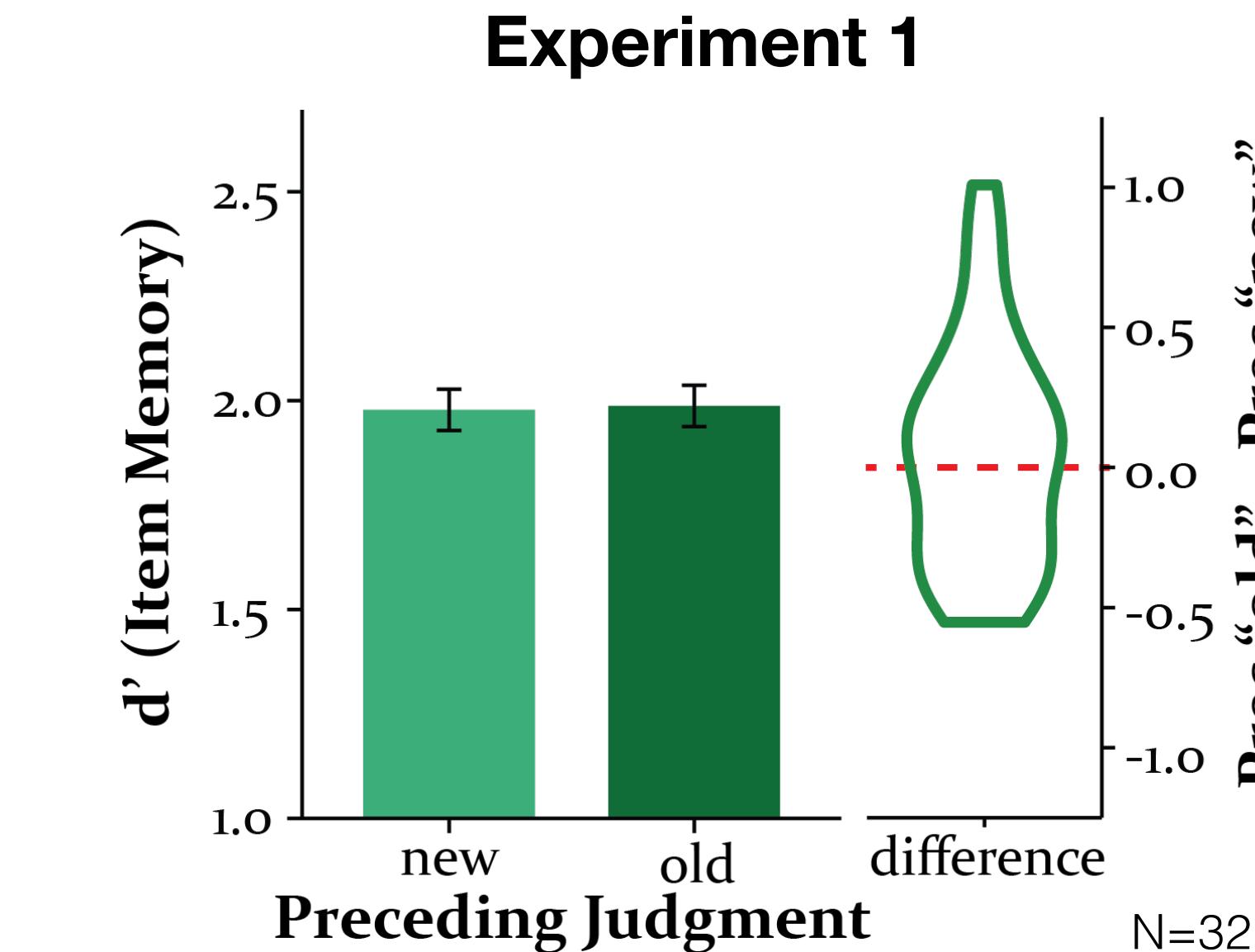
Pattern Completion-Dependent Memory: Assessed memory for associated words on trials correctly recognized as old as a function of judgment on the preceding trial



Participants were more accurate at retrieving associations after identifying an unrelated image as *old* compared to *new*. This effect lasted for seconds.

Item Memory

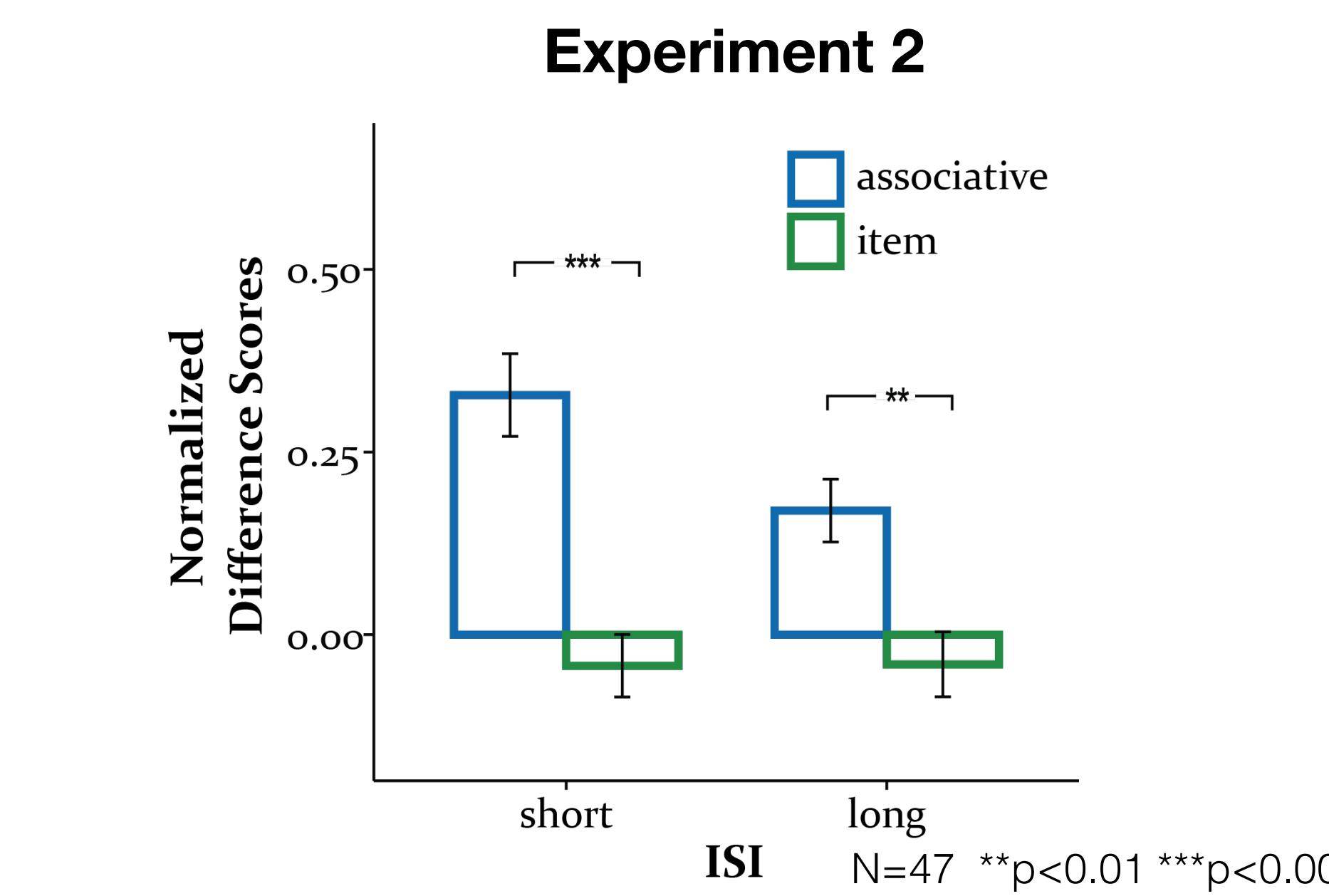
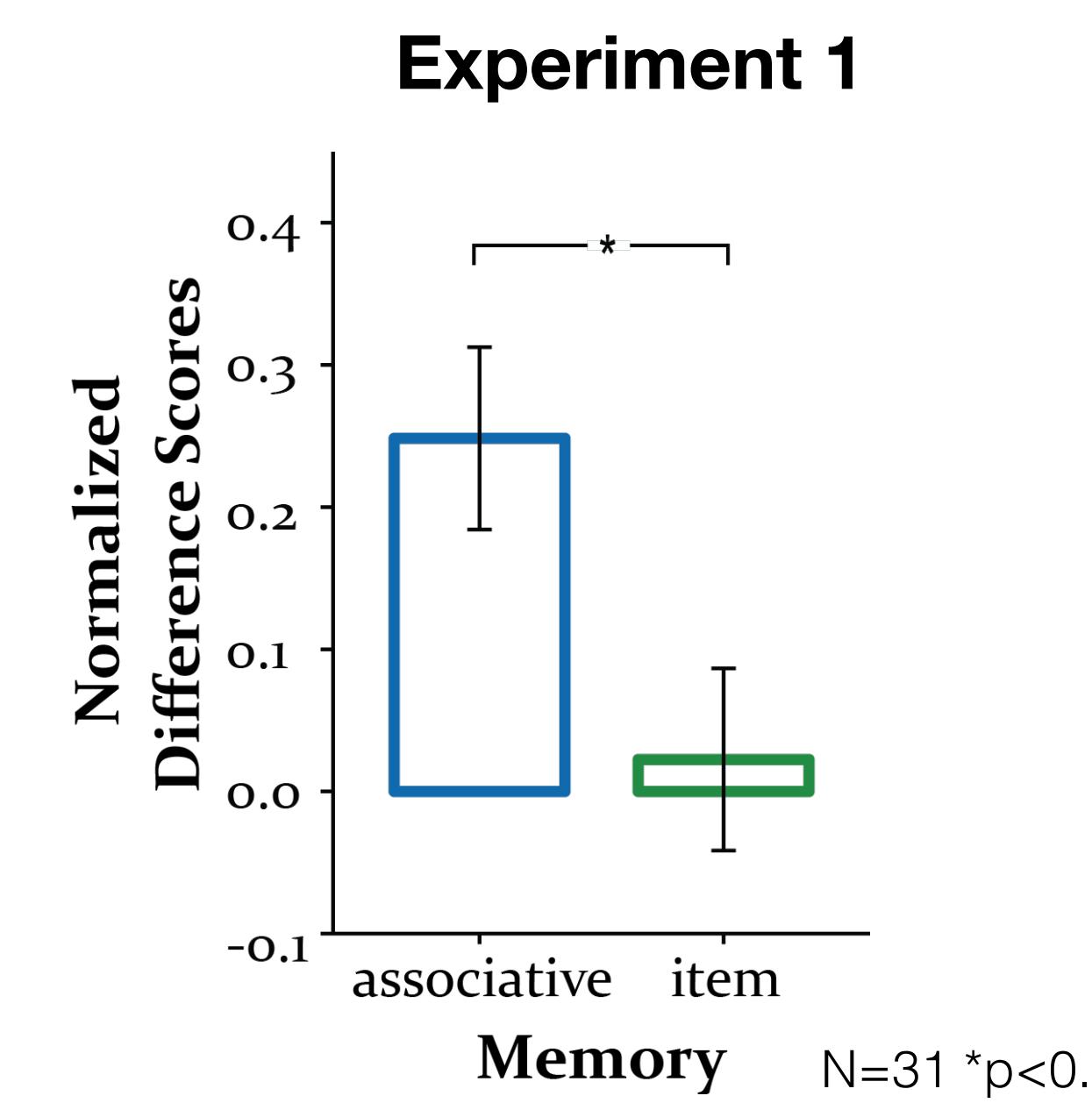
Pattern Completion-Independent Memory: Assessed item memory in the absence of correct associative memory as a function of judgment on the preceding trial



Preceding memory judgments did not influence item memory. No effect emerged even with short delays between trials.

Associative Memory vs. Item Memory

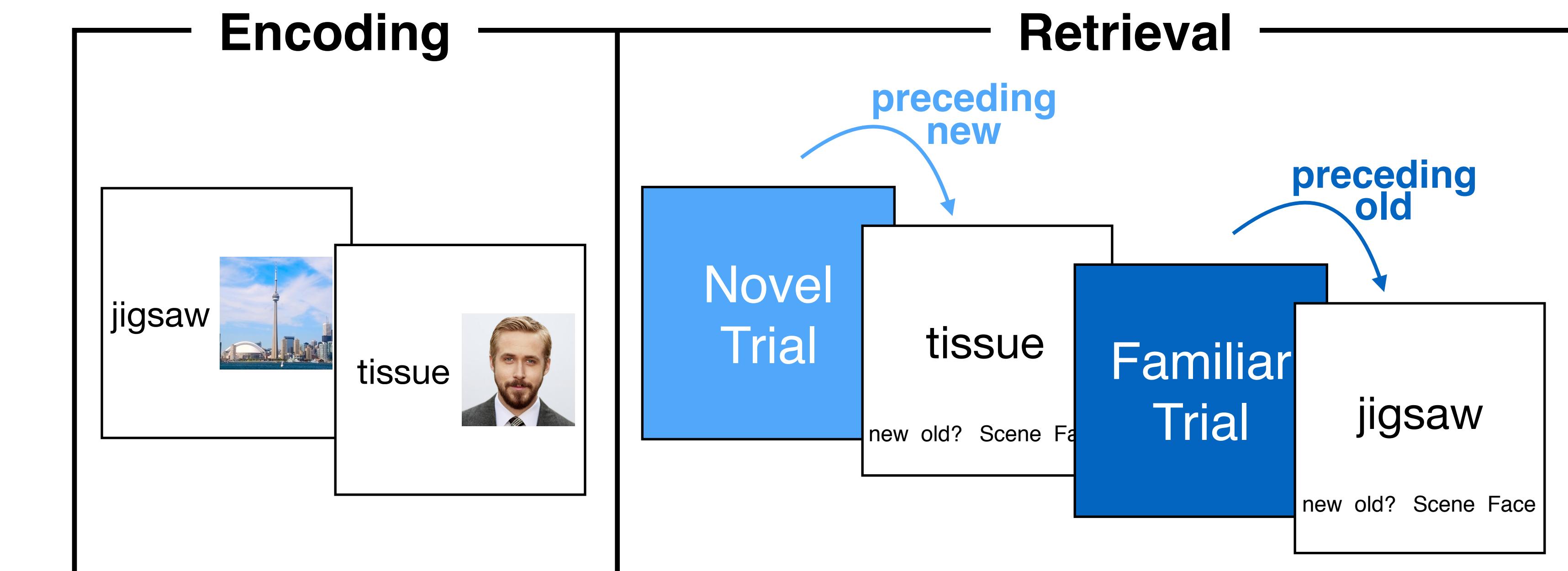
Directly compared preceding judgment's influence on associative and item memory by calculating normalized difference scores ($[prec\ "old" - prec\ "new"]/\text{average memory}$)



Recent familiarity did not benefit memory retrieval as a whole; benefit was selectively observed for associative memory, which depends on pattern completion.

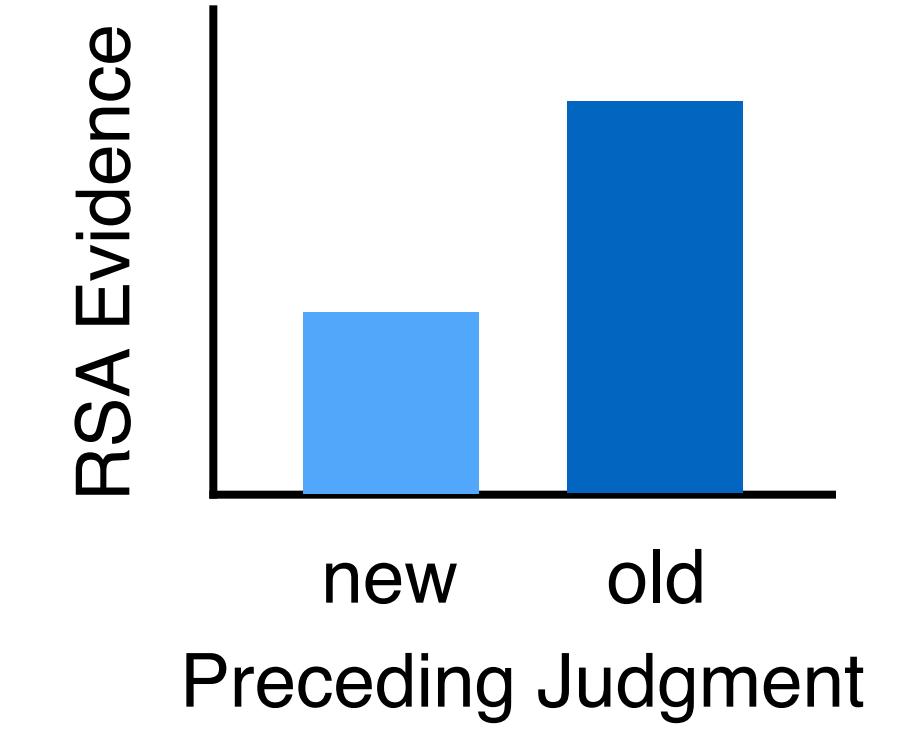
Planned fMRI Design

We will use fMRI to investigate how mnemonic states influence **neural reactivation of memories** by using of decodable **stimulus categories**.



Question 1

Does recent familiarity vs. novelty influence multivariate evidence of memory reactivation?



Question 2

Does the univariate signal during novelty/familiarity detection predict the multivariate reactivation of famous faces and scenes on the following trial?

Summary

We used a subtle, biologically motivated manipulation to shape memory retrieval and investigate the existence of mnemonic states.

Recent familiarity judgments have the power to elicit **lingering mnemonic states** that:

- Facilitate subsequent **pattern completion-dependent** retrieval of associations
- Do not influence item memory**, which is supported by extrahippocampal processes⁵
- Last for seconds**, consistent with the timescale of cholinergic modulation³

Processes that unfold *prior* to stimulus onset can have profound and selective behavioural consequences.

Identifies factors which may elicit pre-stimulus states, opening the door for interventions that can harness mnemonic states to create tailored learning environments.

References

- ¹ Treves, A., & Rolls, E. T. (1992). Computational constraints suggest the need for two distinct input systems to the hippocampal CA3 network. *Hippocampus*, 2(2), 189-199.
- ² Hasselmo, M. E., Schnell, E., & Barkai, E. (1995). Dynamics of learning and recall at excitatory recurrent synapses and cholinergic modulation in rat hippocampal region CA3. *The Journal of neuroscience*, 15(7), 5249-5262.
- ³ Hasselmo, M. E., & Fehlau, B. P. (2001). Differences in time course of ACh and GABA modulation of excitatory synaptic potentials in slices of rat hippocampus. *Journal of Neurophysiology*, 86(4), 1792-1802.
- ⁴ Duncan, K., Sadanand, A., & Davachi, L. (2012). Memory's penumbra: episodic memory decisions induce lingering mnemonic biases. *Science*, 337(6093), 485-487.
- ⁵ Brown, M. W., & Aggleton, J. P. (2001). Recognition memory: what are the roles of the perirhinal cortex and hippocampus? *Nature Reviews Neuroscience*, 2(1), 51-61.