

Shifting the balance between pattern separation and completion:

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

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Introduction

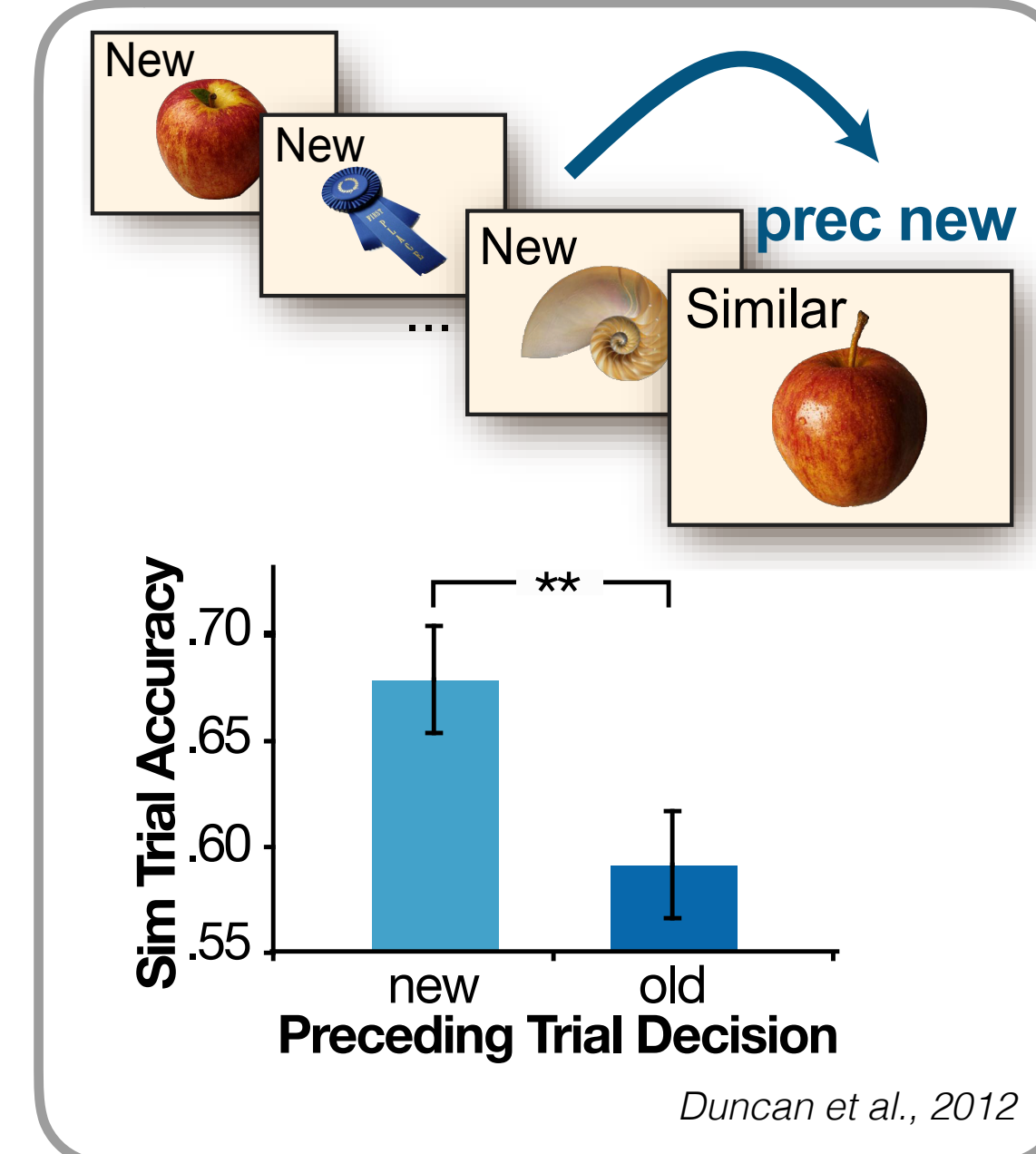
The hippocampus is implicated in episodic memory encoding and retrieval.

Computational models propose that **conflicting processes support encoding (pattern separation) and retrieval (pattern completion)**¹.

Slow acting cholinergic modulation may bias the hippocampus towards separation or completion states².

There is behavioural evidence that novelty exposure can evoke **temporally-extended memory states** towards pattern separation³.

In this study, we investigate the effect of recent novelty and familiarity on pattern completion.



How do recent memory decisions affect associative memory retrieval and recognition accuracy?

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 source memory assessed simultaneously

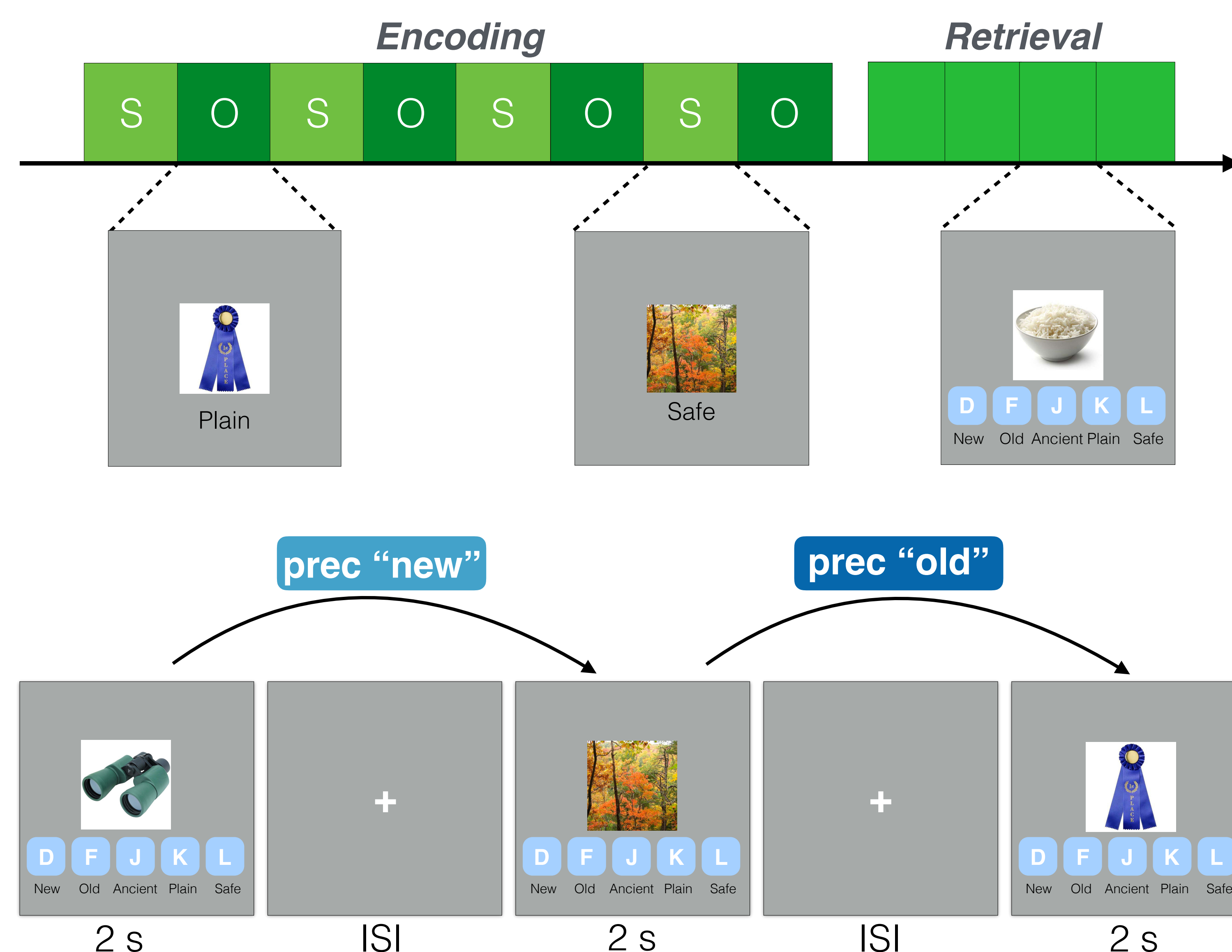
Manipulation: Memory decisions occurred after an unrelated novel or familiar image

Experiment 1

N = 32
Encoding: 242 trials
Retrieval:
484 trials
ISI = 1 s

Experiment 2

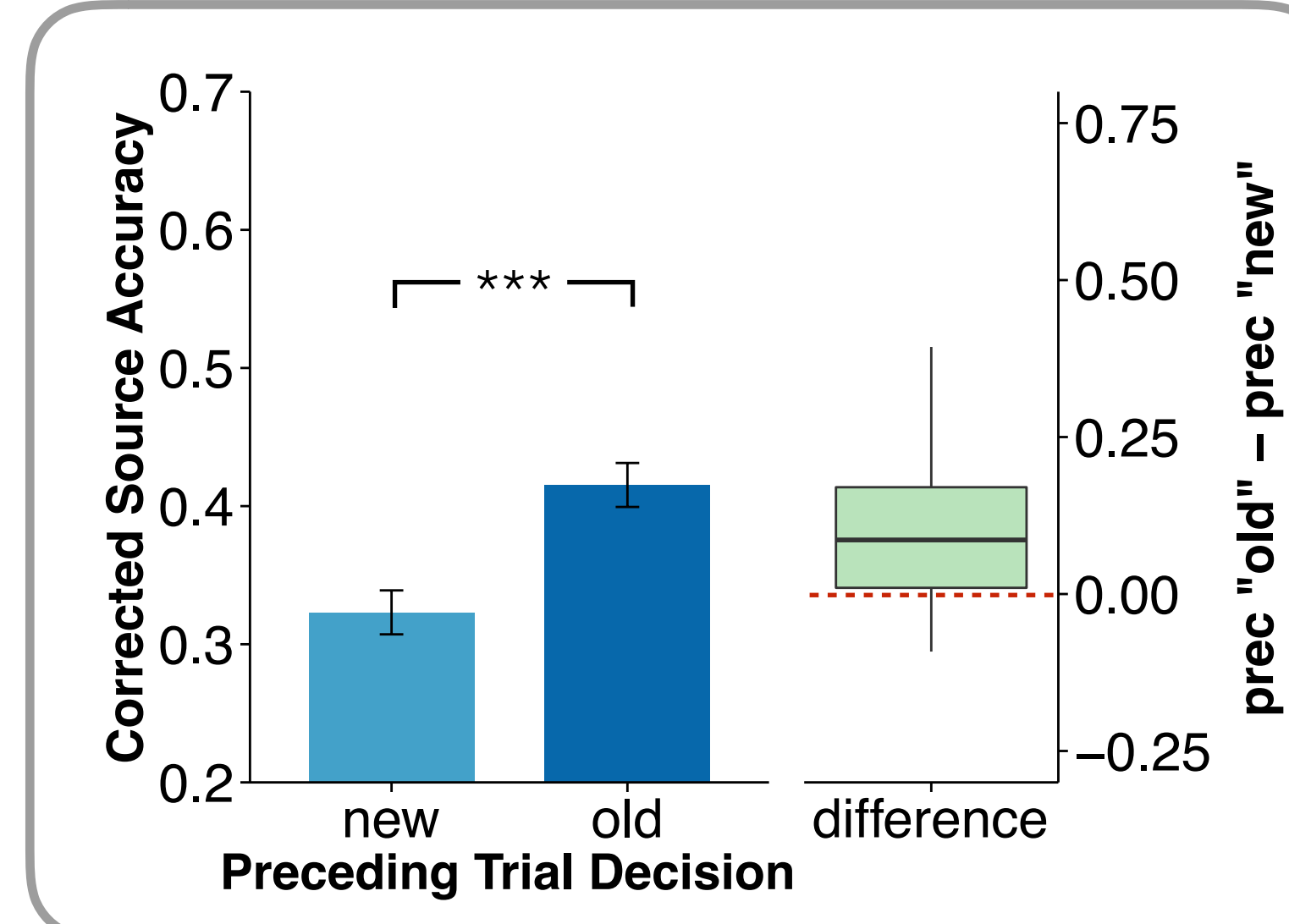
N = 48
Encoding: 196 trials
Retrieval:
392 trials
ISI = 1 s (short), 4 s (long)



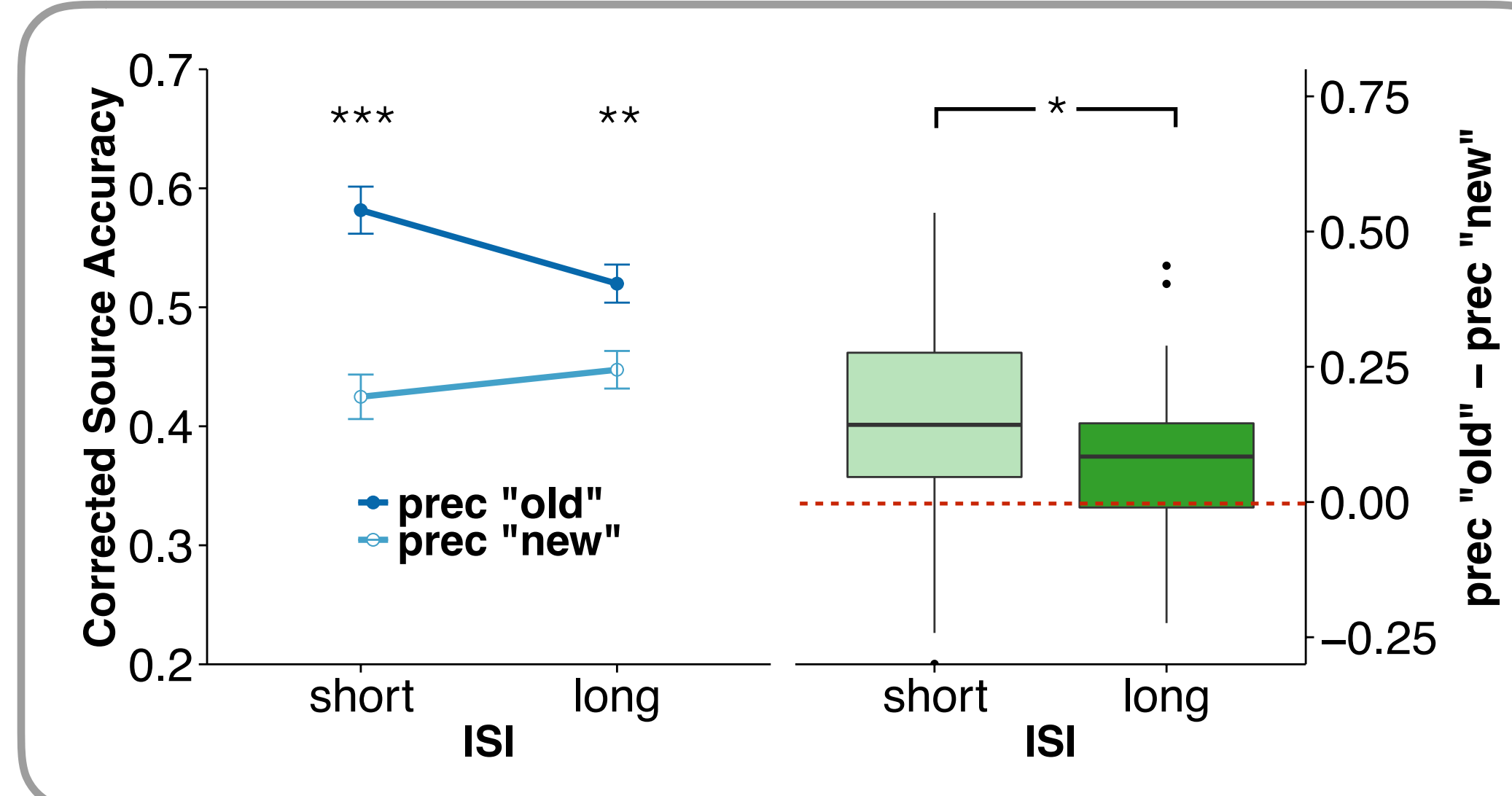
Source Accuracy

Assessed source memory for associated words on trials correctly recognized as old as a function of preceding trial decision

Experiment 1



Experiment 2



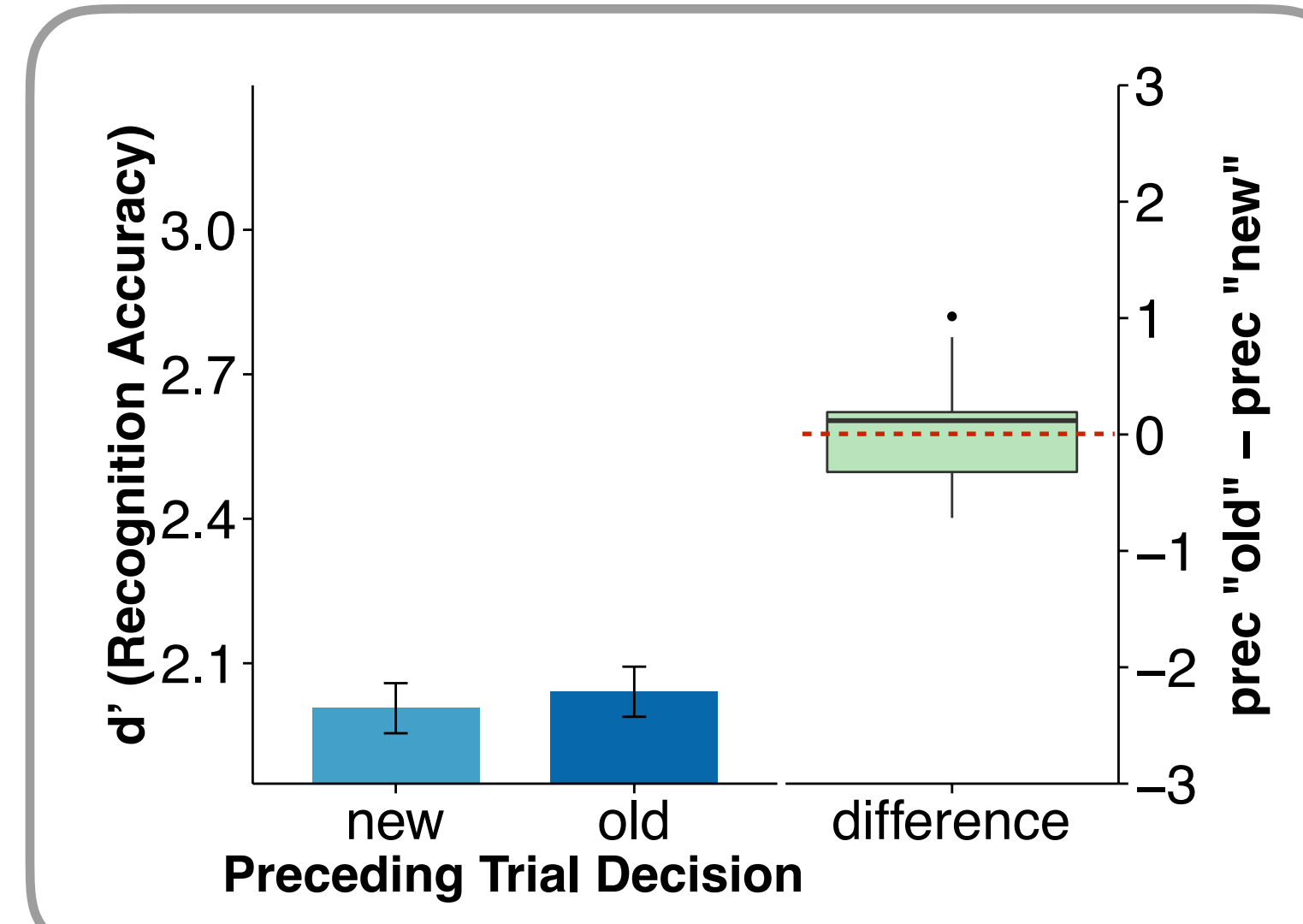
*p<0.05 **p<0.01 ***p<0.0005

Participants were more accurate at retrieving source memories after identifying an unrelated image as *old* compared to *new*. This effect was time-dependent.

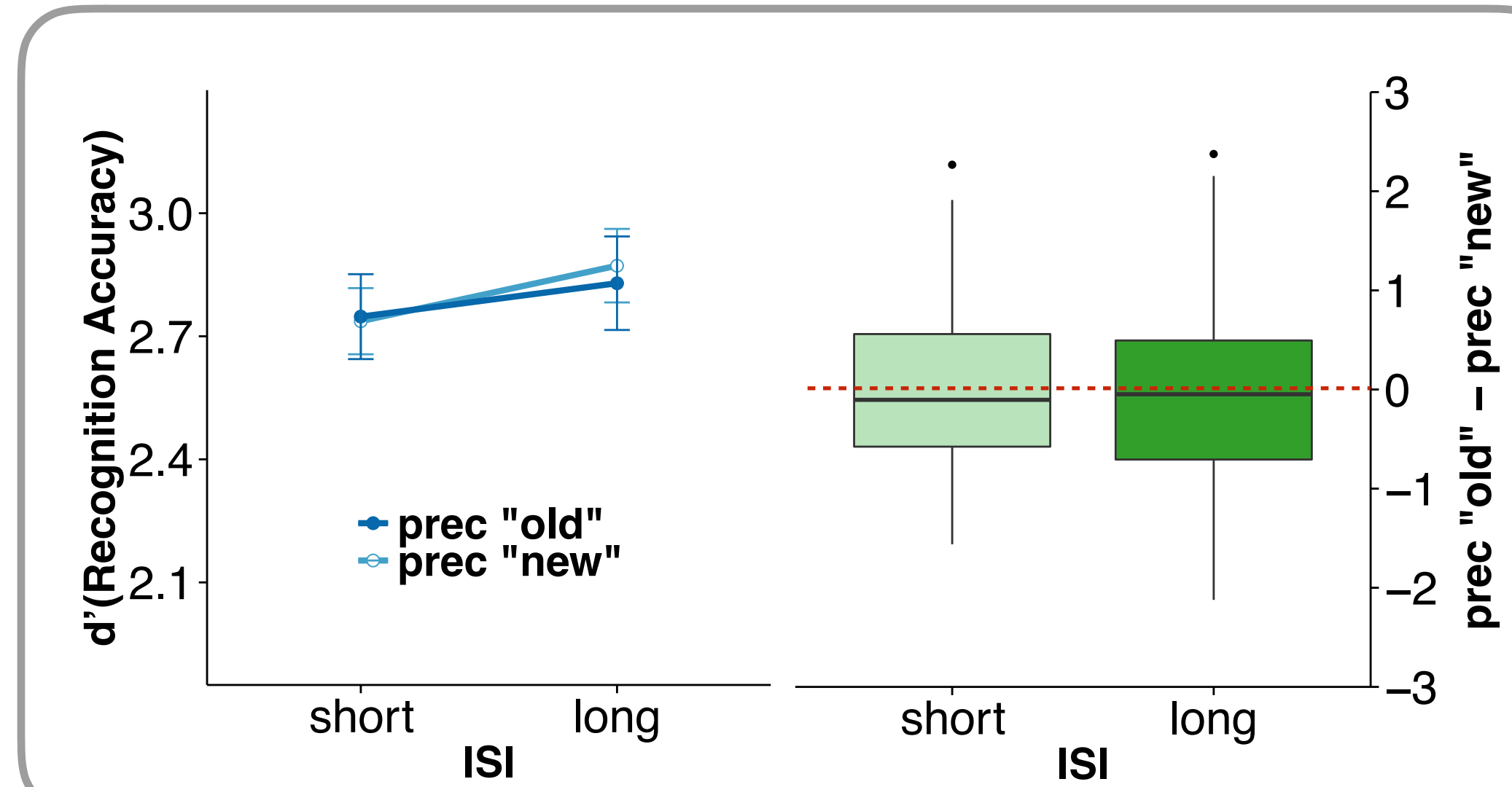
Recognition Accuracy

Assessed item recognition accuracy in the absence of correct word source memory as a function of preceding trial decision

Experiment 1



Experiment 2



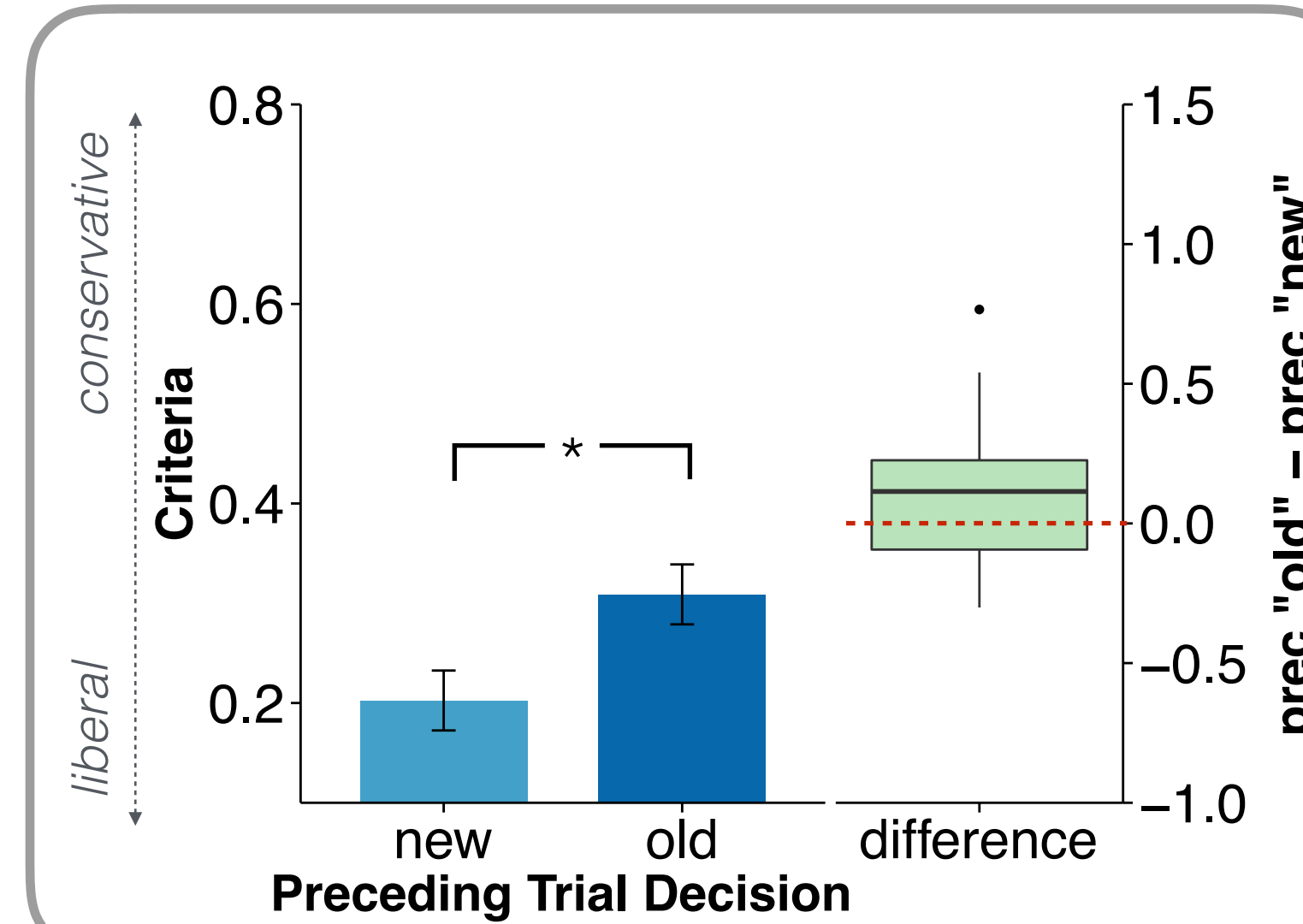
Preceding memory decisions did not influence recognition accuracy. No effect emerged even when introducing longer delays between trials.

Recognition Decision Criteria

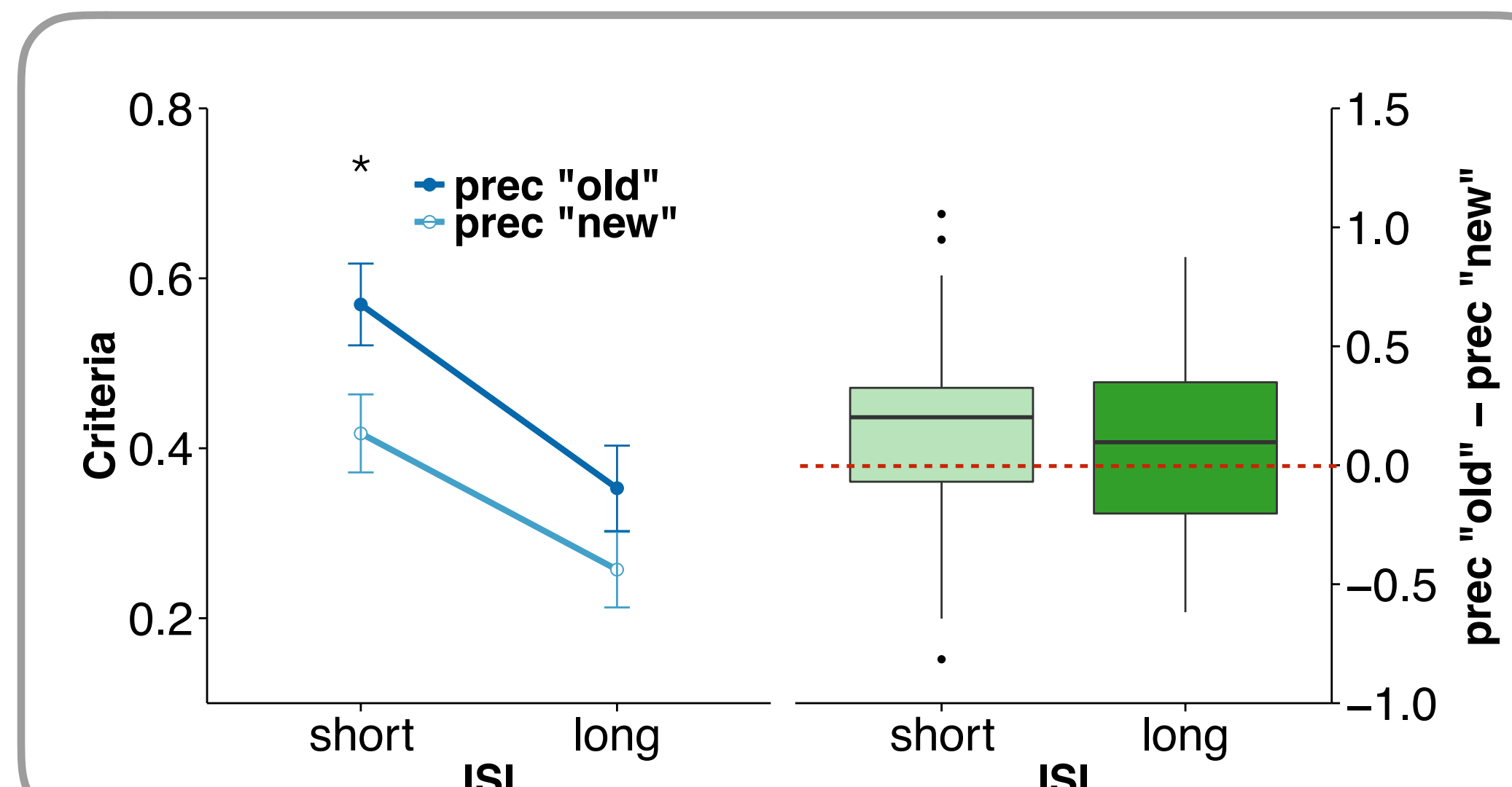
Assessed recognition criteria in the absence of correct word source memory as a function of preceding trial decision

$$C = -(Z_{hit} + Z_{FA})/2$$

Experiment 1



Experiment 2

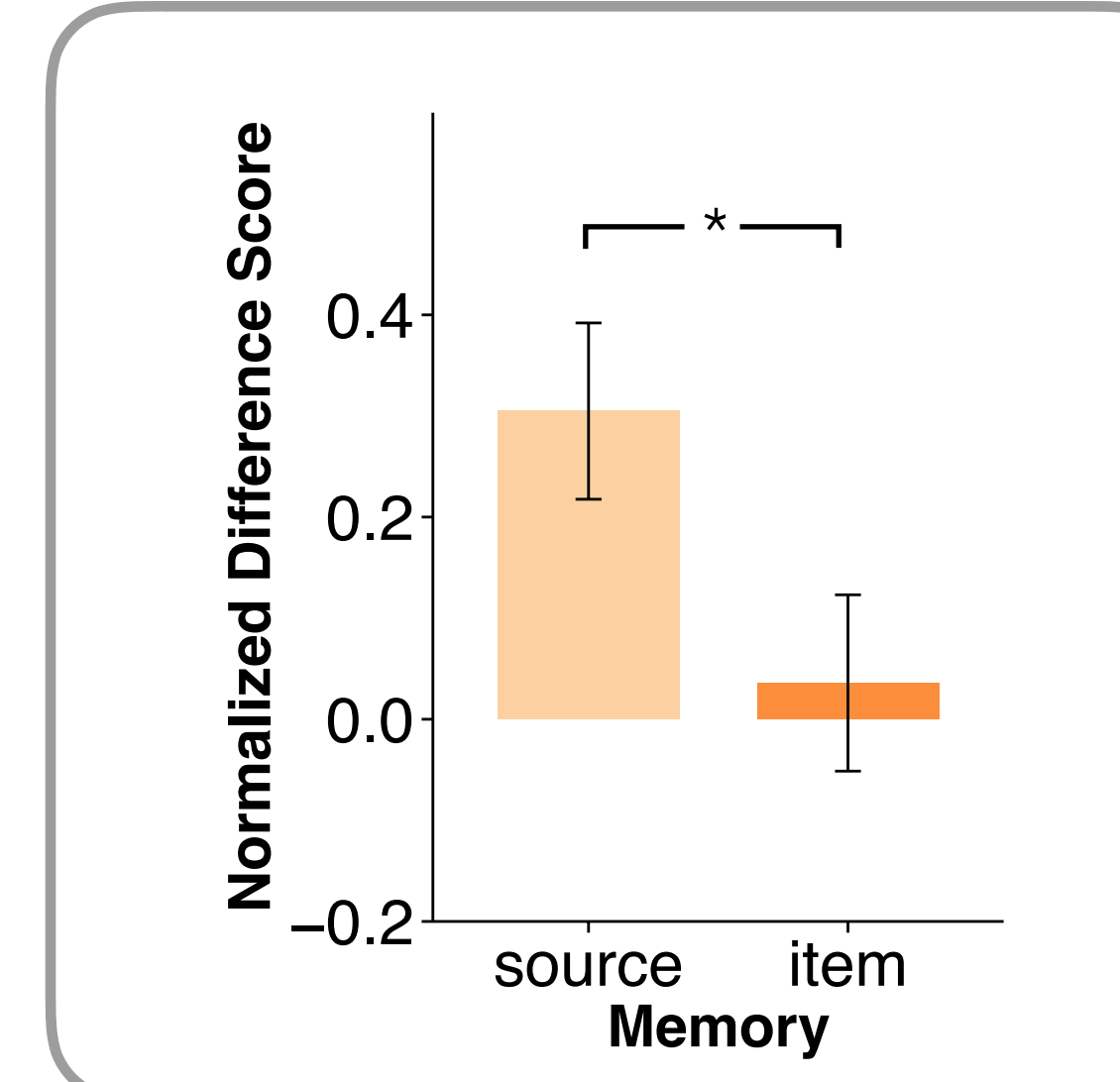


Participants were more likely to think an image was new after identifying an unrelated image as *old* compared to *new*. Participants were more liberal after longer delays.

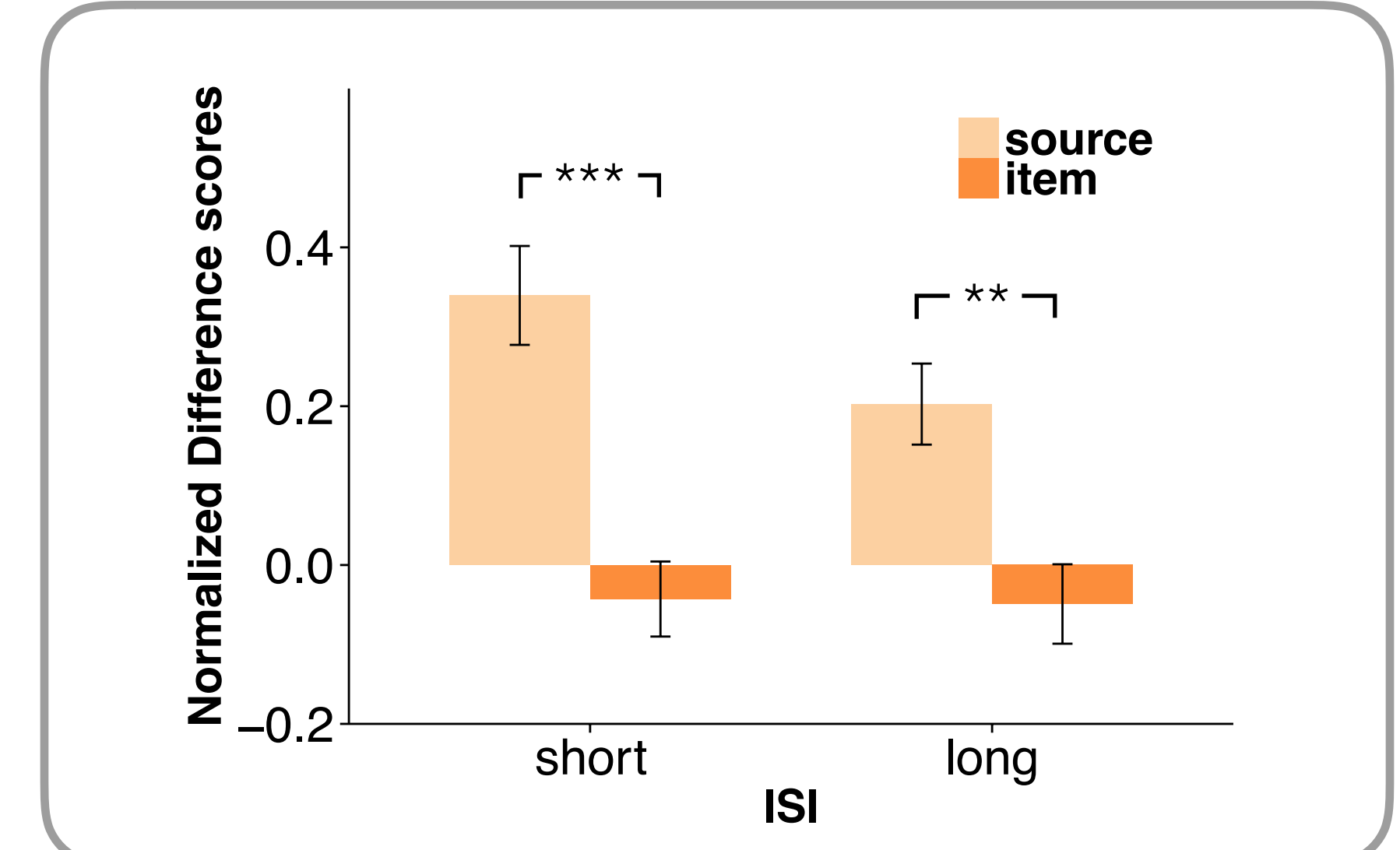
Source Memory vs. Item Recognition

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

Experiment 1



Experiment 2



Recent familiarity does not benefit memory retrieval as a whole; accuracy benefit was selectively observed for source memory but not item memory.

Summary & Future Directions

Recent familiarity selectively benefits memory retrieval processes that rely on hippocampal pattern completion, consistent with computational models proposing the existence of memory states.

Boost in associative retrieval was not driven by response priming or conceptual priming.

The decay of the source accuracy benefit over time indicates that:

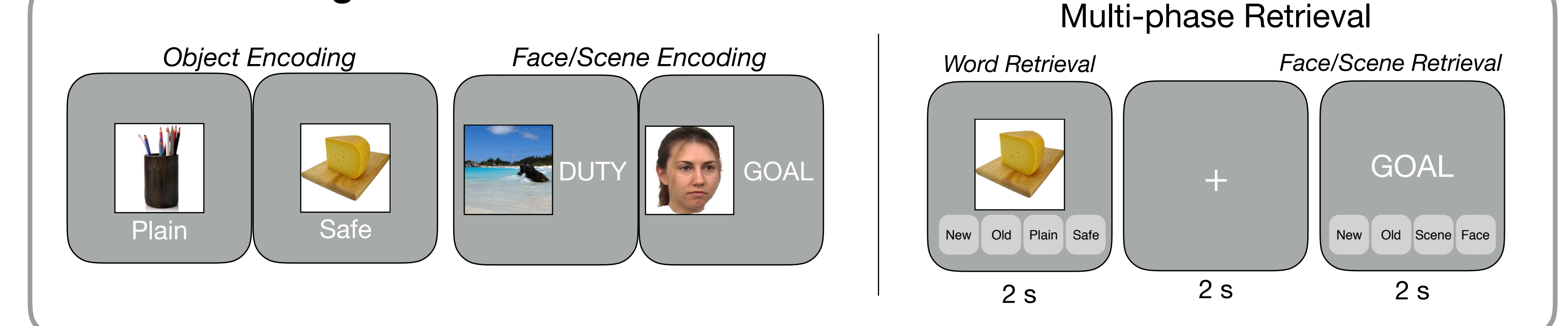
- the boost in associative retrieval is time-dependent, which is consistent with the timescale of cholinergic modulation of the hippocampus;
- preceding familiarity enhances subsequent source retrieval rather than preceding novelty inhibiting it.

Recognition accuracy is not influenced by recent familiarity but the criteria used to make decisions is — items are more likely judged as being 'old' following the detection of a novel item.

The delay between decisions also influences the criteria used to make recognition decisions by making people more liberal in their judgements.

Future studies will use functional neuroimaging to investigate how memory states influence neural reactivation of memories.

FMRI Paradigm



References

- O'Reilly, R. C., & McClelland, J. L. (1994). Hippocampal conjunctive encoding, storage, and recall: avoiding a trade-off. *Hippocampus*, 4(6), 661-682.
- 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.
- Duncan, K., Sadanand, A., & Davachi, L. (2012). Memory's penumbra: episodic memory decisions induce lingering mnemonic biases. *Science*, 337(6093), 485- 487.