



Towards a model of narrative free recall

Gabriel Kressin Palacios, Dhruva Arekar, Xian Li, & Christopher J. Honey
Johns Hopkins University

What determines our recollection of a sequence of events?

- > Models such as the [context maintenance and retrieval model](#)¹ (CMR) account for many properties of human memory.
- > Models are usually fit to recall for lists; it is not known how well they account for recall of meaningfully related sequences of events.
- > [Causal associations](#) play an important role in narrative recall²⁻⁴.

How can we extend CMR to account for causal structure of narratives?

Methods

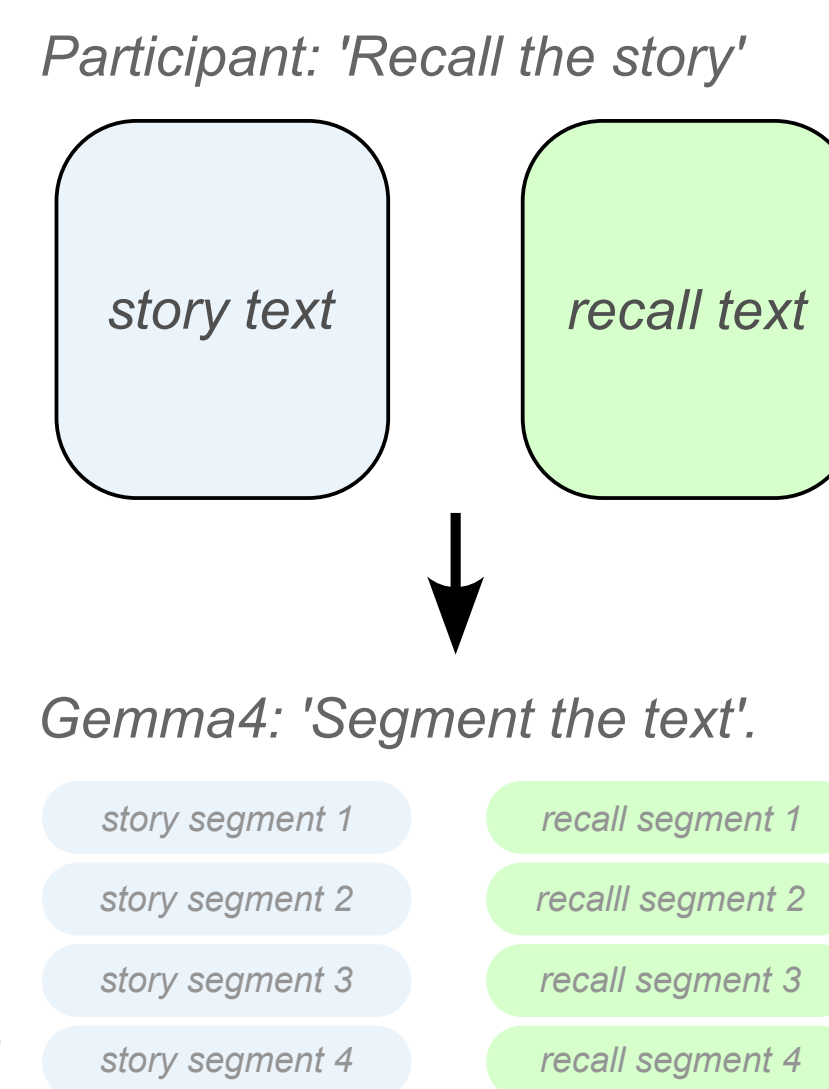
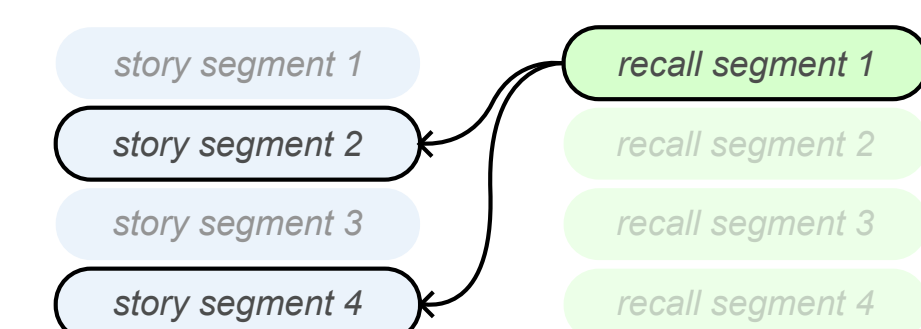
Naturalistic Free Recall Dataset
*Chen et al. 2025*⁵

Segmentation

adapted from
*Michelmann et al. 2023*⁶

rMatch
Matching

Gemma4: Which segments match?

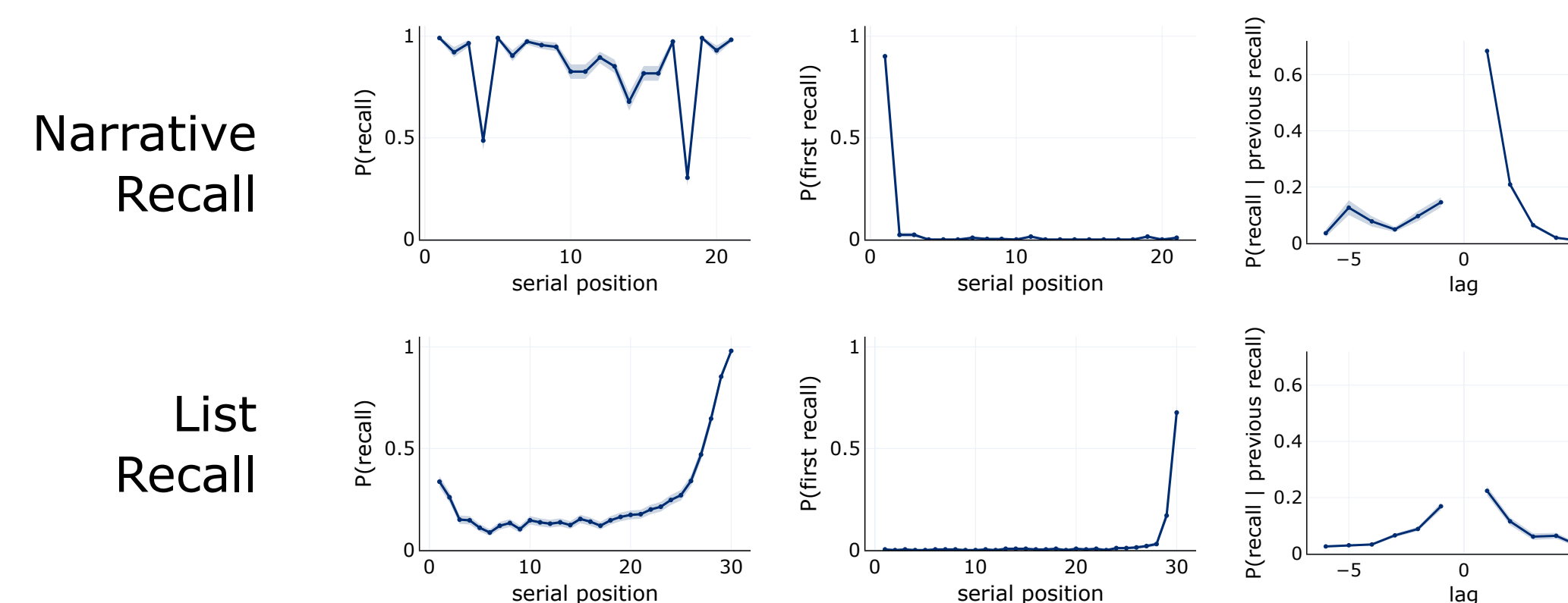


*Li et al. 2024*⁷
Causal Rating

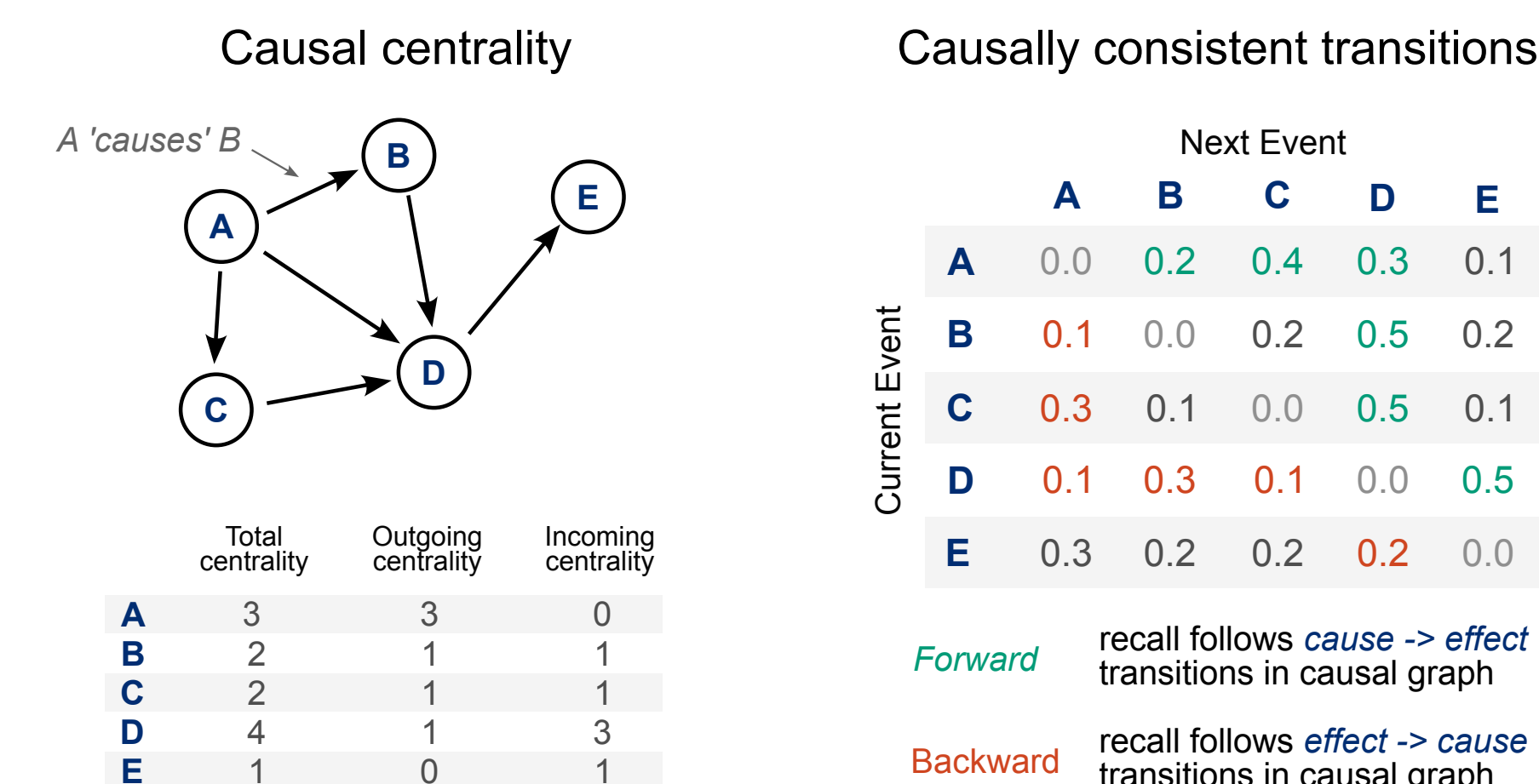
chatGPT: What does segment cause?



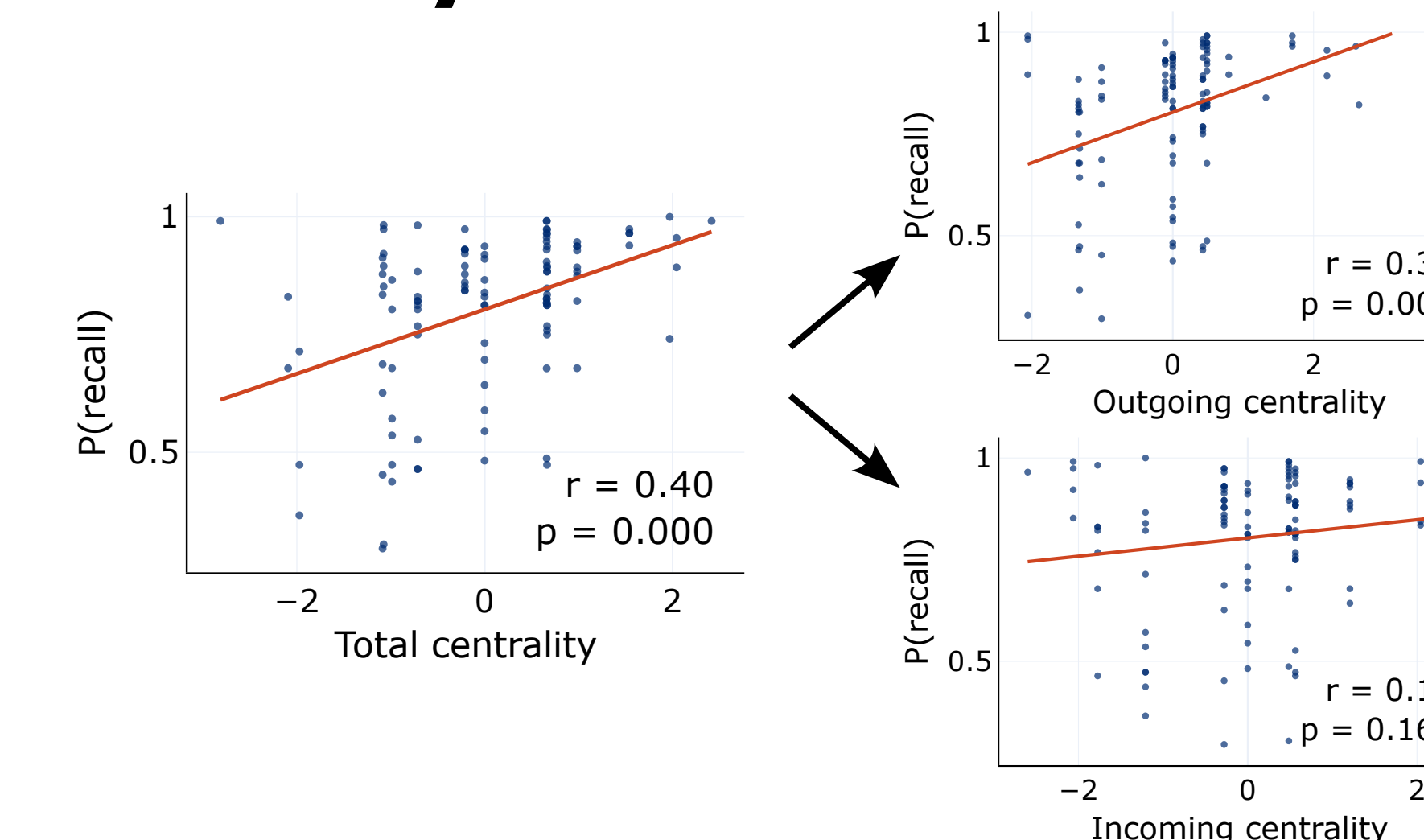
Narrative recall differs from list recall



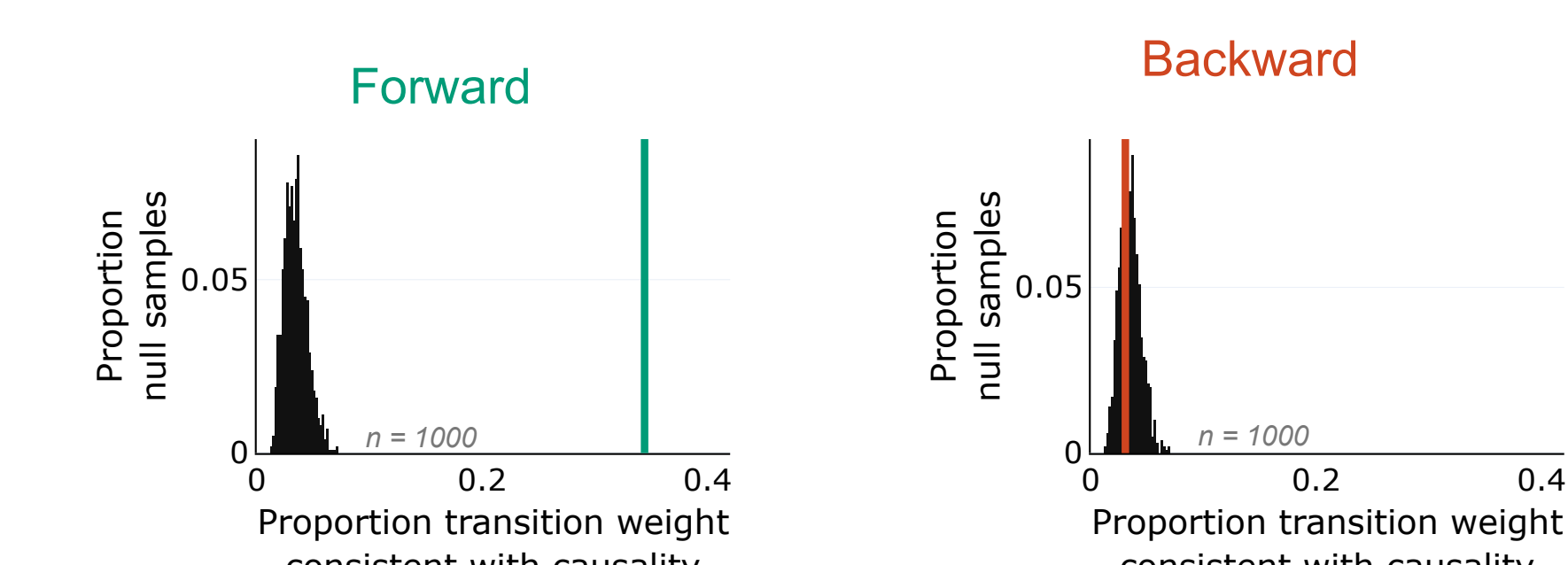
Measuring causal influence



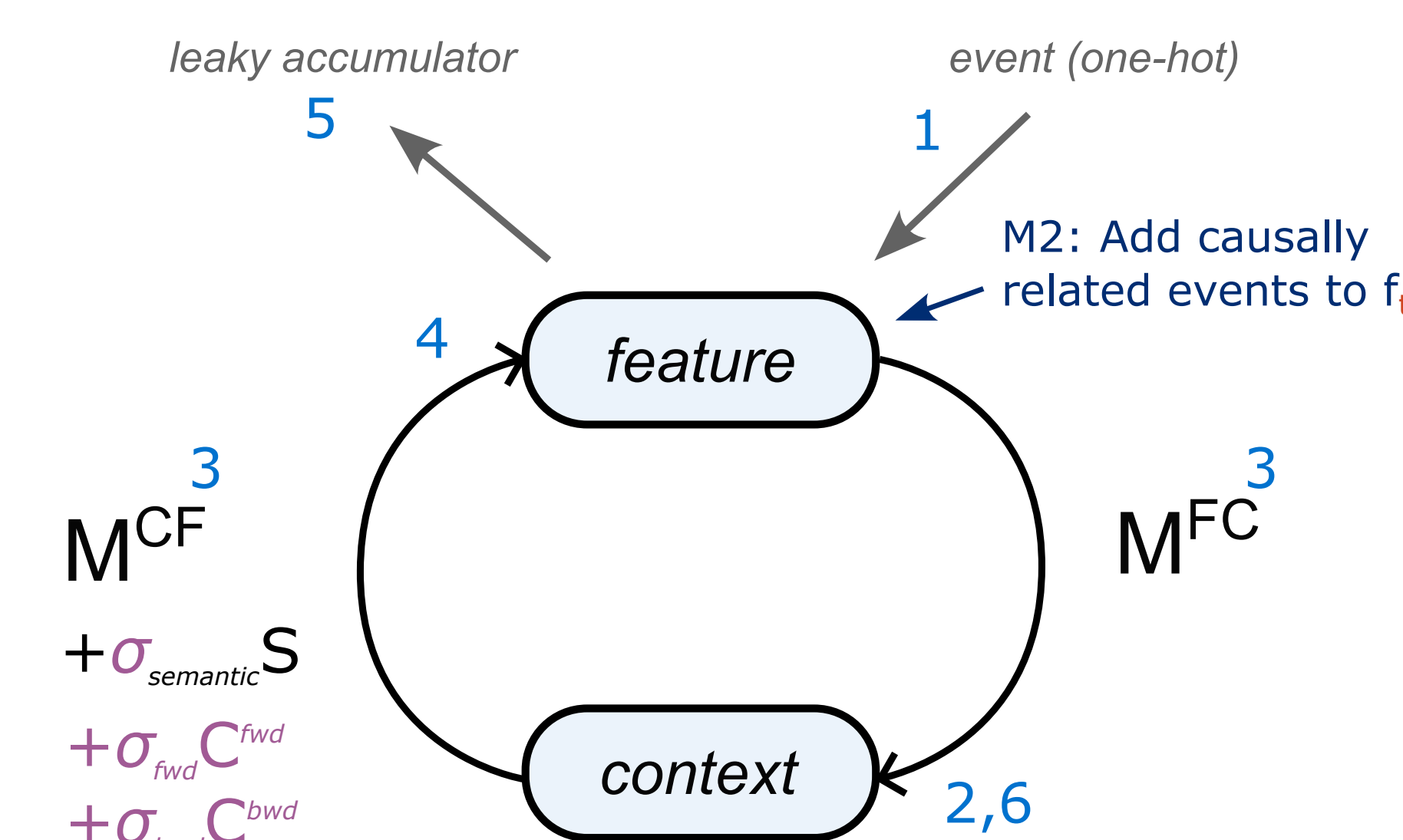
Causal centrality predicted memory



Recall followed forward causal transitions



CMR Model



Encoding

Present item f

Evolve context

$c_{in} = M^{FC} f_t$

$c_t \sim c_{t-1} + c_{in} \beta$

Update M and M

(Hebbian rule)

Decoding

4 Compute feature projection from context

$f_{in} = M^{CF} c_t$

5 Events compete for retrieval

(based on projection)

Evolve context with retrieved item

Variants

Simple CMR CMR without source context

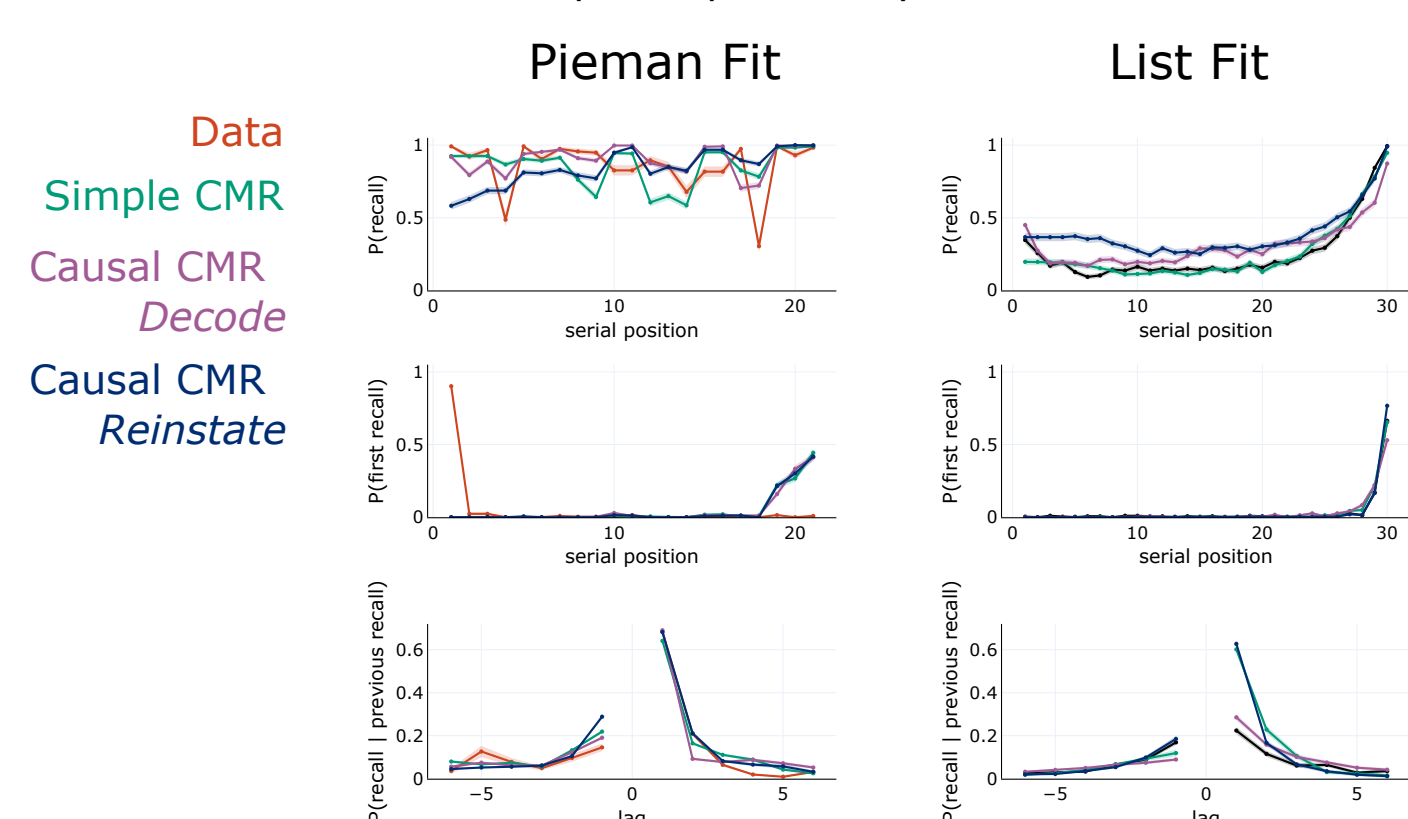
Causal CMR Decode Causal association matrix c influences recall at decoding (weighted by σ).

Causal CMR Reinstate Reinstating context of causally related events at encoding

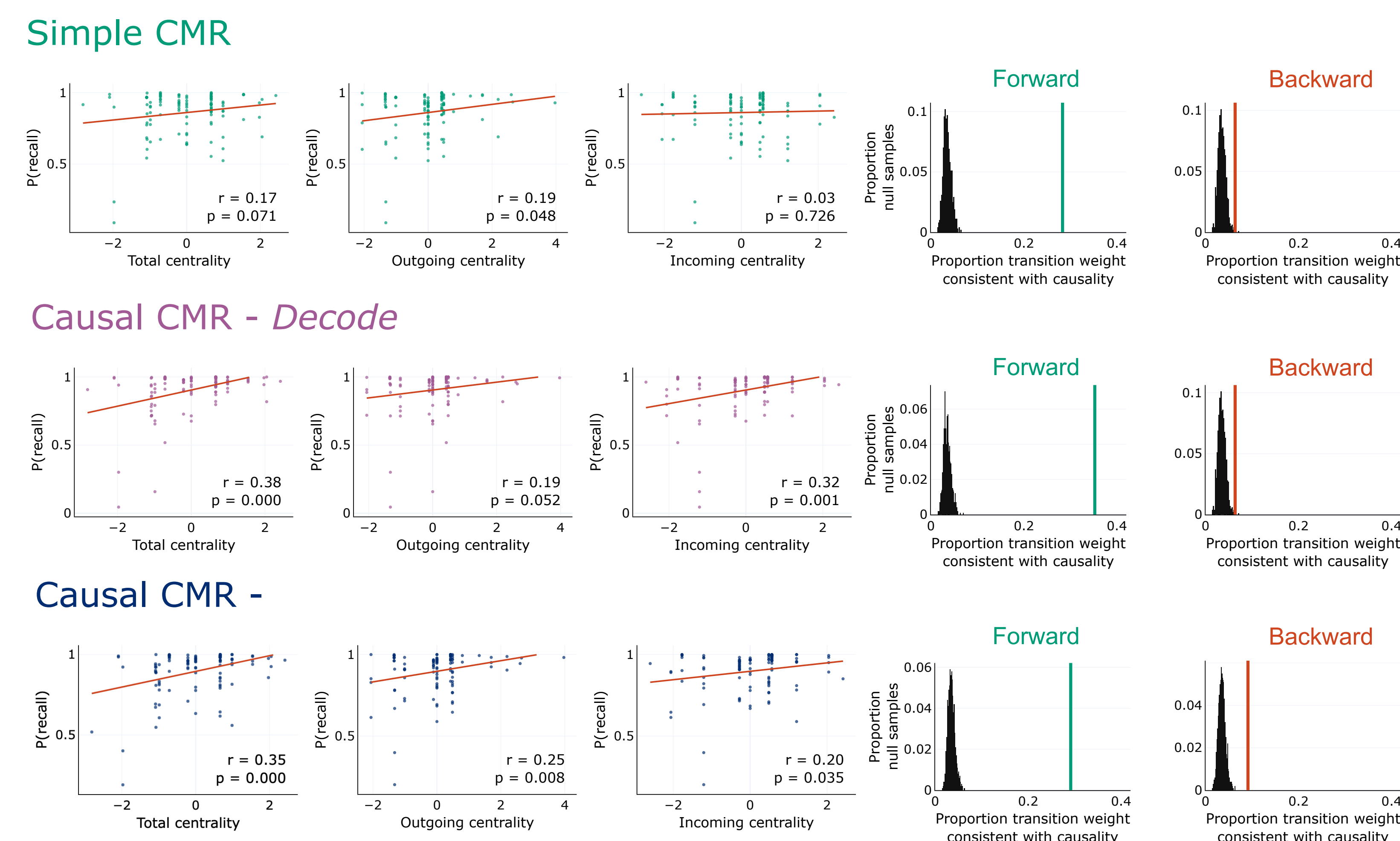
Model Fit

Used genetic algorithm for both list learning and stories.

Evaluated model match to data for recall probability, probability of first recall, conditional response probability, and transition matrix.



Causal CMR can partly account for causal structure in recall



Conclusions

- > Causal CMR versions show potential to model influence of causality on recall. .
- > A step toward modeling free recall of narratives and word lists within a single framework.

Future steps

- > Test with causally complex stories
- > Fit to single participant
- > Model within- vs between- events
- > Proper data annotations

References

- Polyn et al. *Psychological Review* 116, no. 1 (2009)
- Antony et al. *Journal of Cognitive Neuroscience* 36, no. 11 (2024)
- Trabasso, & Van Den Broek. *Journal of Memory and Language* 24, no. 5 (1985)
- Chenet et al. *Nature Neuroscience* 20, no. 1 (2017)
- Racah et al. *Scientific Data* 11, no. 1 (2024)
- Michelmann *Behavior Research Methods* 57, no. 1 (2025)
- Li et al. *Preprint, OSF*, December 5, 2024