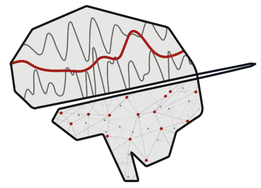
# The diminishing precision of temporal information in episodic memory retrieval

John E. Scofield (jel7c5@mail.missouri.edu; @jscofield24)
Jeffrey D. Johnson (jeffreyjohnson@missouri.edu)



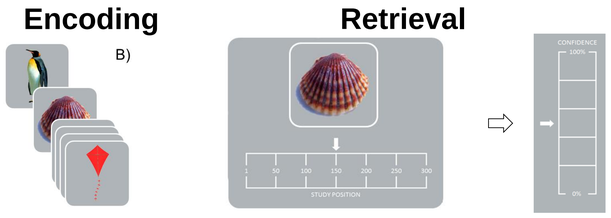
memoryneurolab.org

## Background

- Episodic memory retrieval is often thought to be based in part on the recollection of qualitative information associated with encoded events.[1]
- Previous studies of working and long-term memory have employed a **mixture-modeling** approach in which the recollection of continuous features of memory (e.g., color or space; see right) is fit with two parameters: the proportion of uniformly distributed guesses and the precision of recollecting the feature.[2]
- **We apply the mixture-modeling approach here to understand how another continuous dimension—the time when a memory is encoded—is retrieved.**[3]
- Two experiments addressed the following questions:
  - **How precise are retrieval judgments of time?**
  - **Does guessing play a role in temporal retrieval?**
  - **Can we track temporal precision with scalp EEG?**

## Temporal retrieval task

- Two experiments (Expt. 1: N = 32; Expt. 2: N = 6) had a single encoding phase followed by a retrieval phase.
- During encoding, a series of pictures were presented for 3000 ms each with a 500-ms ISI (+). Subjects rated the pleasantness of each picture on a 4-point scale.
  - Expt. 1: 300 pictures, ~17.5 minutes
  - Expt. 2: 1500 pictures, ~31 minutes
- At retrieval, all encoded pictures were presented again (exp2 500/1500). Subjects first made a continuous judgment of the picture's encoding time (i.e. position along a timeline), followed by a confidence rating (0 to 100) about their time judgment.

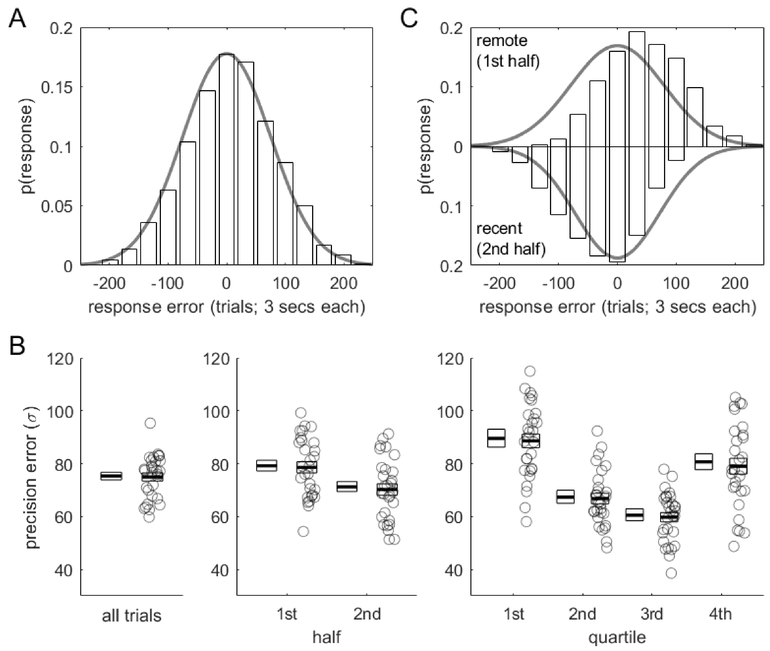



## Data analysis & modeling

- Exp1: Mixture-modeling estimated 2 parameters: **Precision error (*SD*)** standard deviation of a normal distribution fit to trial errors (actual – response). **Guessing (*G*)** uniform distribution accounting for non-recollected trials.
- Exp2: Scalp EEG was recorded from 59 electrodes (1 kHz sampling rate, .01-100 Hz bandwidth). Offline, the data were downsampled to 200 Hz, re-refrenced to mastoid average, and epoched (-200 - 2500 ms, relative to stimulus onset). After ICA-based artifact removal, epochs were band-pass filtered (.05-40 Hz) and baseline corrected.
- Trial-level multilevel regressions were run predicting behavioral precision from scalp-EEG.

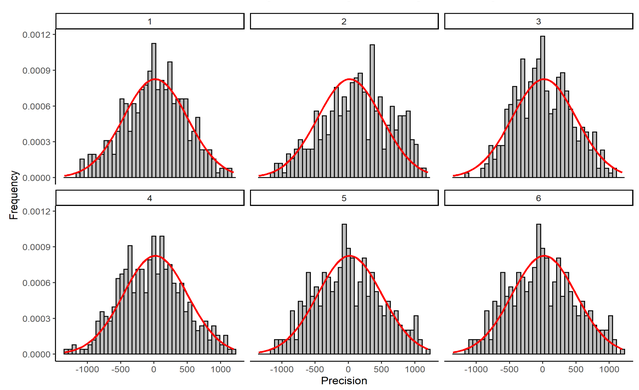
## Experiment 1 Results

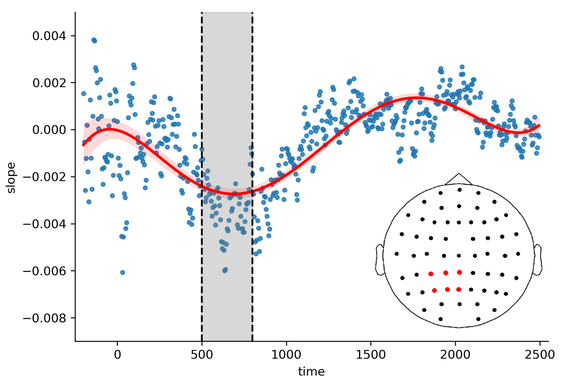
- Subjects distributed their encoding position responses across the timeline
- Group precision was estimated at 75.32, HDI [73.93, 76.80], and was very similar at the individual subject level (*M* = 74.95, *SD* = 8.32)
- **Temporal precision changes with passing time**. Subject-wise Mixture modeling applied in the first- and second-halves of the study list indicated that precision was better for items studied more recently (*M* = 70.21, *SD* = 11.70) than remotely (*M* = 78.59, *SD* = 11.38), *t*(28) = 2.84, *p* = .008, *BF10* = 3.78
- **Temporal judgments exhibit a recency bias**. Responses tended to be more recent than the correct position. The fit of a 2-parameter model, including a parameter to model a shift in the mean of the normal distribution estimated the recency bias to be about 7.7 items (*SD* = 13.49). Model comparison indicated that having both parameters was preferable to a one parameter model. ΔBIC = 44.63.
- **Guessing is negligible in temporal judgments**. The guessing parameter was estimated to be near zero for the subject-based modeling (*M* = .0075, *SD* = .016). To further test the finding that guessing was negligible, we directly compared the 2- and 3-parameter models, the results of which favored the former, ΔBIC = 10.46




## Experiment 2 Results

- Experiment two featured a high-trials, small-N design (N=6). Subjects encoded 1,500 pictures and were tested on 500 pictures.
- Temporal precision distributions are similar across subjects.
- Using trial-level mixed effects modeling, clusters of timepoints across several electrodes predicted temporal precision (*thresholded p < .01)*
- Scalp maps reveal that the magnitude of the effects were most evident in left central and parietal electrodes.
- In a cluster of left parietal electrodes, higher LPE amplitude was associated with decreased (*better*) temporal precision.







## Summary & conclusions

- We present novel evidence characterizing the precision of recollecting temporal information associated with episodic memories, its decline over time, that subjects tend to judge items as more recent, and that guessing is negligible in retrieving temporal items.
- Additionally, using a small-N design, we were able to track behavioral precision estimates with scalp EEG, revealing that amplitude within 500-800ms of stimulus onset predicted behavioral precision.

## References

1. Harlow & Donaldson (2013) *Psychonomic Bulletin & Review*.
2. Harlow & Yonelinas (2016) *Memory*.
3. Montchal, Reagh, & Yassa (2019) *Nature Neuroscience*.

**Poster & Updates!**