Reinstatement of temporal context observed with human scalp EEG during successful episodic memory retrieval

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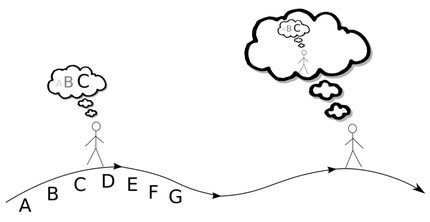
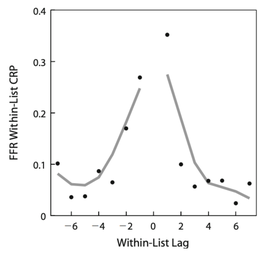
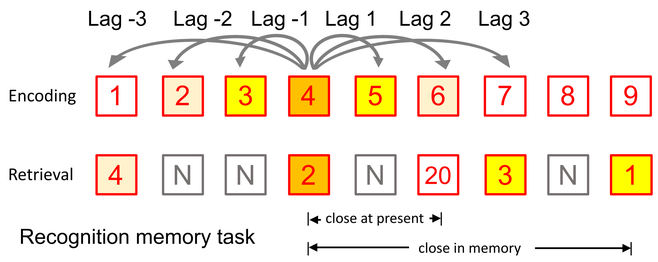
1. Introduction



Computational models of episodic memory hypothesize that it is associated with recovery of a prior state of temporal context [1]. However, thus far neural mechanisms that support this jump back in time (JBIT) have required invasive measurement [2-4]. In this study we report a robust neural JBIT effect observed with scalp EEG in healthy human subjects.

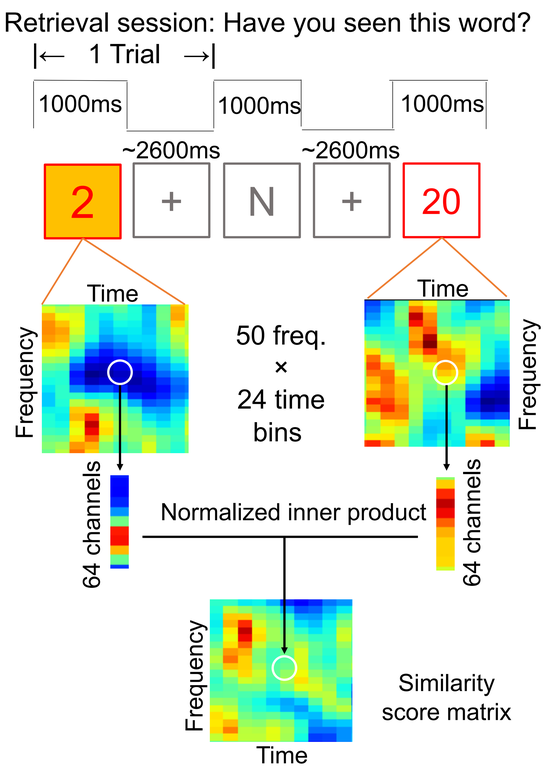
Contiguity effect: stimuli that occur close in time become associated to each other

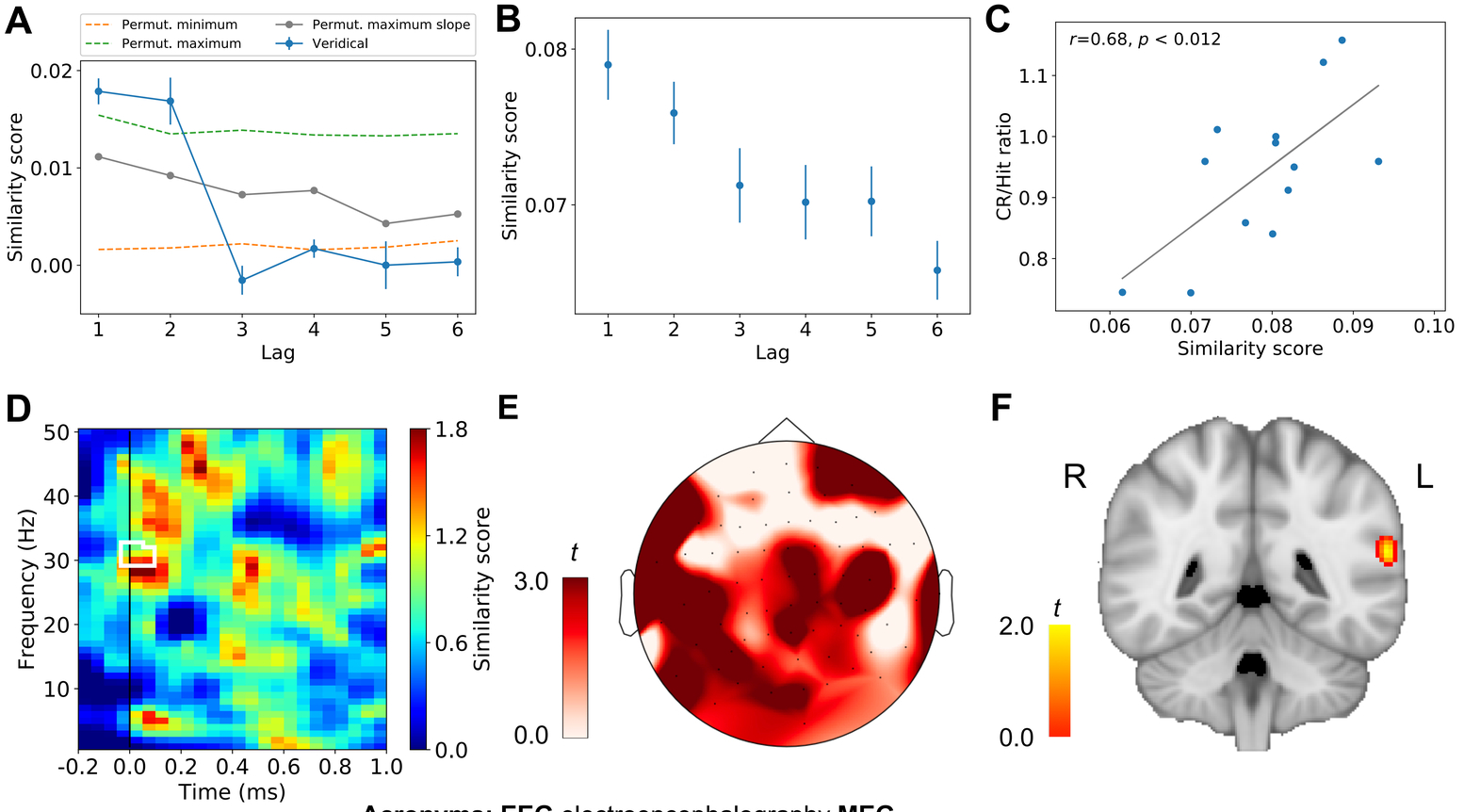




2. Methods

1) Thirteen subjects underwent simultaneous EEG/MEG recordings.
2) EEG signals were decomposed into time-frequency bins that cover a 1000 ms window after presentation of the probe and a frequency range of 1-50 Hz.
3) For each time-frequency bin, a feature vector of EEG amplitudes across 64 channels was used to compute the similarity scores.
4) Source current density was computed using combined EEG/MEG beamformer.





Acronyms: EEG electroencephalography **MEG** magnetoencephalography **CR** correct rejection

3. Results

A. EEG signals in the retrieval session showed the highest similarity (averaged over all time-frequency bins) between items that were immediate and second-order neighbors with respect to the encoding order.
B. Contiguity effect after excluding time-frequency bins with non-significant similarity scores.
C. The lag-1 similarity was significantly correlated with the ratio of CR versus Hit rates.
D. Time-frequency bins contributing the most to lag-1 & lag-2 similarity. The highest similarity scores were found in the gamma frequency within 200 ms from stimulus onset (white boundary).
E. The Hit-CR difference in the gamma frequency from the 0-200 ms time window showed a distributed pattern across electrodes, suggesting non-focal sources.
F. Source-localized gamma activity showed the highest Hit-CR contrast around 160 ms in the left posterior parietal cortex.

4. Conclusion

Items encoded in close temporal proximity elicit similar neural activity during retrieval. This mechanism can be captured by scalp EEG. These results open the door to non-invasive studies of neural JBIT mechanisms that support episodic memory.

5. References

[1] Howard & Kahana (2002) *J Math Psychol.*
[2] Manning et al. (2011) *PNAS.*
[3] Yaffe et al. (2014) *PNAS.*
[4] Folkerts et al. (2018) *J Neurosci.*
[5] Lohnas et al. (2018) *PNAS.*