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NEURAL MECHANISMS OF MEMORY CONTROL AND SELECTION

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Background: Our brains store memories of a vast number of past experiences. To guide behavior effectively we use external cues and strategic control to select which memories will be retrieved. Electroencephalography (EEG) provides time-resolved measures of the underlying neural processes, and we can neural signatures of recollection when people retrieve goal-relevant versus irrelevant memories. Here, we combined established and novel electrophysiological measures to understand selective memory retrieval.

Aims: We used multivariate decoding of scalp-recorded EEG patterns and the left parietal event-related potential (ERP) effect to investigate the neural dynamics of selective recollection, the impact of external memory cues and the goal representations proposed to enable memory selection.

Method: In two EEG experiments, people studied objects in two sources: a picture or auditory word format [1]. At test, one source at a time was targeted, using either written words (Experiment 1, $N = 28$) or line drawings (Experiment 2, $N = 28$) as external cues. We used a multivariate classifier to quantify reinstatement of study phase neural patterns when people successfully identified targets or non-targeted items. If recollection is selective, ERPs and reinstated neural patterns would be more pronounced for targets.

Results: The two EEG measures revealed distinct patterns of selectivity from 500-800 ms post-stimulus. The left parietal ERP was larger for targets than non-targets only when retrieval cues overlapped strongly with the targeted source (auditory words in Experiment 1, and pictures in Experiment 2; interaction $F(1, 54) = 38.04$, $p < 0.001$, $\eta^2_p = 0.413$). In contrast, neural pattern reinstatement was selective for whichever source overlapped more with the external cues [2], whether this was the targeted or the non-targeted format (robust $t(32) = 3.00$, $p = .010$, $\xi = 0.490$ and $t(32) = -2.71$, $p = .011$, $\xi = 0.356$). In both experiments ERPs also revealed goal-directed control, with preparatory reinstatement of targeted neural patterns in Experiment 1 as predicted by the encoding specificity principle (cluster $p = .006$, .023).

Conclusions: The data suggest that selection depends on both external cues and internal, goal-directed control. While neural pattern reinstatement tracked external cue overlap with stored memories, the left parietal ERP tracked both goals and cue overlap, suggesting that downstream processing may modulate initial neural reinstatement, in line with goals.

Keywords: Episodic memory, ERP, EEG, Multivariate decoding, Selective retrieval

Publications:

Moccia, A., & Morcom, A. M. (2022). Cue overlap supports preretrieval selection in episodic memory: ERP evidence. *Cognitive, Affective & Behavioral Neuroscience*, 22(3), 492–508. <https://doi.org/10.3758/s13415-021-00971-0>

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