Oscillatory correlates of enhanced memorability following a shift in the perceptual modality of studied material

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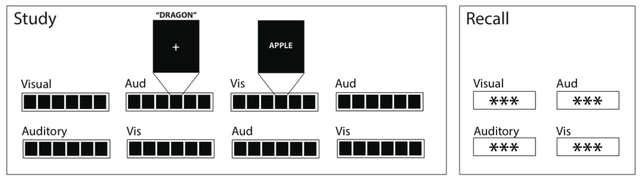
Introduction

Prior work by Sederberg et al. (2006) has examined how patterns of oscillatory activity change over list position. This research expounded on the neural correlates of an item's position within the list as well as its successful encoding, particularly with respect to start-of-list primacy effects.

Similar mid-list behavioral boosts to memorability have been observed following shifts in perceptual or task-related features (Geiselman, 1975; Polyn et al., 2009), but their neural correlates have yet to be examined. We aimed to characterize the oscillatory responses following perceptual shifts in stimulus properties in order to better understand the processes contributing to post-shift items. We used a variant of a classic paradigm in which this mid-list behavioral boost has been observed across shifts in presentation modality (Murdock & Walker, 1969).

Experiment Paradigm

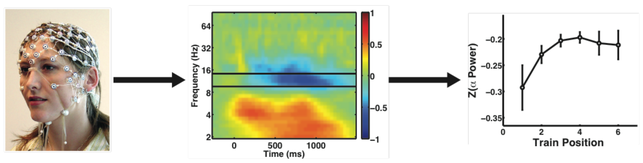


22 participants each studied and recalled a total of 32 lists over two sessions.

Each list contained 24 items that were presented either visually (on screen) or auditorily (over headphones). Items were organized into four 6-item trains, with presentation modality shifting between trains.

Two free recall periods immediately followed each list, with each period targeting a specific modality.

Scalp EEG Methods

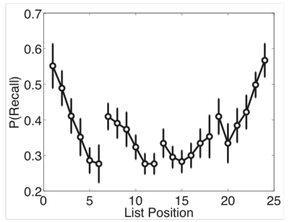


We collected scalp EEG from each participant using a 128-electrode cap. Wavelets were used to measure oscillatory power. We calculated the average oscillatory power over six frequency bands (ranging 2-100 Hz) to examine how these signals changed over various study items of interest.

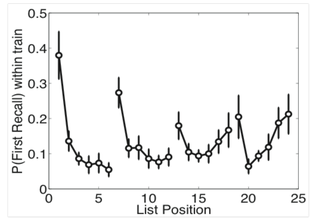
Behavioral Findings

Mid-list trains (2 and 3) showed increased recall performance for items immediately following a modality shift compared to mid-train items ($p<0.01$).

Post-shift items were recalled earlier and more often than mid-train items, and these effects were independent of presentation modality ($p>0.1$).

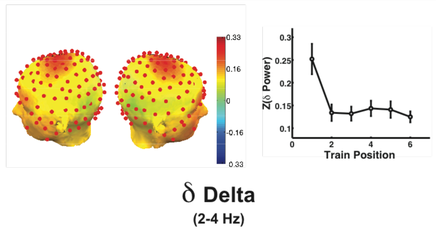


Probability of recall by list position.

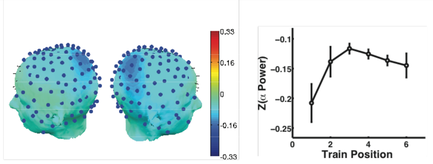


Conditional probability of first recall: The probability of being the first item recalled from a given train (if any).

Oscillatory List Position Effects

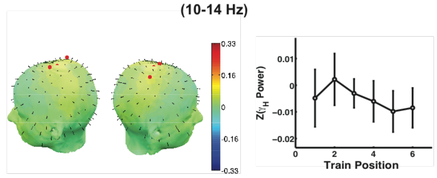


δ **Delta**
(2-4 Hz)



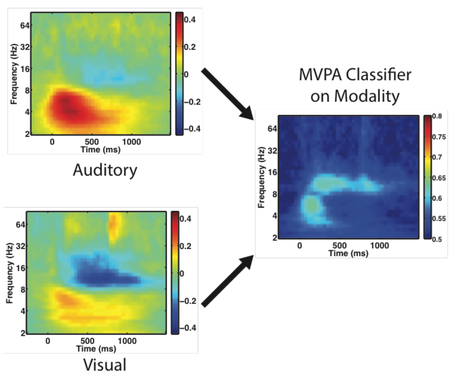
α **Alpha**
(10-14 Hz)

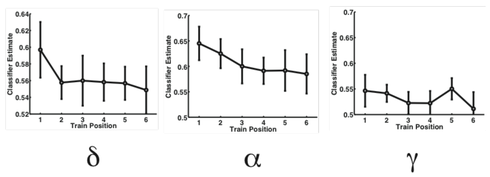
For mid-list trains of like-modality items, post-shift positions showed patterns of **high delta power** that then decreased as a function of train position, and **low alpha power** that increased across train positions (as compared with mid-train positions). No change in gamma power.



γ **Gamma**
(44-100 Hz)

Modality Independence



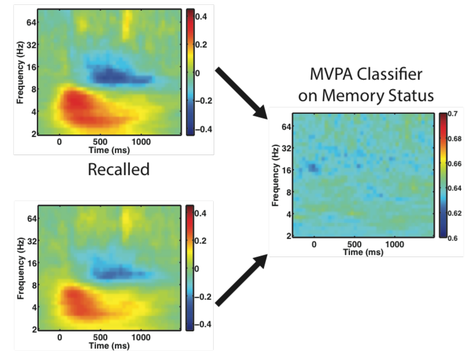


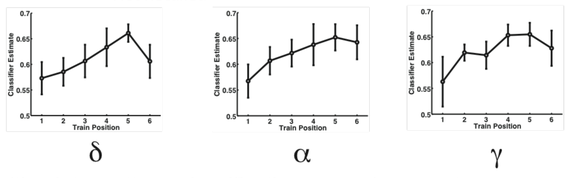
δ α γ

A multivariate pattern classification on *presentation modality* revealed **no significant change** in classifier performance across mid-list train position for any frequency band ($p>0.05$).

Post-shift item responses provide no additional modality-specific information than mid-train items.

Subsequent Memory





δ α γ

A multivariate pattern classification on *subsequent memory status* showed a **significant change** in classifier performance over train position ($p<0.05$), with less discriminable patterns of activity for items following a shift in modality.

Some process beyond typical mid-list memorability processes is contributing to improved recall for these items.

Summary

Consistent with prior work by Murdock & Walker (1969), we observed a boost in memorability for items immediately following a shift in presentation modality. These items showed an item-induced oscillatory response particularly reflected in the delta and alpha frequency bands.

This response seems to reflect a modality-independent process that benefits memorability for items at shifts in stimulus properties, beyond the typical mid-list processes that characterize subsequently remembered material. Future work will further characterize the oscillatory correlates of these post-shift boosts to memorability, as well as use a modeling framework to investigate the cognitive consequences of these shifts on the memory system.

Acknowledgments

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