THE NEURAL DYNAMICS OF RETRIEVING CONTEXT-DEPENDENT EMOTIONAL ASSOCIATIONS

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BACKGROUND

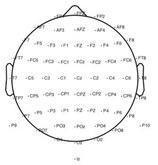
Context-dependent retrieval is thought to rely on the hippocampus and its interactions with prefrontal cortex. In rodent models, these interactions are marked by increased hippocampal-prefrontal synchrony in the theta band[1]. Human work has also indicated that theta oscillations play a role in context-dependent memory processes[2]. In a recent study, both theta and alpha synchrony were shown to be affected by the strength of associations that were learned over time[3].

Little is known, however, how these dynamics are affected by the motivational significance of the memoranda. To investigate this issue, we conducted a **scalp EEG** study in which participants learned and retrieved aversive or neutral object-sound associations in one of two different contexts.

We aimed to:
- examine the neural processes related to using *context cues* to support accurate *associative retrieval*
- determine whether memory-related theta synchronization and alpha desynchronization[4] are modulated by the motivational significance and strength of associations

EEG METHODS

Participants
N=27 healthy young adults
(additional 3 excluded based on data quality)



EEG Acquisition & Processing
64-channel BioSemi ActiveTwo System
Resampled to 512 Hz
Re-referenced to average of left and right mastoids
High-pass filter at .5 Hz
Onset-locked epoch definition [-1.2 4.55]
Response-locked epoch definition [-2.5 0.825]
Automated artifact rejection
ICA-based artifact correction with automated component rejection via SASICA
Final visual inspection/rejection

Time-frequency decomposition
Morlet wavelets
5 – 10 cycles
Frequency range: 4-50 Hz
Implemented in EEGLAB

Time-frequency power analysis
Power averaged across trials of interest
Baseline normalization [-0.5 -0.1]
Contrasts computed between conditions of interest
Frequency band-specific power
- Averaged across frequencies in theta (4-7 Hz) and alpha (8-12 Hz) bands

Statistical analysis & cluster correction
- FieldTrip non-parametric randomization tests
- Spatiotemporal clusters for each averaged frequency band

References: [1]Place, R., Farovik, A., Brockmann, M., & Eichenbaum, H. (2016). *Nature Neuroscience,* 19(8), 992-994. [2]Hsieh, L. T., & Ranganath, C. (2014). *NeuroImage,* 85, 721-729. [3]Clarke, A., Roberts, B. M., & Ranganath, C. (2017). *bioRxiv* https://doi.org/10.1101/198838 [4]Hanslmayr, S., Staresina, B. P., & Bowman, H. (2016). *Trends in Neurosciences*, 39, 16-25.
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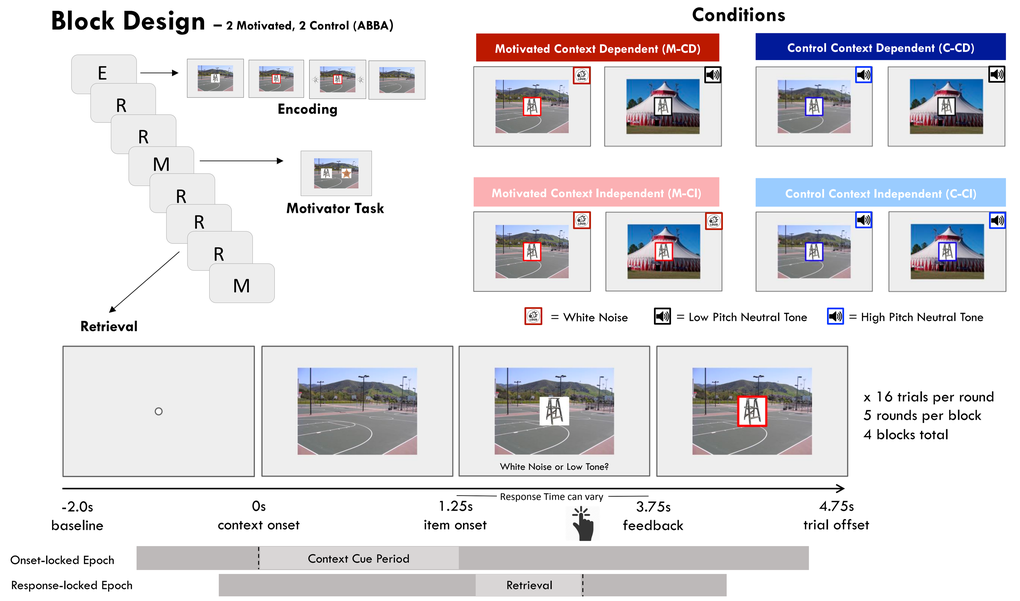
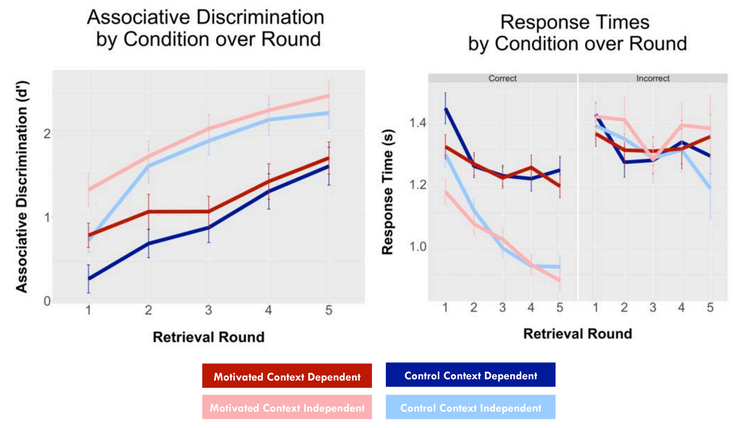
EXPERIMENTAL DESIGN



BEHAVIORAL RESULTS



Associative discrimination was significantly influenced by motivation (motivated > control), context-dependence (CI > CD), and the number of retrieval rounds (late > early).

Response times were significantly influenced by context-dependence (CI < CD) and the number of retrieval rounds (late < early), with larger RT improvements for the CI condition.

EEG RESULTS

Context Cue Period

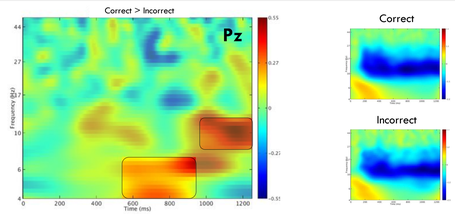
Context cue-related processes related to successful associative retrieval: Correct vs Incorrect

Theta, 4-7Hz:
correct > incorrect

550 - 950 ms

Alpha, 8-12Hz:
correct > incorrect

950 - 1250 ms



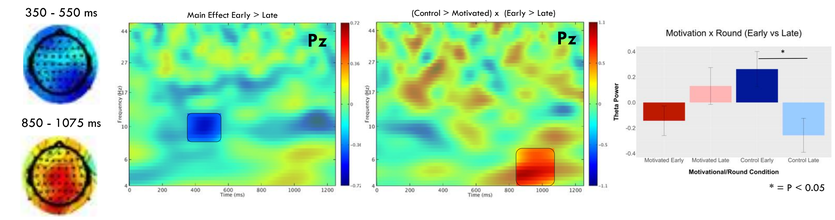
Context cue-related processes related to associative learning over time: Motivation x Retrieval Round (early, late)

Alpha, 8-12Hz:
Significant main effect
early < late

350 - 550 ms

Theta, 4-7Hz:
significant interaction
control > motivated x *early > late*

850 - 1075 ms



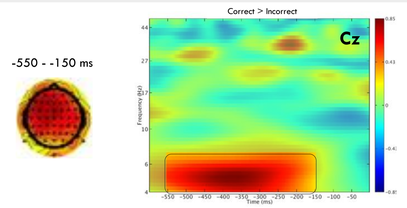
Response-locked Retrieval Period

(limited to Context-Dependent trials to reduce RT differences)

Retrieval processes related to successful associative memory: Correct vs Incorrect

Theta, 4-7Hz:
correct > incorrect

-550 - -150 ms

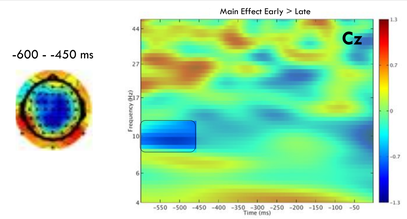


Retrieval processes related to associative learning over time: Motivation x Retrieval Round (early, late)

Alpha, 8-12Hz:
Significant main effect
early < late

No main effects of motivation or round x motivation interactions

-600 - -450 ms



SUMMARY

Context cue-related theta power was related to memory accuracy and association strength, with decreasing power as object-sound associations became well-learned.
- Interestingly, theta changes over time were observed in the control condition but not in the motivated condition.
- This result may be due to **differential reliance on contextual cues** when associations are aversive in nature.

Alpha desynchronization was also diminished as associations became well-learned.
- This was true during both the context cue period and the retrieval period, and for both the control and motivated conditions.

Planned future analyses will relate context cue-related processes to the speed of accurate retrieval. We predict that this relationship will be stronger for context-dependent vs independent retrieval.