

# Long-term Memory-guided Attention & Theta-band Oscillations

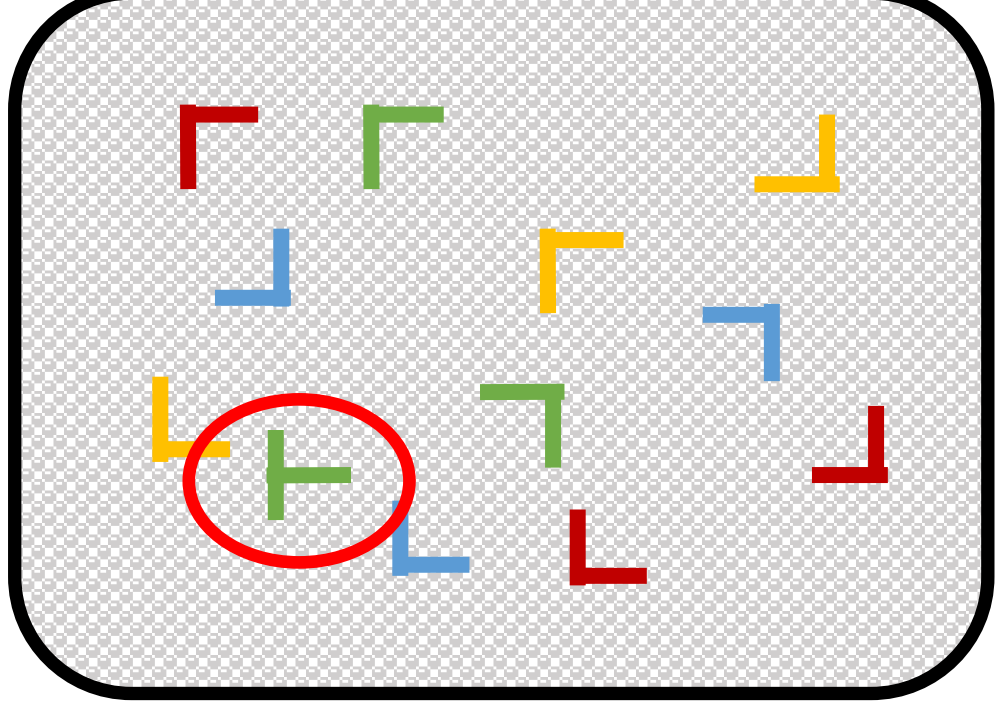
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## Previous Literature

Configuration-target location association



- ✓ Target detected faster for old configurations vs. new configurations (Chun & Jiang, 1998).
- ✓ Target detected faster when participants **deliberately** associate sound-clip with tone location (right/left ear) (Zimmermann et al., 2017).

## What is Missing?

- Does associative learning between context and target occur in naturalistic listening situations?

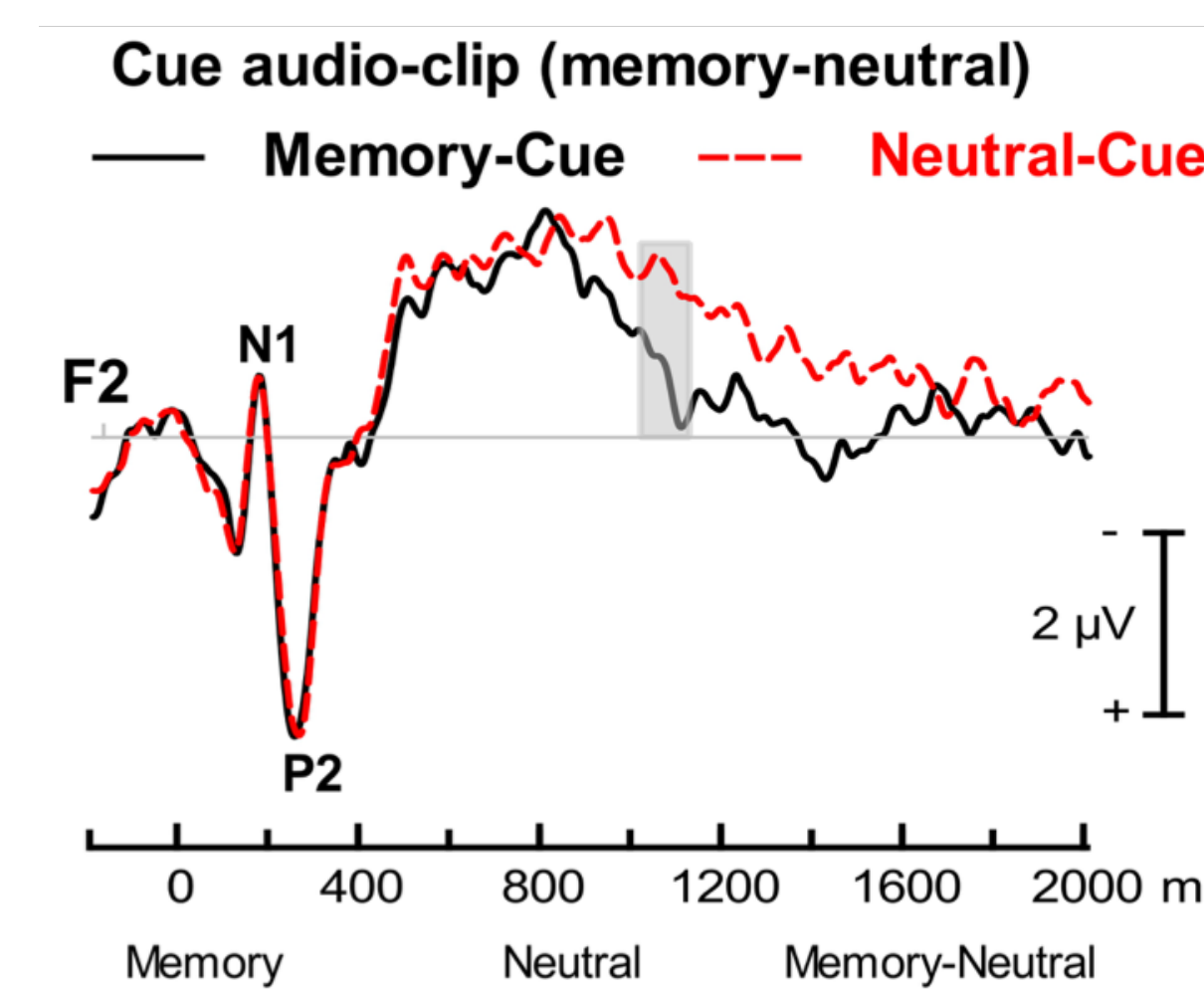
## Aims:

1. Test whether incidental associations between tone and sound-clip can guide auditory attention.
2. Use EEG to index implicit processes involved in the memory retrieval process.

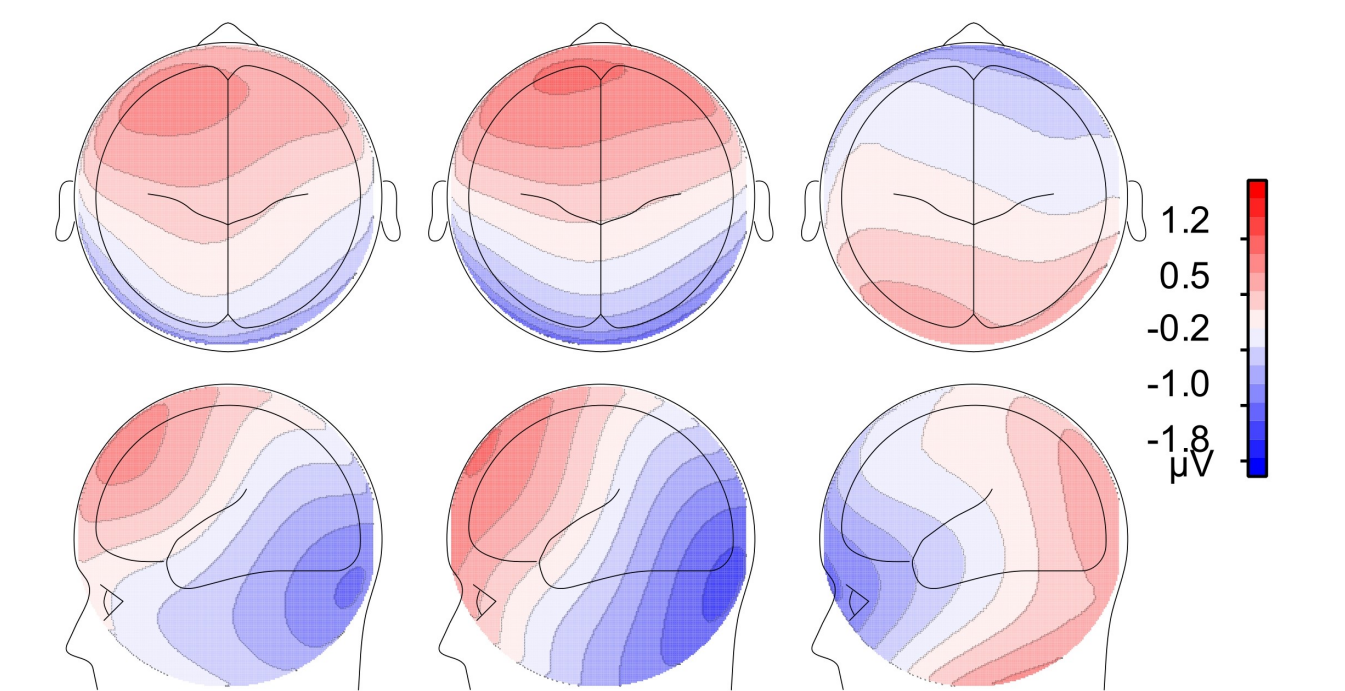
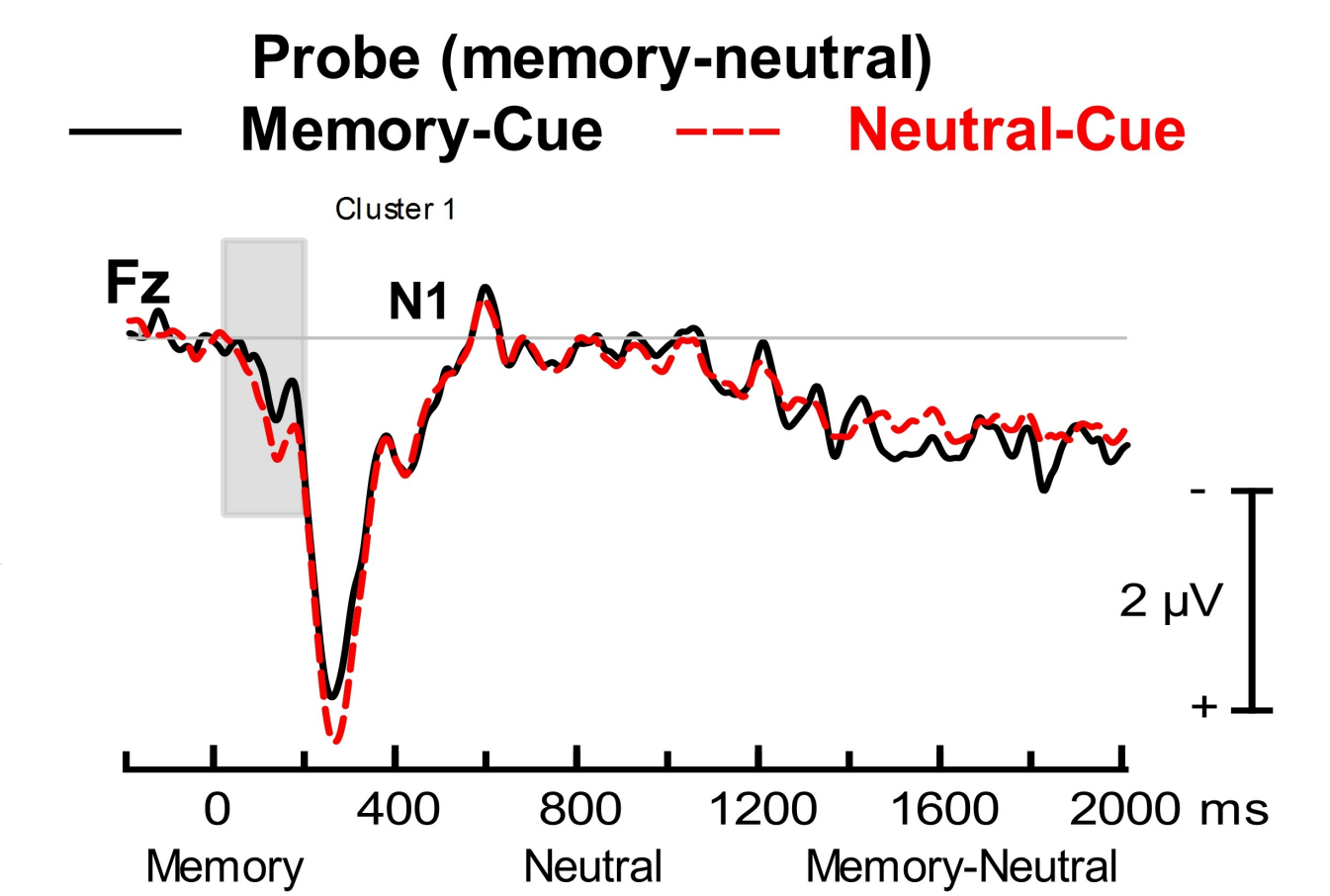
## EEG Results

### A) Cue-audio clip

**Cue-audio clip**  
1 Cluster over frontal and fronto-central areas  
 $* p < .05$



### B) Probe-audio clip

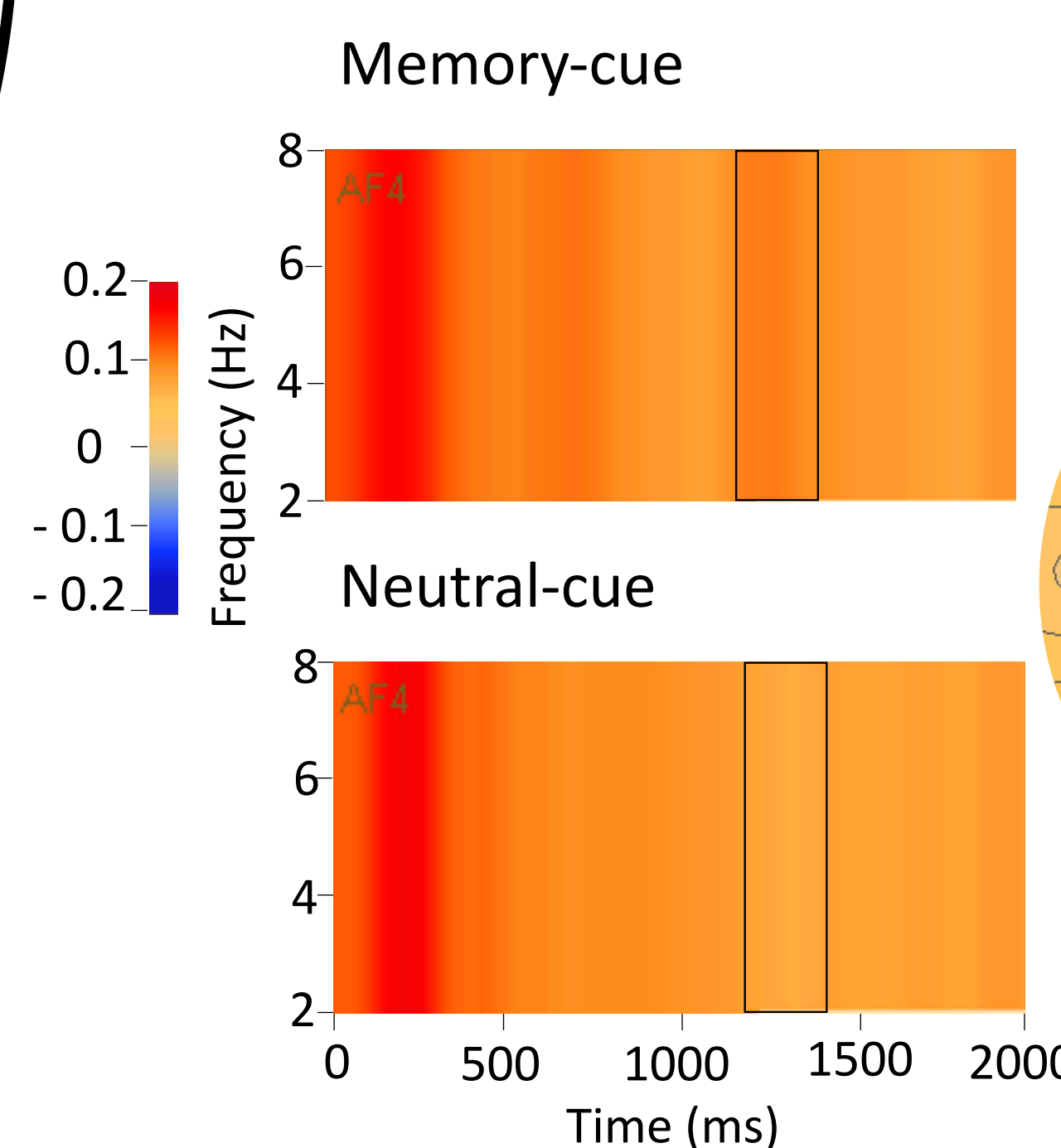


**Probe-audio clip**  
2 Clusters over frontal and right parietal areas  
 $* p < .05$

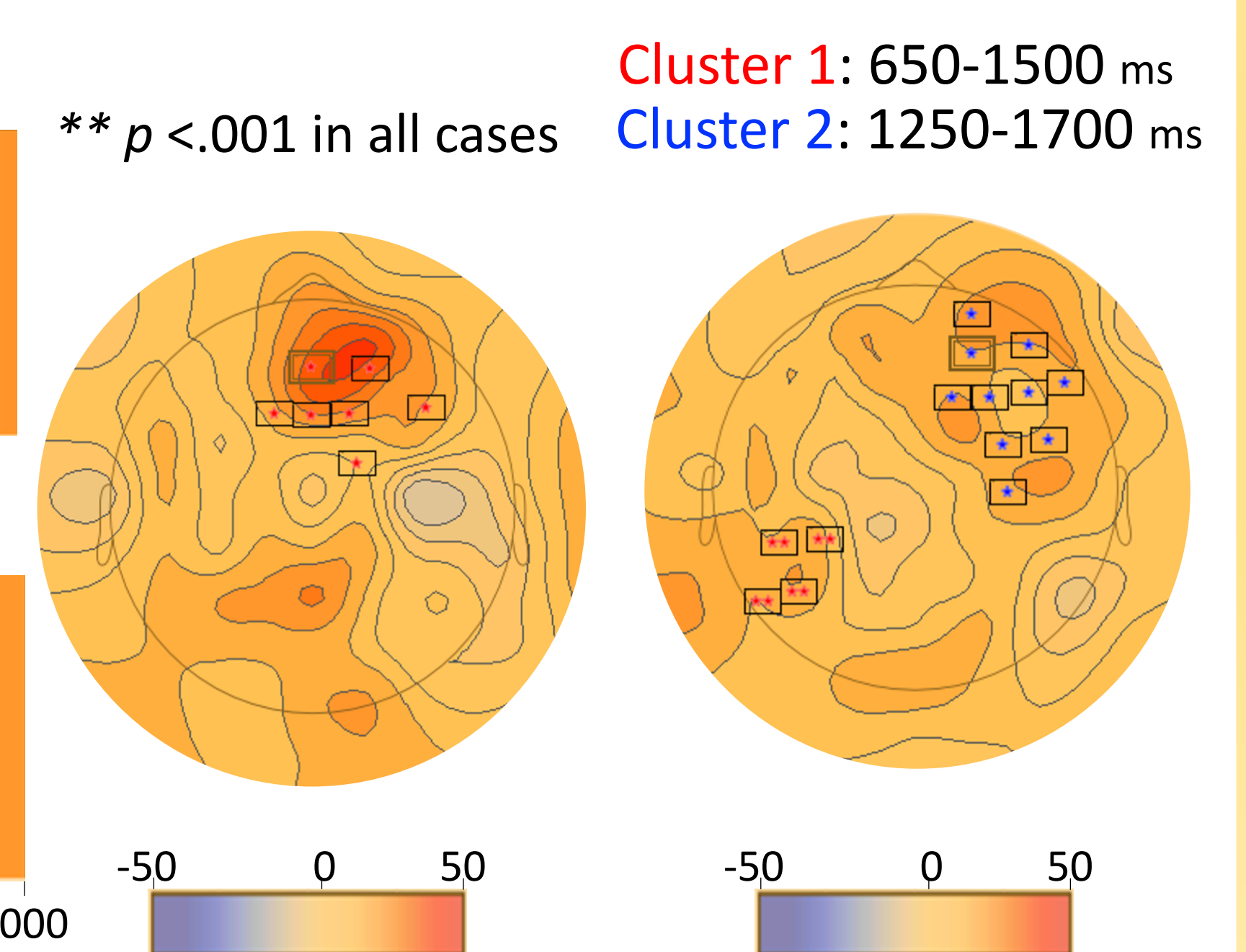
## Theta (3-7 Hz) inter-trial phase locking

Memory-cue has greater phase synchrony than Neutral-cue

### A) Cue audio-clip



### B) Probe audio-clip



## Methods

### Stimuli

- 80 (old) & 20 (new) 'real-world' sound-clips
- Lateralized (right or left ear, or none) pure tone target embedded in clip

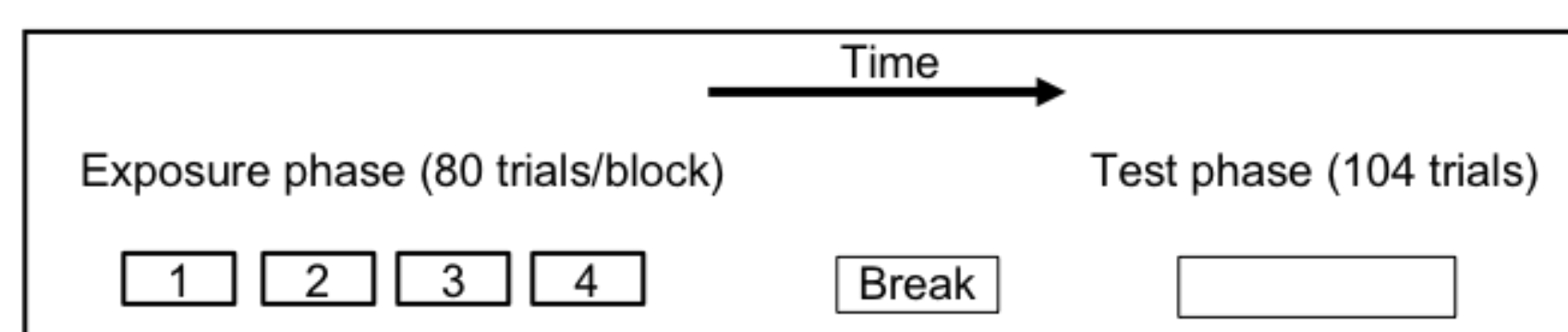
### Participants (N=26)

- Normal hearing
- 18-35 yrs ( $M = 26.1$   $SD = 4.3$ )

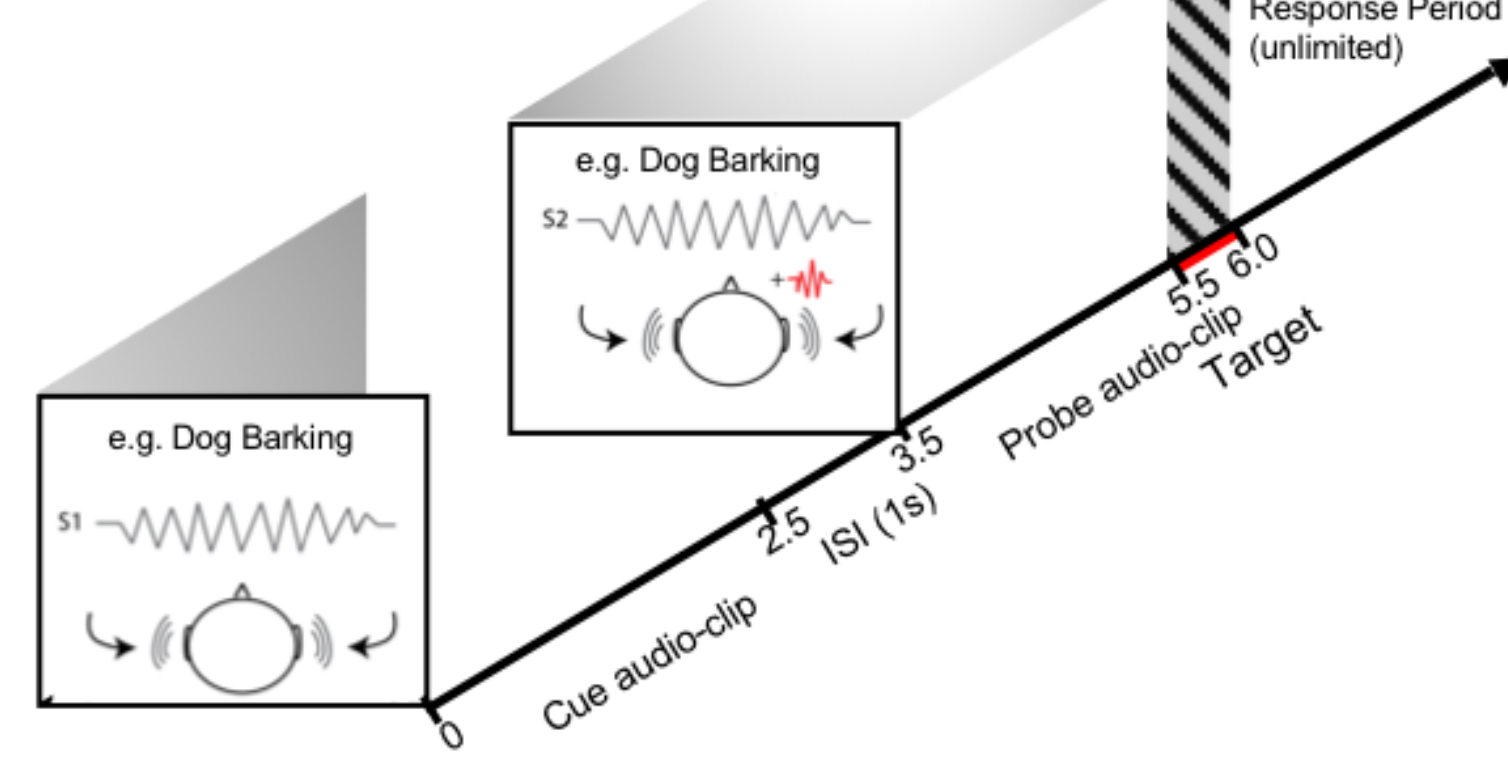
Incidental Association (Memory-Cue)



No Association (Neutral-Cue)



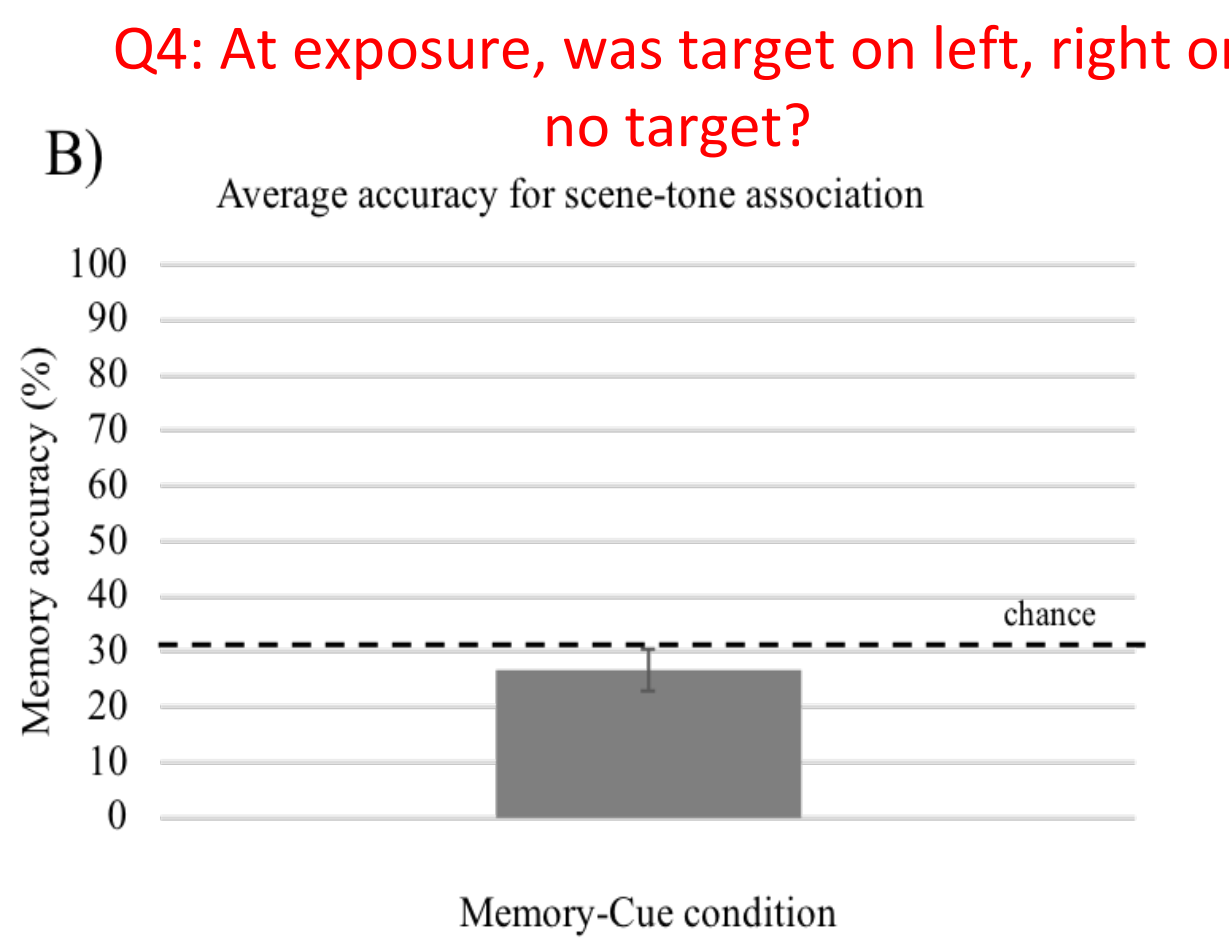
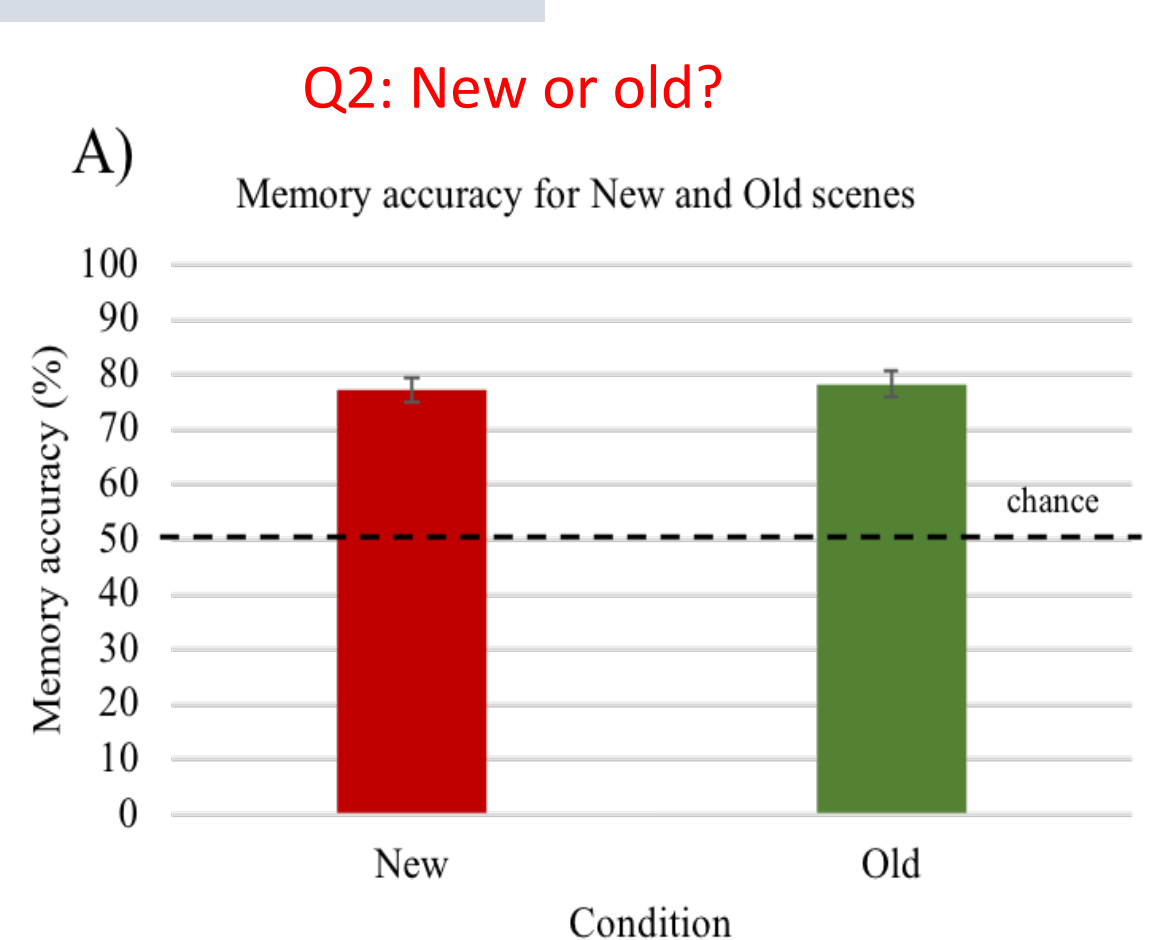
### Test phase



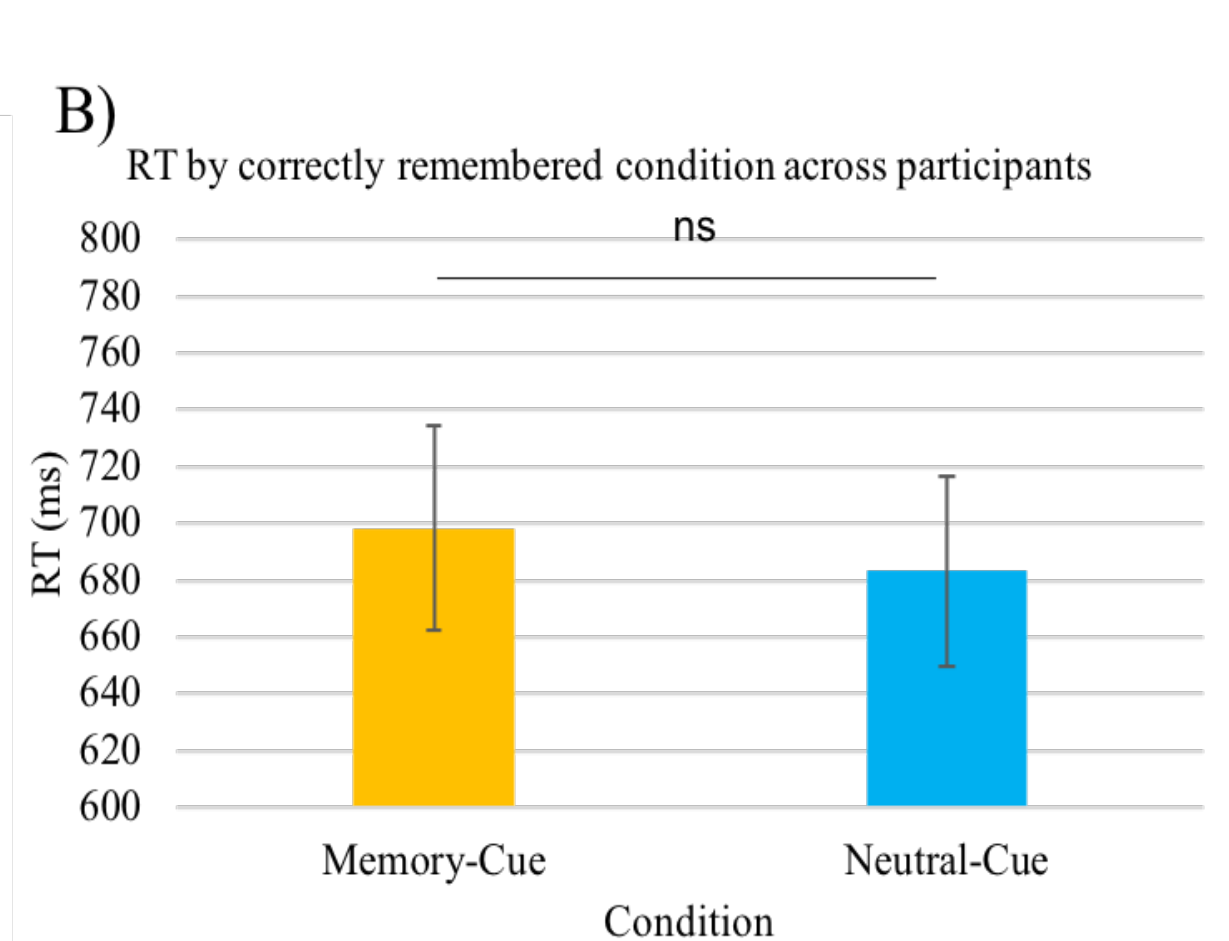
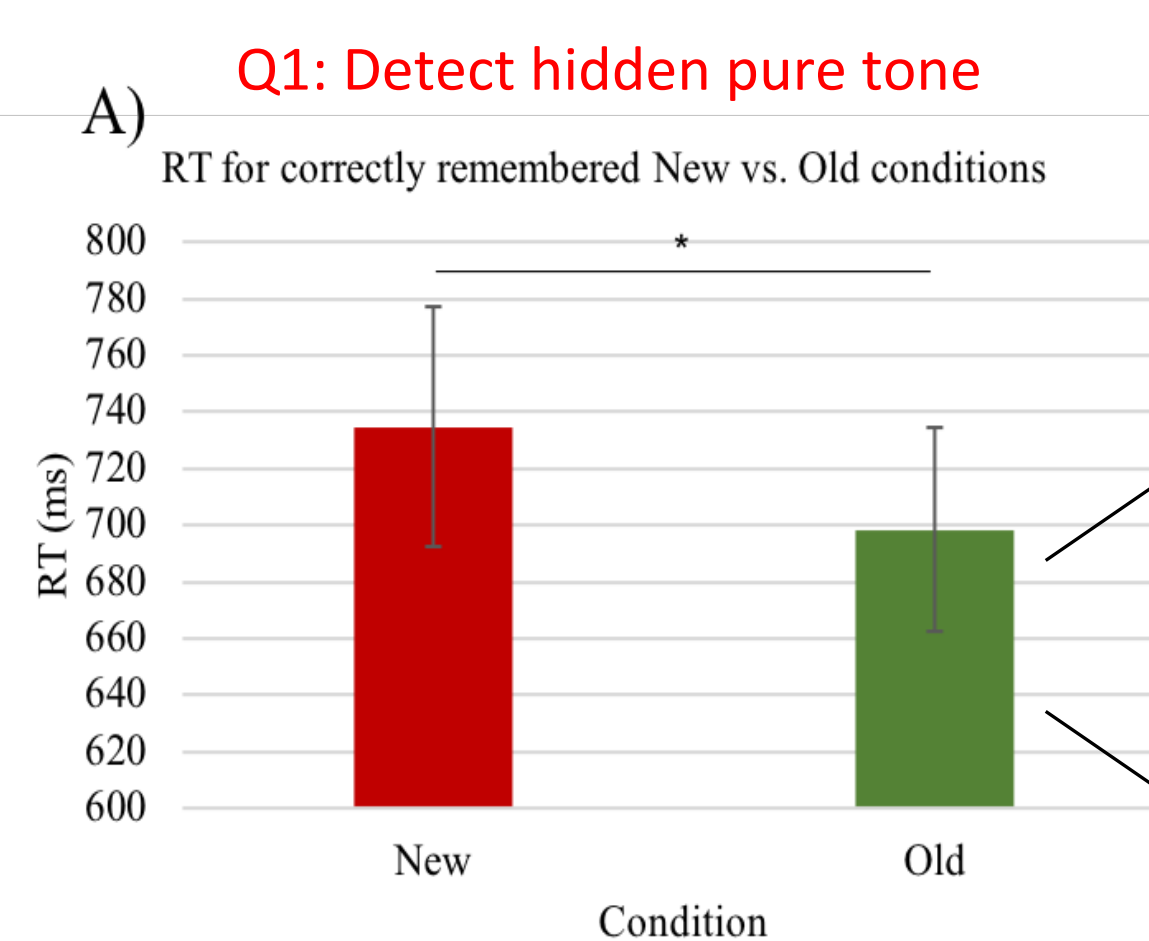
### Task

- Exposure phase** (incidental learning)
- Classify sounds (manmade/natural)
- Surprise test phase** (retrieval)
1. Detect hidden pure tone
  2. Old or new?
  3. If old, recollected or merely familiar?
  4. At exposure, was target on left, right or no target?

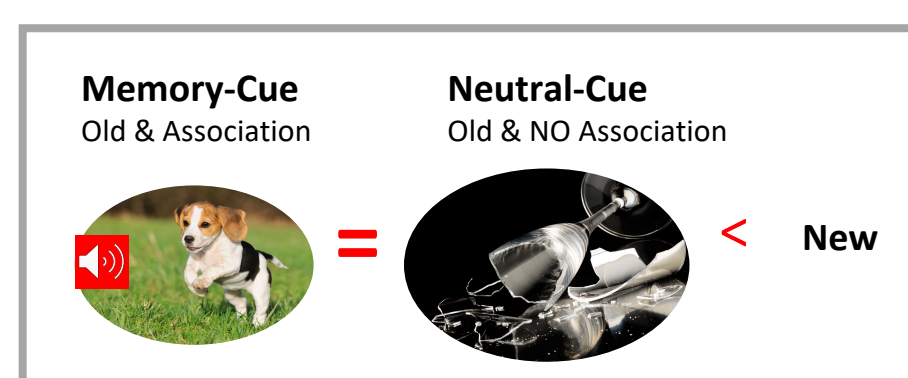
## Results Behavioural



Memory for the scene is good but memory for the location or presence of the tone is not



Memory enhances processing of tone by speeding responses but does not facilitate lateralized allocation of attention.



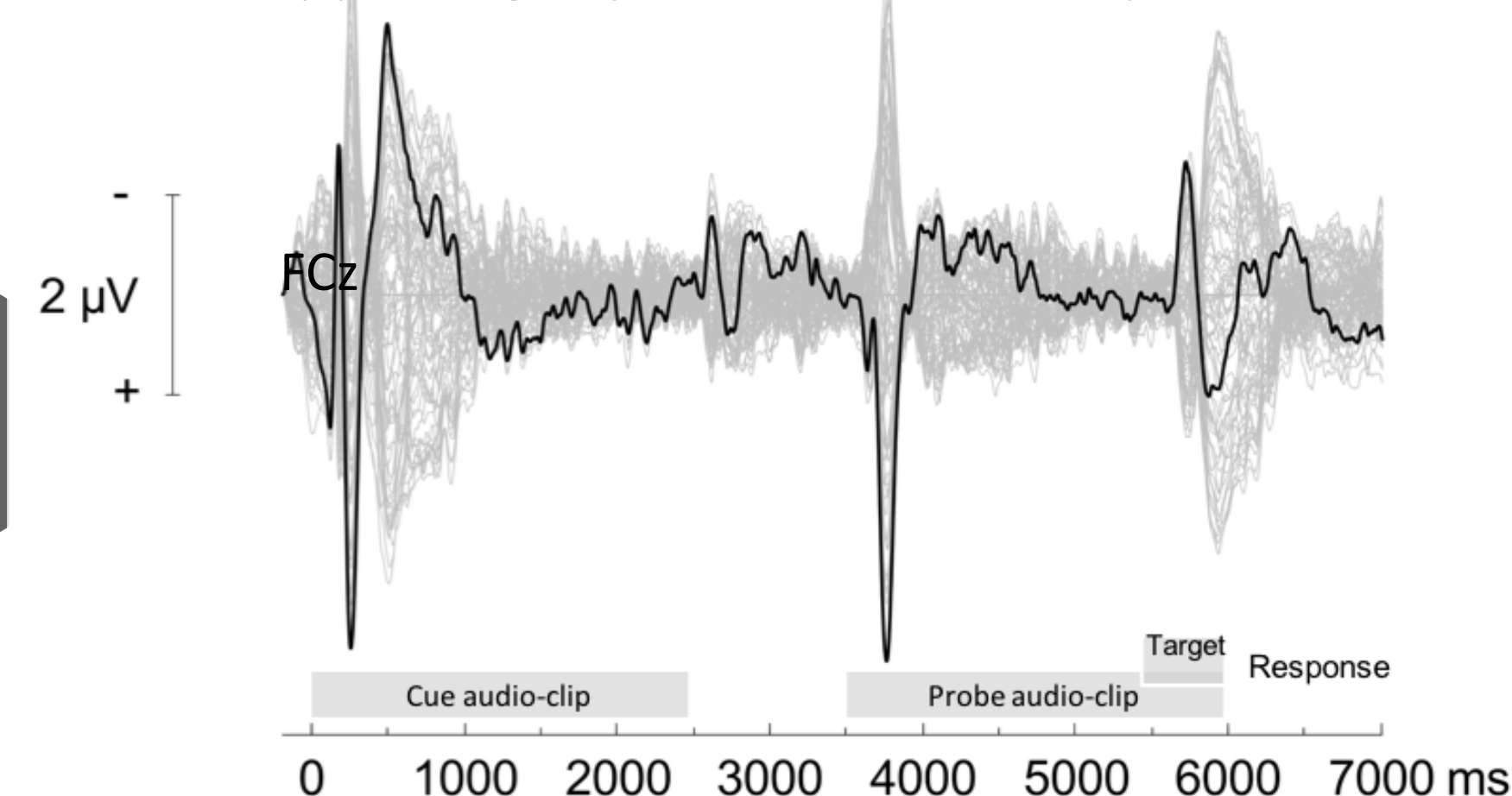
## Conclusion & Future Directions

- ✓ Implicit associations were formed (neural trace), but not at the level that influences behaviour.
  - Manipulate **attention at encoding** on memory-guided attention at retrieval.
- ✓ Greater theta synchrony for memory-cue vs. neutral-cue may reflect **cortical synchronization between the hippocampus and prefrontal cortex** (Günseli & Aly, 2020).
  - Network may interface long-term memories with attentional systems to guide search.
  - Source analyses

## EEG Analyses

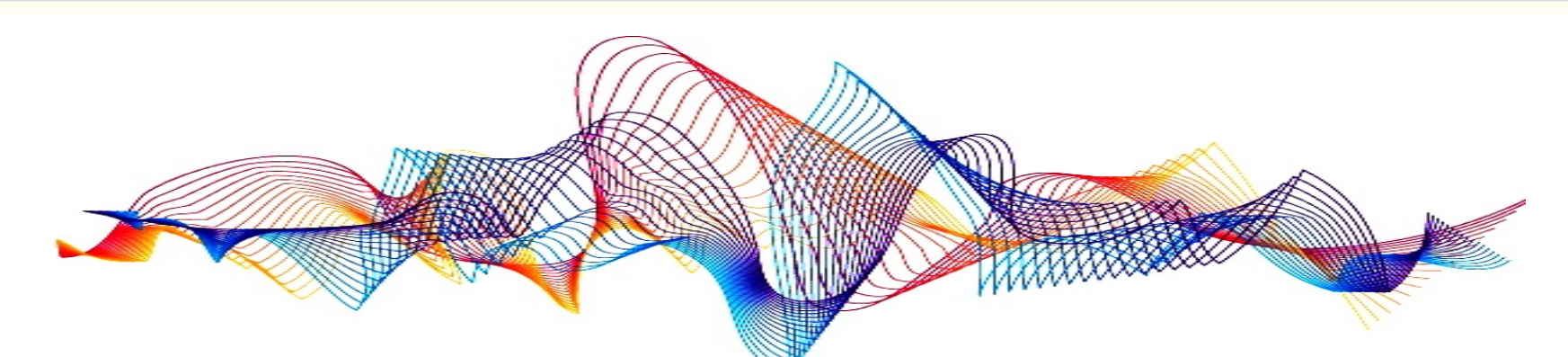
Time-domain analyses at two different time windows:  
cue audio-clip and probe audio-clip  
• memory-cue vs. neutral-cue

Butterfly plot of group mean event-related potentials (ERPs)



## Applications

- Attention monitoring
- Advertisement
- Habit formation and behaviour change



## References

1. Chun, M. M., & Jiang, Y. (1998). Contextual cueing: Implicit learning and memory of visual context guides spatial attention. *Cognitive Psychology*, 36, 28–71. <http://dx.doi.org/10.1006/cogp.1998.0681>
2. Codex Anatomicus. (2018). *Ear anatomy art* [Online image]. Retrieved from <https://www.codexanatomy.com/products/ear-anatomy-art-watercolor-splash>

3. Günseli, E., & Aly, M. (2020). Preparation for upcoming attentional states in the hippocampus and medial prefrontal cortex. *eLife*, 9, e53191. <https://doi.org/10.7554/eLife.53191>
4. Kimbell, S. (2014). *Axial human brain print* [Online image]. Retrieved from <https://www.etsy.com/uk/listing/583426108/axial-human-brain-print-12-x-12>
5. Zimmermann, J. F., Moscovitch, M., & Alain, C. (2017). Long-term memory biases auditory spatial attention. *Journal of Experimental Psychology Learning Memory and Cognition*, 43(10), 1602–1615.

Thank you to...

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