Probing the Function of Delay-period Alpha-band Oscillations in Visual Working Memory

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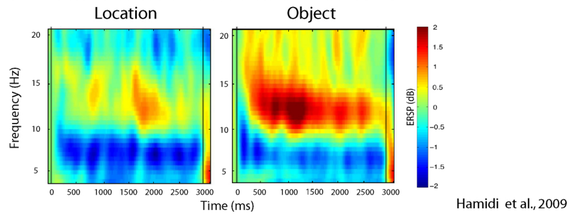
Introduction

- Sustained alpha-band (8-14 Hz) oscillations have been reliably observed during the delay period of working memory tasks in which participants are required to remember either objects or locations when both object and location information are present in the stimuli. (Hamidi et al., 2009; Jokisch & Jensen, 2007)



Hamidi et al., 2009

- Interestingly, when to-be-remembered locations are marked by identical stimuli (e.g., uniform circles) alpha-band power is minimal. (Unpublished observations).

- One hypothesis is that increases in alpha-band power represent the functional inhibition of cortical regions that process task irrelevant information.
- An alternative hypothesis is that increases in alpha-band power may support the binding of information represented in distal cortical regions (e.g., dorsal and ventral streams).

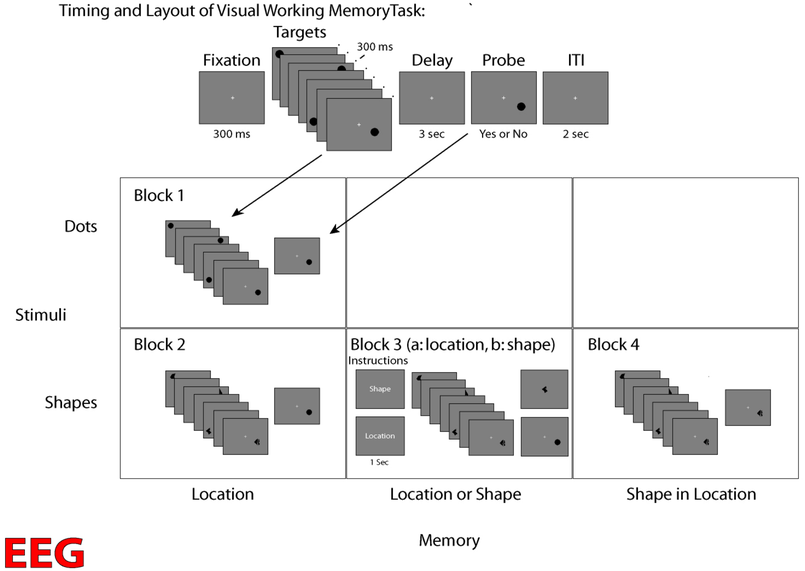
Question: Does sensitivity of alpha-band power to the nature of the stimuli marking to-be-remembered locations (i.e., unchanging dots vs. (irrelevantly) changing shapes) reflect inhibition or binding?

Method

Participants:
- 12 (8 female), mean age 21.58 (SD = 1.38)

Task:
- Participants completed 4 variants of a visual delayed recognition task. Object identity increased in salience and behavioral relevance with each block.
- 48 trials per block
- Conditions were presented in the same order for all participants in order to ensure that particpants remained naive to potential task relevence of objects during blocks 1 and 2.

Timing and Layout of Visual Working MemoryTask:



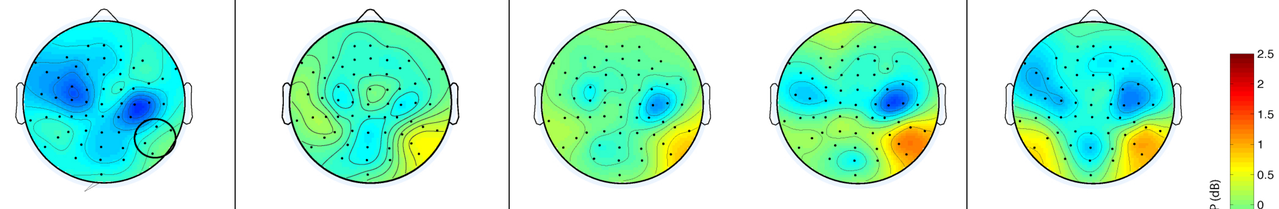
EEG

- Data were recorded from 60 electrodes (Nextim, Helsinki)
- Data acquired at 1450 Hz, filtered (0.1 to 100 Hz), and downsampled to 500 Hz
- Artifacts were removed by visual inspection and through Independent Components Analysis

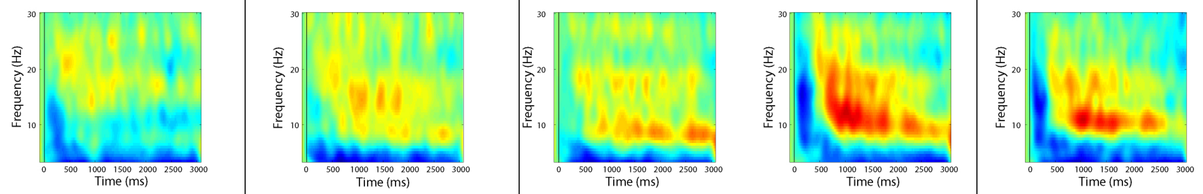
Block	Location of Dots	Location of Shapes	Location or Shape Identity		Shapes at Locations
Information In Memory	Locations	Locations	Locations	or Shapes	Shapes at Locations

ERSP

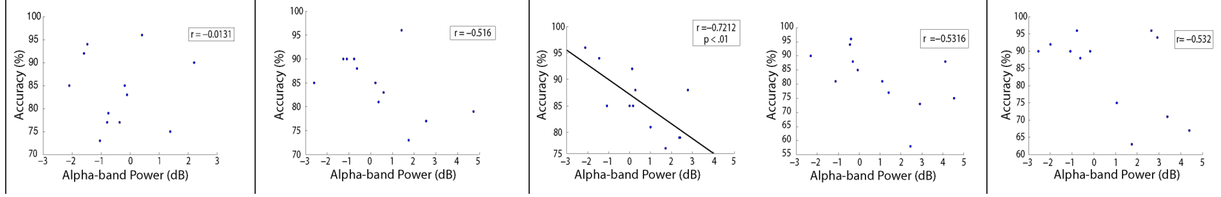
Topography of Mean Alpha-band Power (dB) Averaged Across Participants



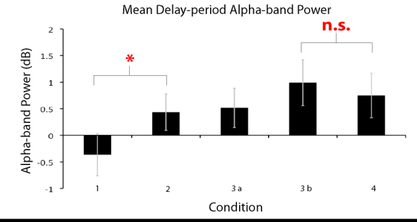
Event Related Spectral Potential Averaged Across Participants



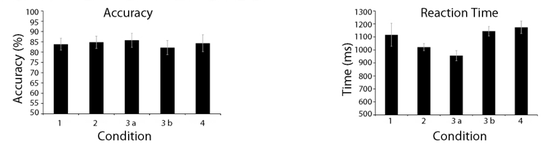
Correlation between Alpha-band Power (dB) and Task Accuracy



Hypothesis Tests



Behavioral Data



No Significant Main Effect for Accuracy or Reaction Time (All F's <1)

Conclusions

- Alpha-band power is significantly greater when stimuli are presented as unique shapes than when stimuli are presented as uniform circles.

- Alpha-band power is not significantly different between tasks that call for the participants to ignore stimulus information (either shape or location) and the tasks which require participants to remember both shapes and locations.

- These results provide evidence of multiple functions for alpha-band oscillations in working memory task performance:

  - The negative correlation between delay-period alpha-band power and location memory performance in the 'location or shape' condition is consistent with an inhibition account.

  - Absence of a significant drop in delay-period alpha-band power between object memory performance in the 'location or shape' block vs. the 'shapes in locations' block is inconsistent with an inhibition account, and suggests a role for alpha-band oscillations in binding location and identity information.

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