Visual Working Memory and workload components in ECoG during n-Back task

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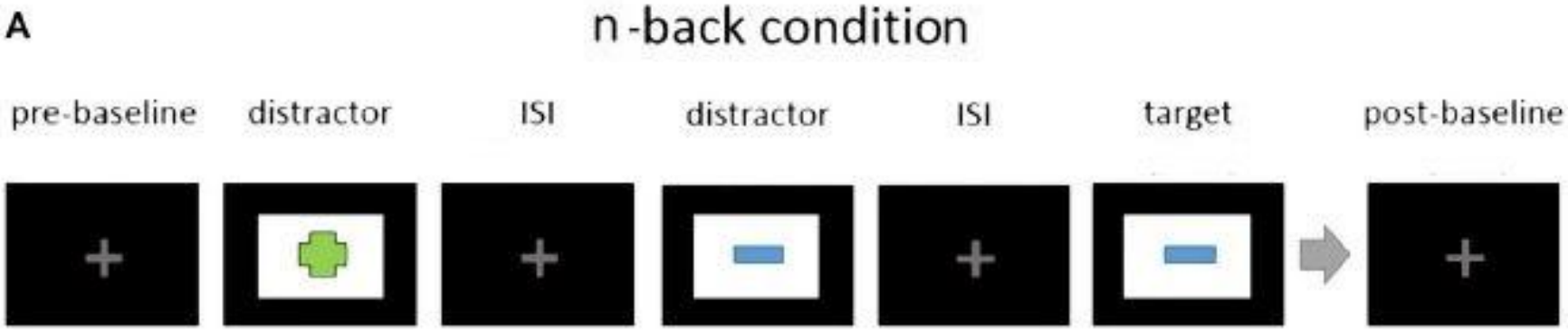
Background

- Investigating the brain activity in experiments with different **visual working memory** *(VWM)* **workloads** could be a powerful tool in describing and understanding its underlying mechanisms.
- VWM workload has been repeatedly correlated with shifts in average power of particular EEG and MEG bands, specifically, alpha decrease in Medial Parietal Cortex and theta increase in Prefrontal Cortex *(PFC)*. These are often related with attention, central executive (storage), and recall processes.
- Activity in the broadband spectrum -- like High Gamma (50-125Hz) and Ripple (125-250Hz) -- correlates more with local neuronal population activity like LFP compared to EEG.
- Thus, deeper study of these correlations is required to help to uncover the cortical processing mechanisms.

N-back Task


A
n-back condition
pre-baseline
distractor
ISI
distractor
ISI
target
post-baseline

Research Question

- **Do the broadband frequencies obtained through ECoG represent VWM or its processes across different cortical areas?**
- **What effect does changing the requirements of VWM, hence the workload, have on these frequencies?**

Hypothesis

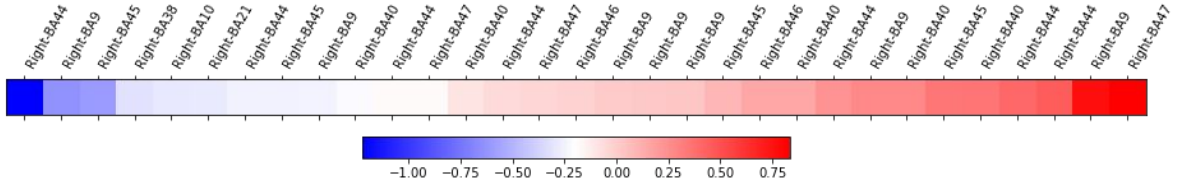
- **Since the visual working memory requirements (workload) are not related to motor electrode activity, upon excluding the electrodes lying in the specialized motor areas, we should see changes in regions known to exhibit such differences for different workloads.**

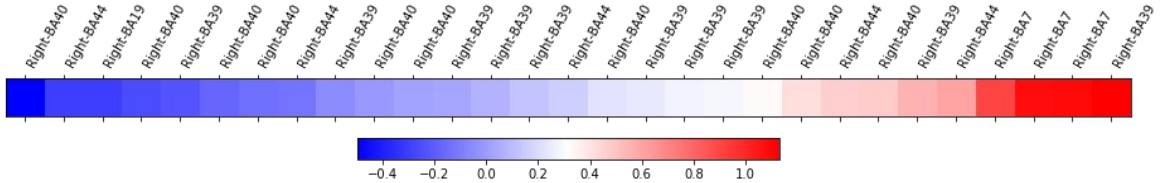
- **The workload requires the interaction between attention and recall, process observed in parietal and prefrontal cortex, with the spatial precision of ECoG we hypothesized that the high gamma band traditionally related with LFP activity could be a precisely expression of the activation in cortical areas , give us some spatial information about the workload process in the VWM.**

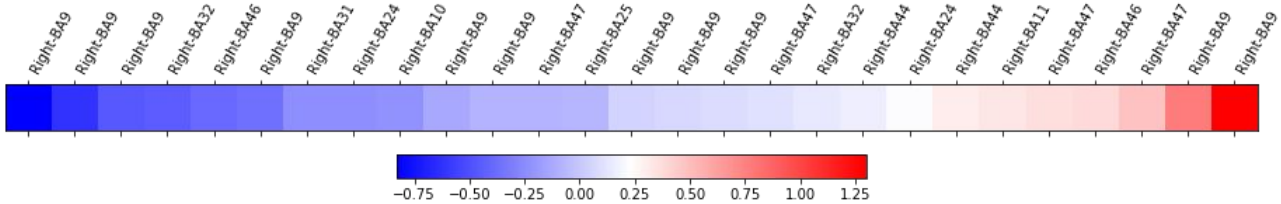
Results

	Band	Acc: Sub-0	Acc: Sub-1	Acc: Sub-2
0	Alpha	0.57	0.70	0.53
1	Gamma	0.55	0.75	0.43
2	Hi-gamma	0.75	0.97	0.62
3	Ripple	0.73	1.00	0.48

1. Decoding accuracy of 0/1 workload increases for broadbands.
   - Using Logistic Regression over average band power.
2. Parietal Cortical region ECoG data also significantly decodes VWM workload than frontal & temporal counterparts.
   a. Sub-0 electrode locations:
   b. Sub-1 electrode locations:
   c. Sub-2 electrode locations:







Next Steps - Future Lines of Work

- Explore datasets with greater number of subjects and trials for the same task.
- Perform time-dependent regression modeling of such systems to investigate the temporal dynamics of these shifts of power of broadband frequencies
- Investigate synchrony within oscillations in broadband frequencies across PFC, Temporal lobe, and Parietal lobe.
    - Such oscillations are repeatedly linked with the maintenance of specific-feature information in VWM, and may also underlie VWM representation itself.