Assessing the relationship between alpha power and hemodynamic activation during emotional mental imagery

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Background

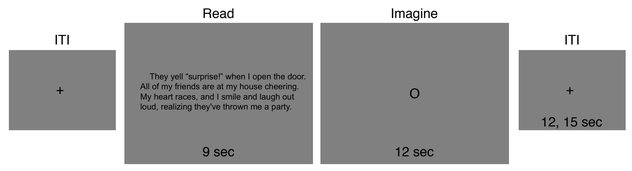
Mental imagery is a critical factor in the etiology and maintenance of many psychiatric disorders, as well as a component in gold-standard treatment options. At the level of hemodynamics, research has demonstrated that mental imagery **activates frontal, motor, and visual networks** of the brain. Scalp-recorded EEG has also shown an **increase in alpha-band activity** during mental imagery tasks.

To define the neurophysiology of mental imagery, we combined the information from blood oxygen level-dependent (BOLD) signals with concurrently recorded EEG alpha-band power during a visual script-driven mental imagery task.

Method

Participants: 21 undergraduate students, 7 female, M_{age} = 19

Stimuli: 57 pleasant, neutral, and unpleasant scenes



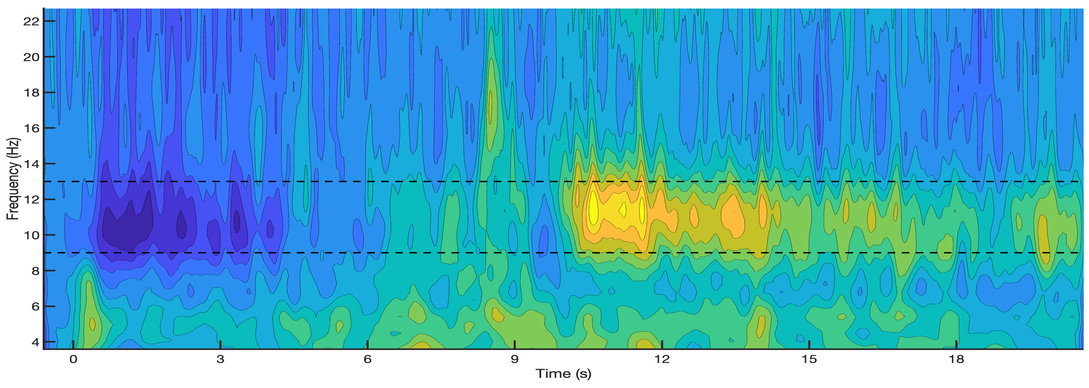
Analyses:

1. **TR-based:** BOLD percent change at *each TR* correlated with parietal alpha power for each TR segment
2. **Trial-based:** Average BOLD percent change during the imagery period correlated with alpha power change from reading period to imagery period across *all trials*

Results

Alpha Replication

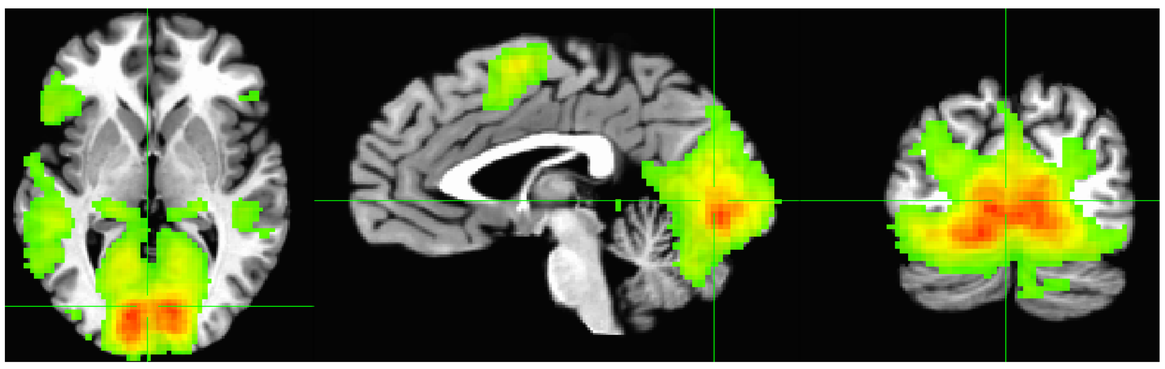
.85 Baseline-corrected power 1.3



Time-frequency analyses demonstrate a decrease in the alpha-band during the reading period and a corresponding **increase during the imagery period**, which exceeds pre-trial alpha power, regardless of valence.

BOLD Replication

-36.3 t values 36.3



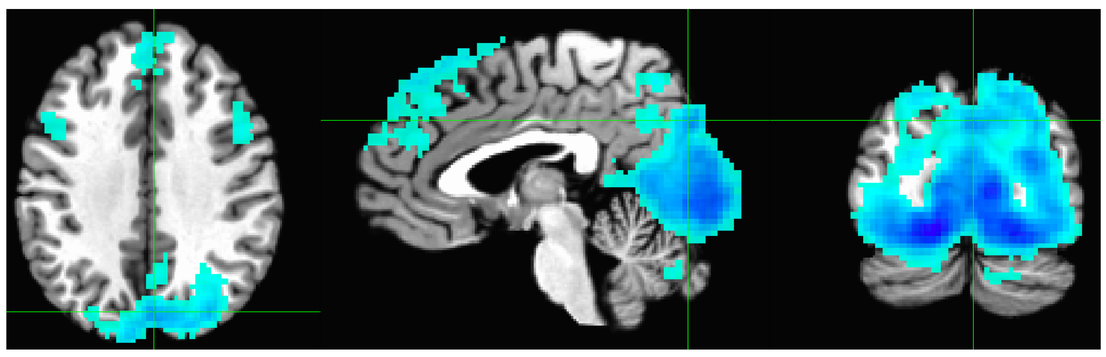
Average BOLD percent change during imagery is **significantly larger than zero** in the regions of the **imagery network**: frontal gyri, motor areas (precentral gyrus, SMA), the dorsal and ventral visual stream, primary visual cortex, and cerebellum.

Alpha-BOLD coupling

Are alpha power changes <u>sensitive</u> to BOLD changes in the imagery network?

TR-by-TR analysis (method check):

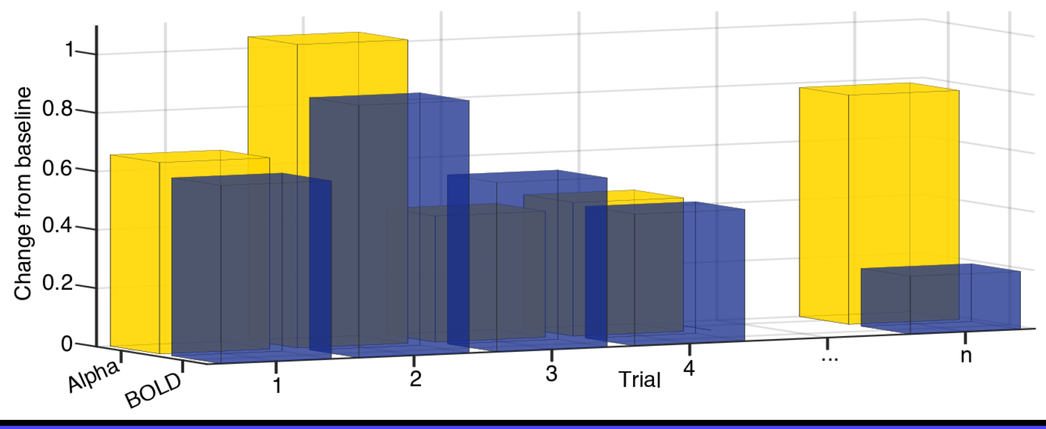
Parietal alpha power correlated with BOLD percent change, per TR, results in significant negative correlations within occipito-parietal and midline frontal regions



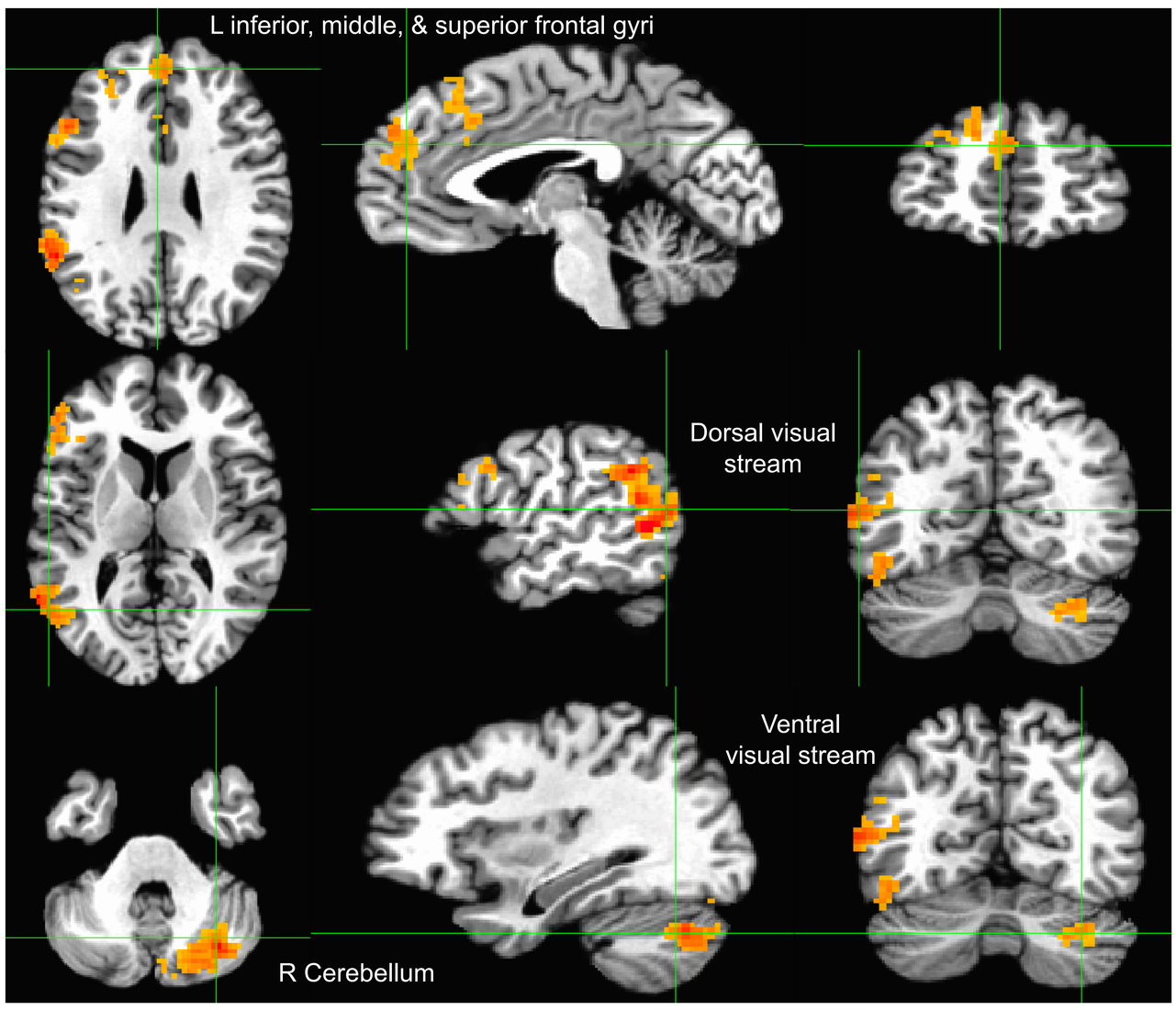
-.12 Spearman's rho -.09

Trialwise analysis (hypothesis testing):

Parietal alpha power change correlated with mean BOLD change during imagery period, per trial



Trialwise correlations



.13 Spearman's rho .22

Conclusions

- Concurrent EEG-fMRI data acquisition did **not** interfere with data quality as both previous EEG-based alpha and fMRI-BOLD effects were replicated during imagery
- Across the entire experiment, a negative correlation of BOLD and alpha-band activity is seen occipito-parietal and midline frontal regions
- Alpha power increases are associated with higher BOLD activity in the imagery network, suggesting **alpha power indexes engagement in a mental imagery task**