Investigating the effects of pre-stimulus activity on spatio-temporal feature integration

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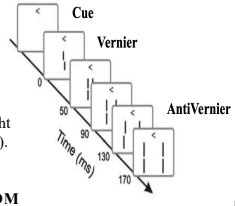
Introduction

- Visual detection is modulated by pre-stimulus alpha rhythms (8–12 Hz)[1].
- The effect of pre-stimulus activity in other tasks, beyond detection, remains unknown.
- We investigate the role of ongoing EEG rhythms during non-retinotopic spatio-temporal integration, in which features of sequential stimuli are integrated over time[3].

Method

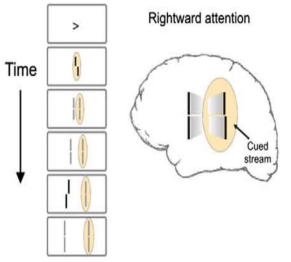
The sequential metacontrast paradigm (SQM)

- Attend to the cued stream
- Report the perceived offset direction (left or right)
- The attended stream contains one line with a slight offset (**V**) or two lines with opposite offsets (**V-AV**).



Non-retinotopique feature integration in the SQM

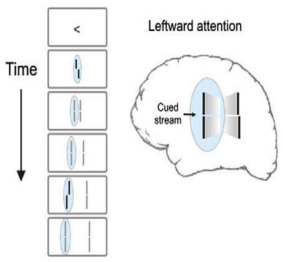
V (Vernier)



A single offset in the attended stream is attributed to the entire stream.

- Performance is above chance level.

V-AV (Vernier-AntiVernier)



Two offsets in the same stream cancel each other.

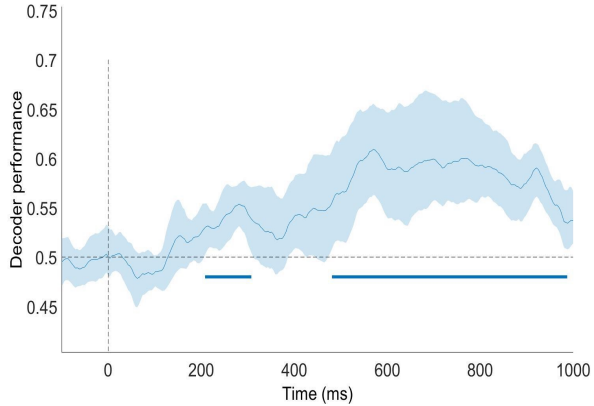
- Performance is at chance level.

EEG decoding and pre-stimulus analysis

- Step 1: Identify EEG patterns of non-retinotopic integration. Linear Discriminant Analysis (LDA) was used to discriminate trials with a single and correctly reported offset (V hits) from trials with a second offset (erroneously) reported (V-AV misses).
- Step 2: LDA-informative electrodes were used to evaluate whether pre-stimulus rhythms (power and phase) modulates non-retinotopic integration.

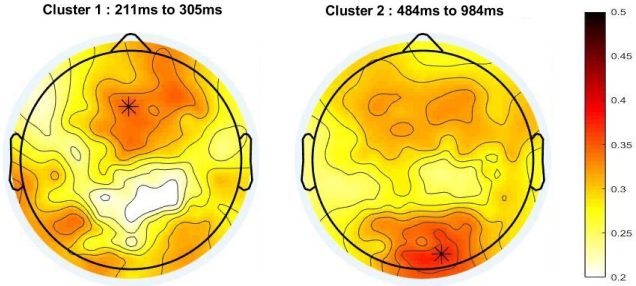
Results

A. Brain signal decoding (LDA): V hits vs V-AV misses



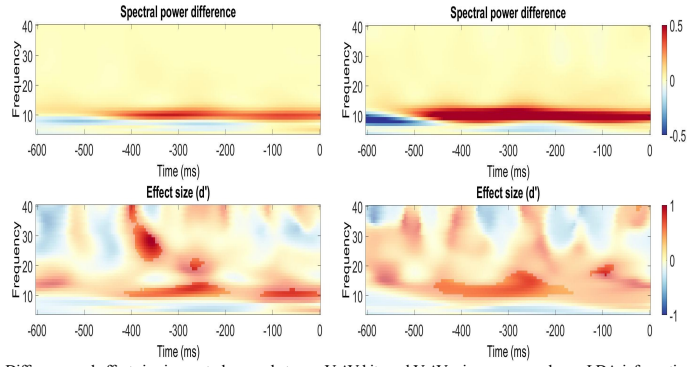
The classifier performance discriminating V hits from V-AV misses (mean and 95% CI). Significant time windows are highlighted (cluster-based permutation test, $p < 0.05$).

B. Scalp topographies from discriminant signal



LDA-derived scalp activation patterns at the two significant windows. Absolute power values are plotted and asterisks show electrodes with highest values.

C. Pre-stimulus spectral power: V-AV hits vs V-AV misses



Difference and effect size in spectral power between V-AV hits and V-AV misses, averaged over LDA-informative electrodes. Significant clusters are highlighted using permutation test and false-discovery rate control (FDR = 5%).

Discussion

- EEG LDA discriminated trials where the central vernier was correctly reported (V hits in V condition) from trials where the central vernier was not reported due to spatio-temporal feature integration with the second opposite vernier (V-AV misses in V-AV condition).
- As this integration is attributed to non-retinotopic processing[4], the resulting EEG maps might be related to non-retinotopic processing.
- When analyzing the most active electrodes within these maps, results suggest that the relative dominance between the first and second offsets in V-AV condition could be modulated by pre-stimulus alpha power. However, no significant effects were found in pre-stimulus phase.

References

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2. Iemi, L., Chaumon, M., Crouzet, S. M., & Busch, N. A. (2017). Spontaneous neural oscillations bias perception by modulating baseline excitability. Journal of Neuroscience, 37(4), 807–819.
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