Differential EEG Markers of Selective Attention and Feature Binding in Visual Search

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Introduction

Attentional mechanisms are implicated in both the selection of targets among distractors and the binding of features within those targets in visual search tasks.

While EEG markers of selective attention (N2pc)[1] and resource allocation (P3b)[2] have previously been identified, specific EEG markers of feature binding processes have yet to be established.

The aim of this study was to identify EEG markers that are differentially sensitive to selection attention and feature binding processes within visual search.

Two search tasks with similar selective attention but different feature binding demands were designed.

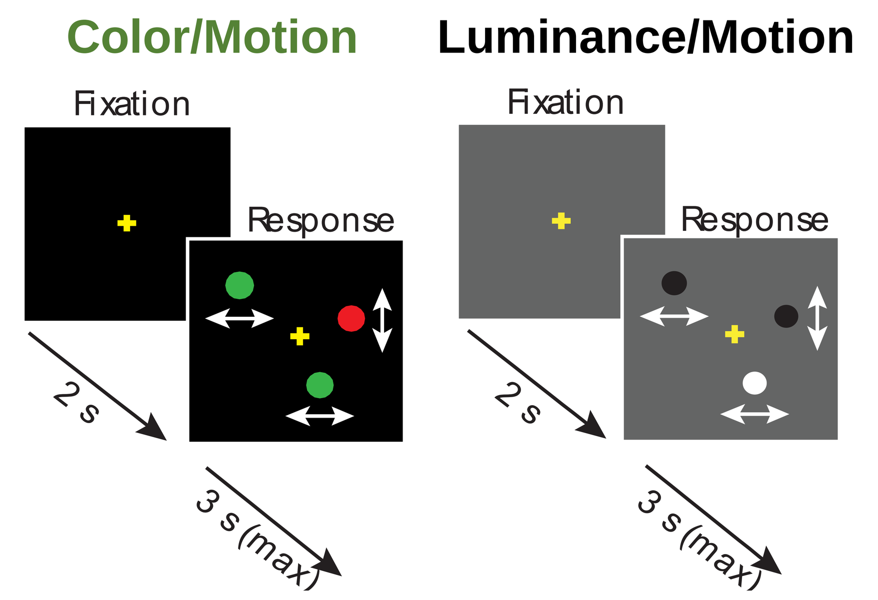
Methods

Participants (*N* = 29, Mean Age = 20.2 years, 22 F / 9 M) completed two conjunction visual search tasks: **isoluminant color/motion (C/M)** and **luminance/motion (L/M)**, which place differential demands on cross-cortical interactions.

In both tasks, the target was a vertically oscillating dot among horizontally or vertically oscillating distractor dots that shared a feature with the target.

- In **C/M**, the target was a red dot amongst distractor green or red dots (across-stream).
- In **L/M** the target was a black dot amongst distractor white or black dots (within-stream).
- Targets were presented among 0, 2, or 4 distractors, 60 trials each (½ in LVF & ½ in RVF).

Participants made speeded responses to indicate which side (left or right) the target appeared.



Behavioral RT and accuracy were measured while scalp EEG were continuously recorded from 64-channels. EEG data were processed offline using EEGLab[3] and ERPLab[4]. Epochs were time-locked to search display onset and baseline-corrected to the fixation period (-300 to 0 ms).

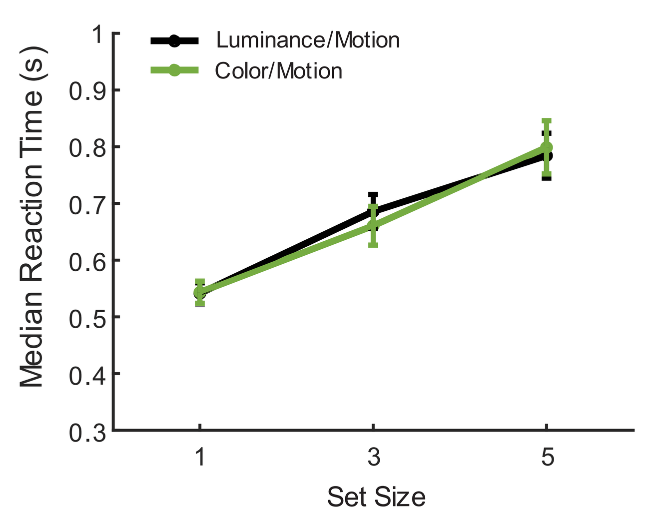
Perceptual Components of Interest:

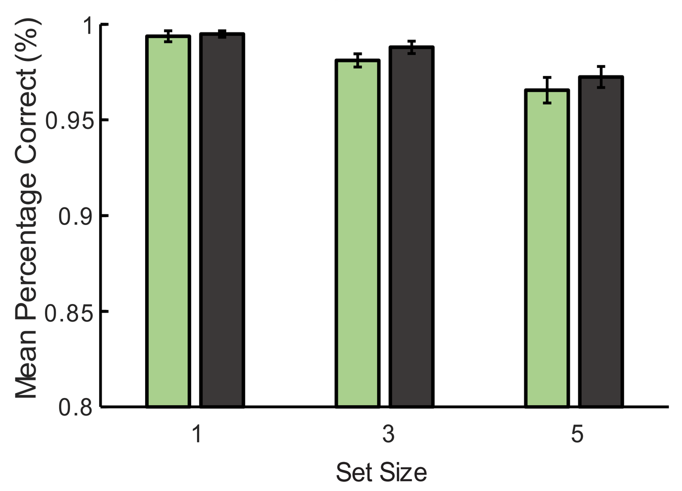
- **P2** (Pz, POz, Oz; 100–230 ms): feature analysis[5]
- **N2** (Pz, POz, Oz; 160–250 ms): motion discrimination[6]

Attentional Components of Interest:

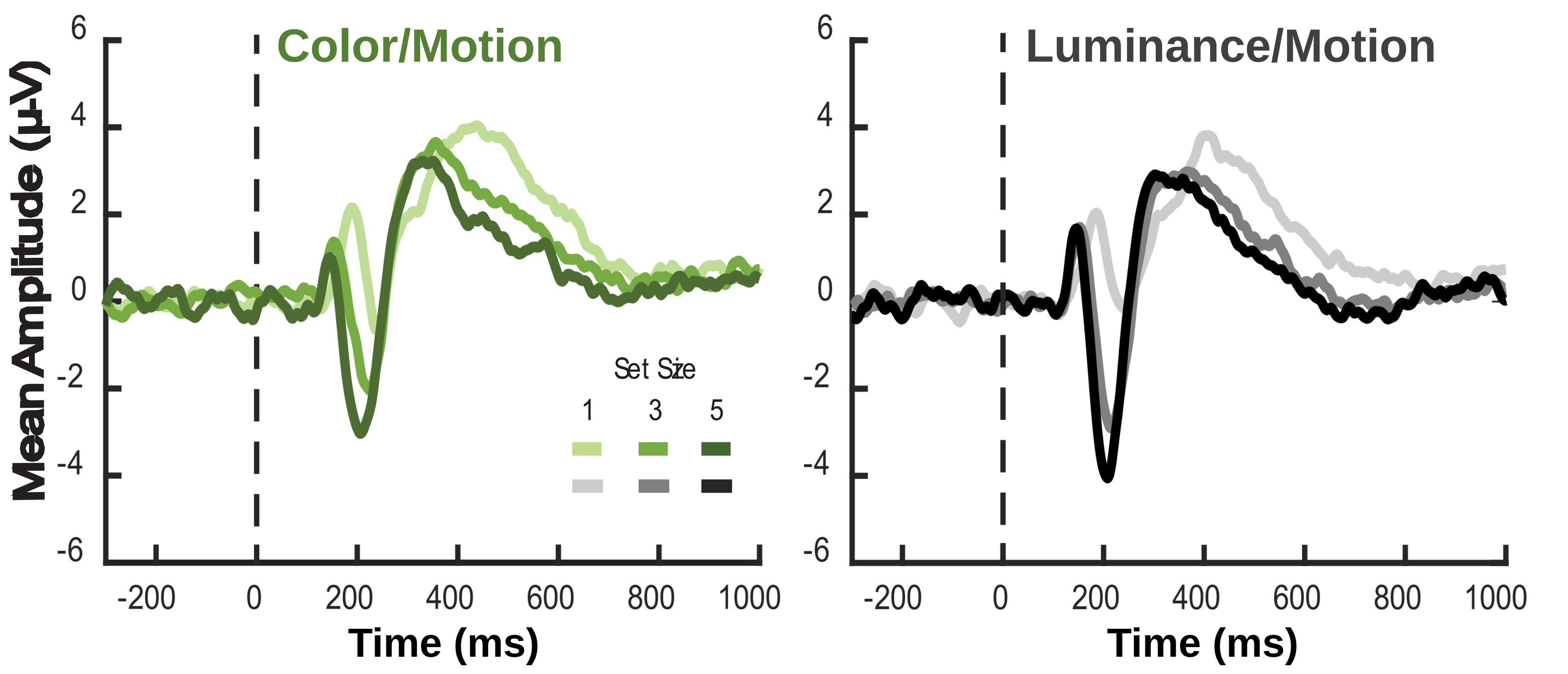
- **Contralateral N2pc** (P7/P8;160–250 ms)
- **Contralateral P3b:** (PO3/PO4; 350–600 ms)

Reaction Time & Accuracy

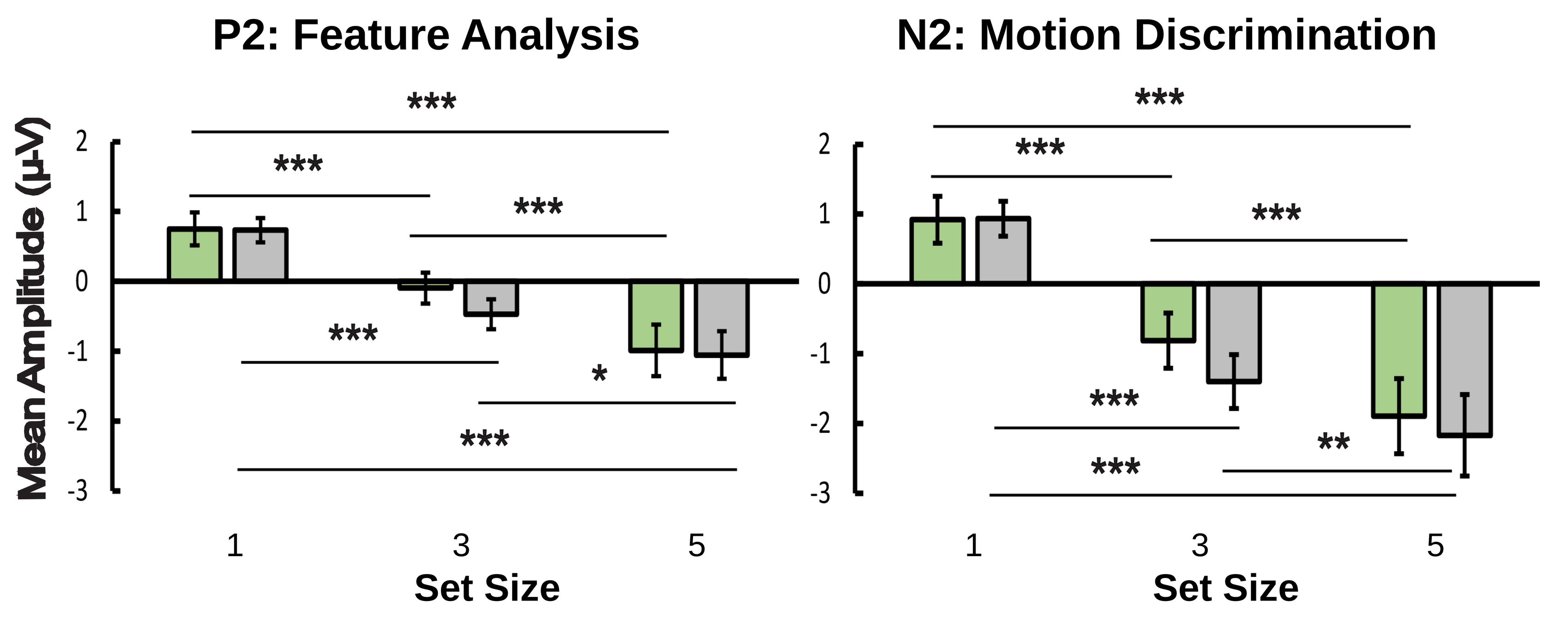




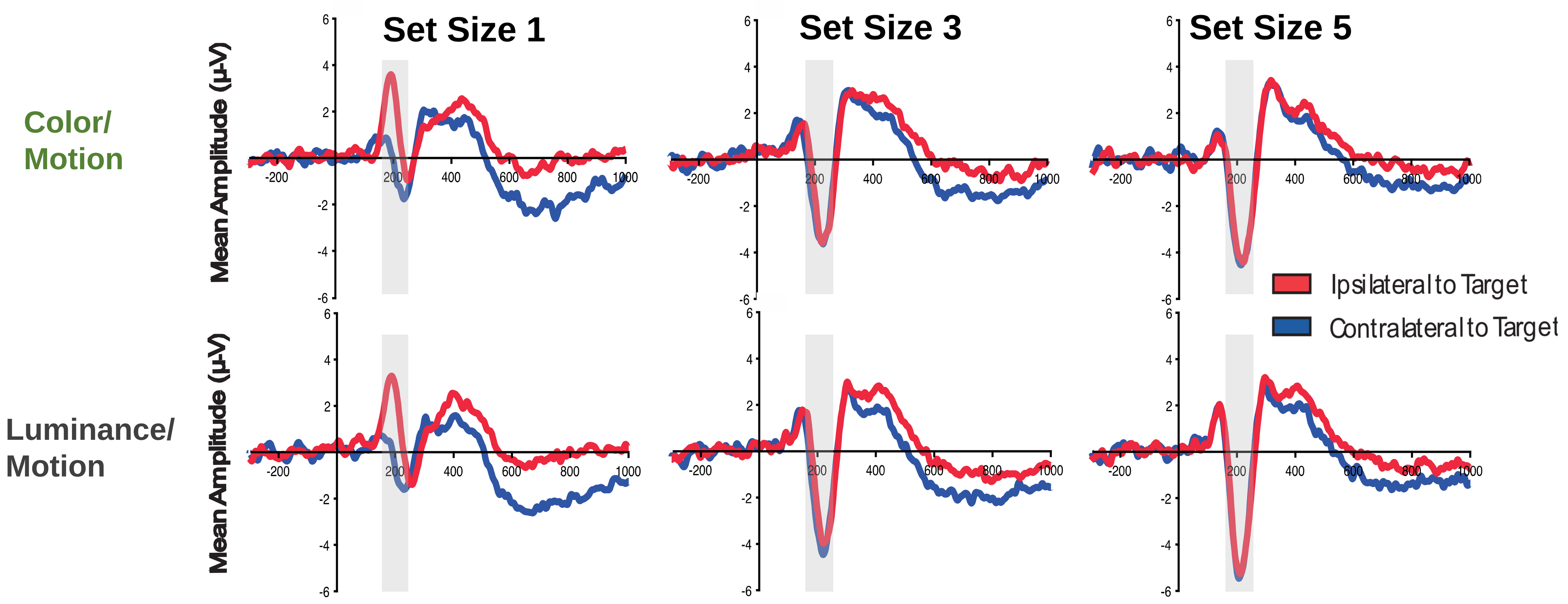
Grand Average ERPs (Pz, POz, Oz)

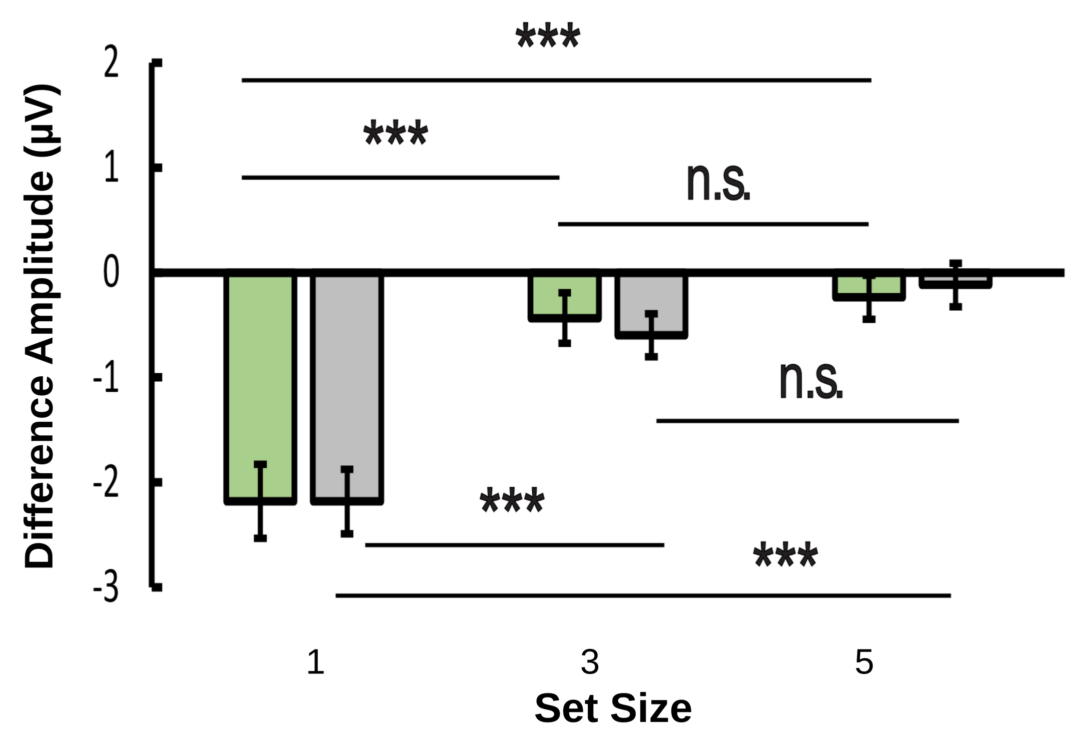


Perceptual Markers (Pz, POz, Oz)

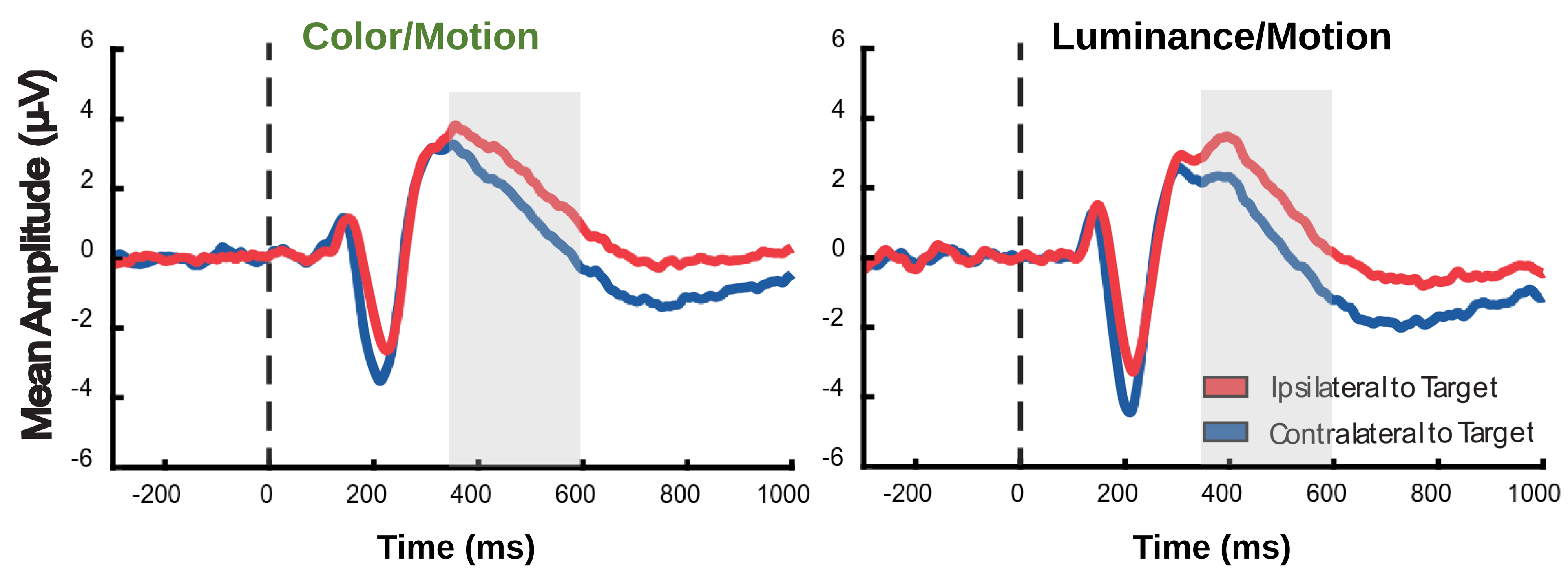


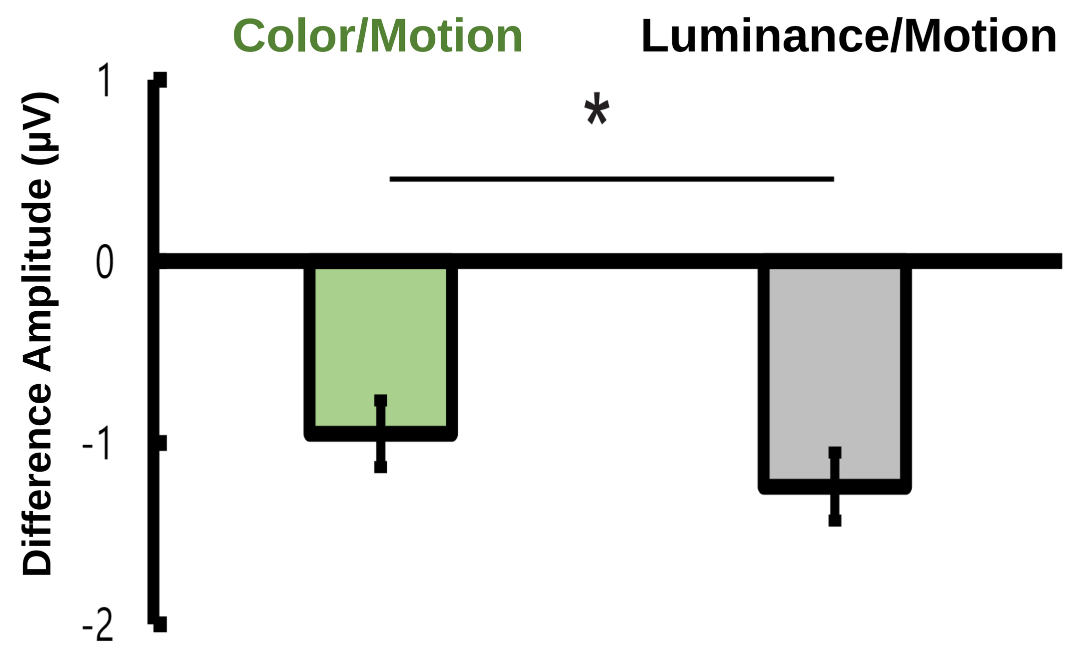
Early Attentional Marker: Contralateral N2pc (P7/P8)





Late Attentional Marker: Contralateral P3b (PO3/PO4)





Summary

Behavioral Results:

- RTs increased with set size, but did not differ across tasks. There was no interaction between set size and task.
- Accuracy decreased with set size, but did not differ across tasks. There was no interaction between set size and task.

Perceptual EEG Markers (P2 & N2):

- P2 amplitudes decreased with set size, but did not differ across tasks. There was no interaction between set size and task.
- N2 amplitudes increased with set size, but did not differ across tasks. There was no interaction between set size and task.

Early Attentional EEG Marker (N2pc):

- N2pc amplitudes increased with set size
- N2pc difference amplitudes (contralateral – ipsilateral waveforms) decreased from set size 1 to set sizes 3 & 5.
- N2pc difference amplitudes did not differ across tasks, and there was no interaction.

Late Attentional EEG Marker (Contralateral P3b):

- P3b difference amplitudes (contralateral - ipsilateral waveforms) did not differ across set size.
- P3b difference amplitudes were greater in the **L/M** task than the **C/M** task.
- There was no interaction between set size and task.

Conclusions

- Reaction time and accuracy did not differ across **L/M** and **C/M** tasks and increased similarly with set size, suggesting comparable perceptual processing and selective attention demands.
- P2, N2 and N2pc components also did not differ across tasks and were similarly influenced by set size, confirming comparable perceptual and selective attention process in **L/M** and **C/M.**
- In contrast, the P3b component differed across tasks but not set size, indicating that the **L/M** and **C/M** tasks place differential demands on later attentional resource allocation processes.
- These findings suggest that the contralateral P3b may be a marker of feature binding, and in particular reflects the need for greater reentrant attentional binding processes[7] in the **C/M** task.

References

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