



Age-related deficits in alpha-band modulation during probabilistic cueing of visual spatial attention

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Introduction

- The modulation of alpha (8–13 Hz) band oscillations has become a canonical marker of visual spatial attention.
- Previous studies have demonstrated age-related deficits in visual spatial attention.
- However, it still remains elusive to what extent normal aging changes the electrophysiological correlates of visual spatial attention.
- We tried to investigate how alpha-band modulation is impacted during normal aging in the same experiment with probabilistic cueing by assessing differences between two age groups.

Methods

Paradigm

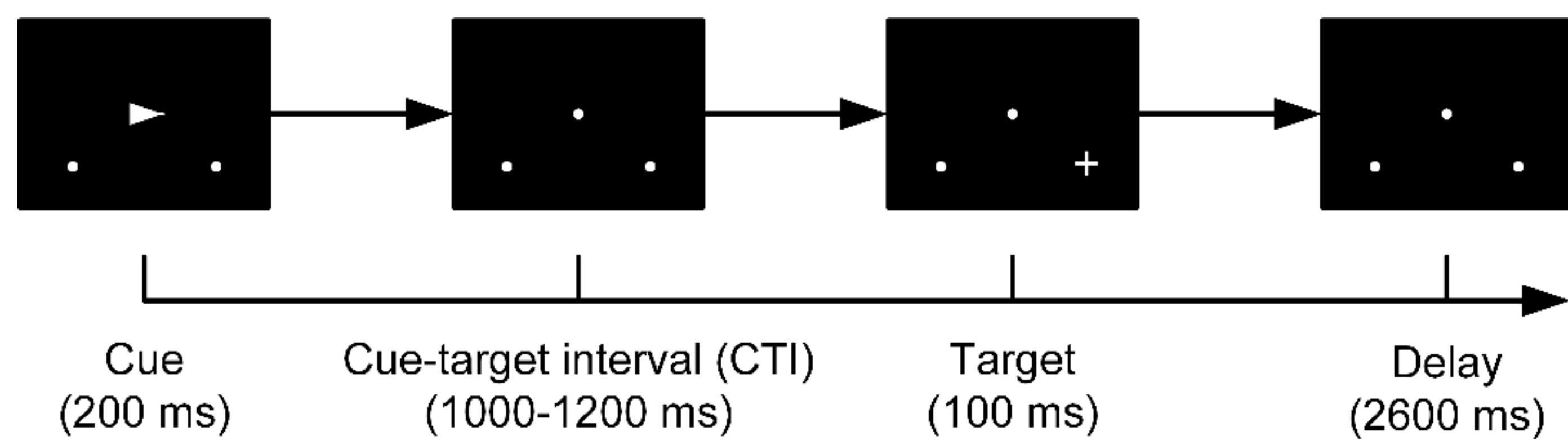
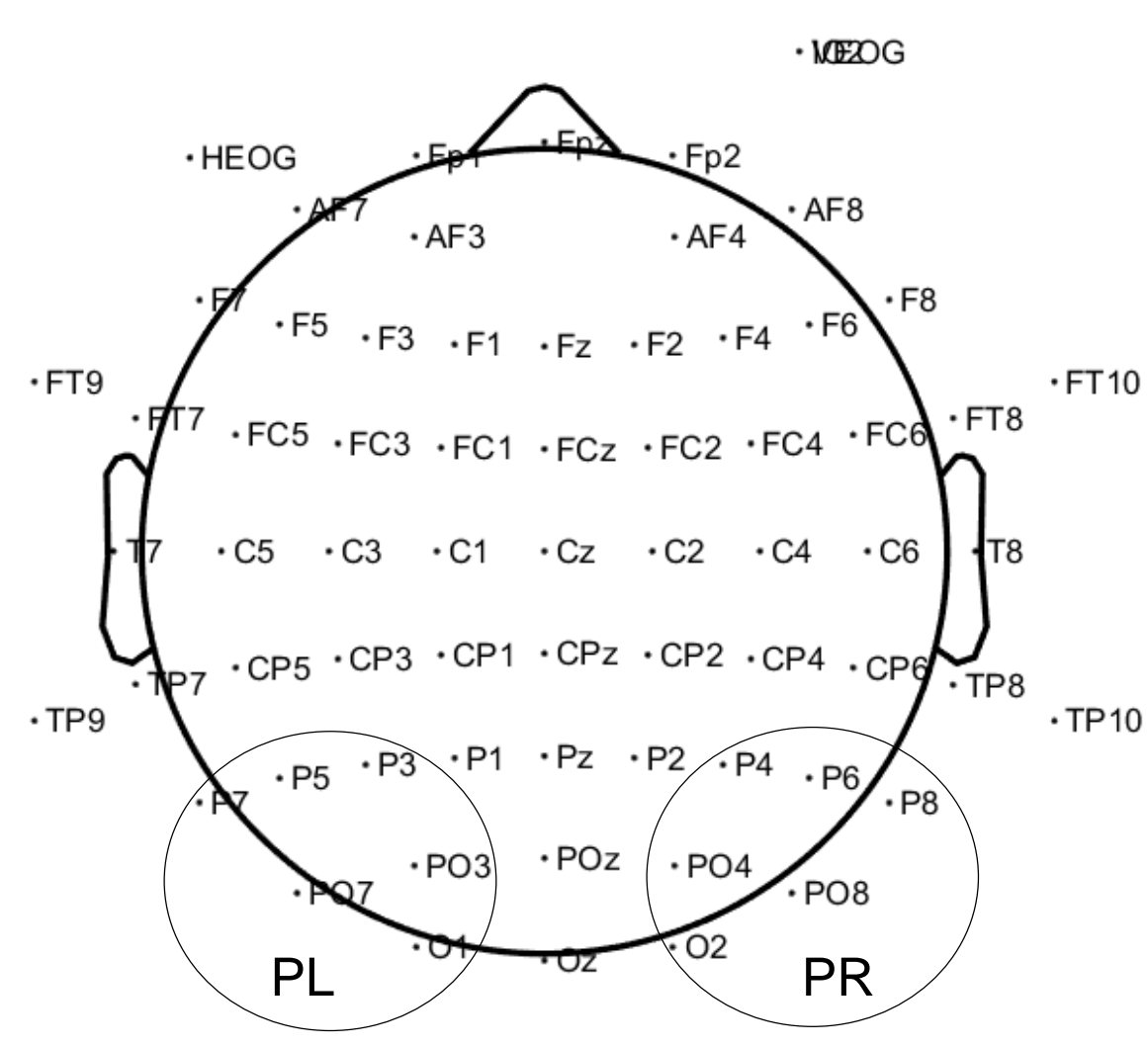


Figure 1. The spatial attention task with probabilistic cueing. Each subject was required to covertly orient attention to either the left or the right visual location via a cue, and make a button response as accurately and quickly as possible when the target presented later was a plus sign (50% probability) in both attended and unattended visual field.

Data Acquisition and Analyses

- 24 healthy young subjects
- 30 healthy older subjects
- 64-channel scalp EEG recording
- EEG preprocessing in MATLAB
- Two posterior ROIs
 - PL:** P3, P5, P7, PO3, PO7, O1;
 - PR:** P4, P6, P8, PO4, PO8, O2.



- Cue-related alpha power were calculated by averaging averaged across the 6 electrodes within each ROI (PL, PR).
- Sensory facilitation resulted from visual spatial attention was indexed by examining the N1 time-locked to visual targets within two ROIs.

Results

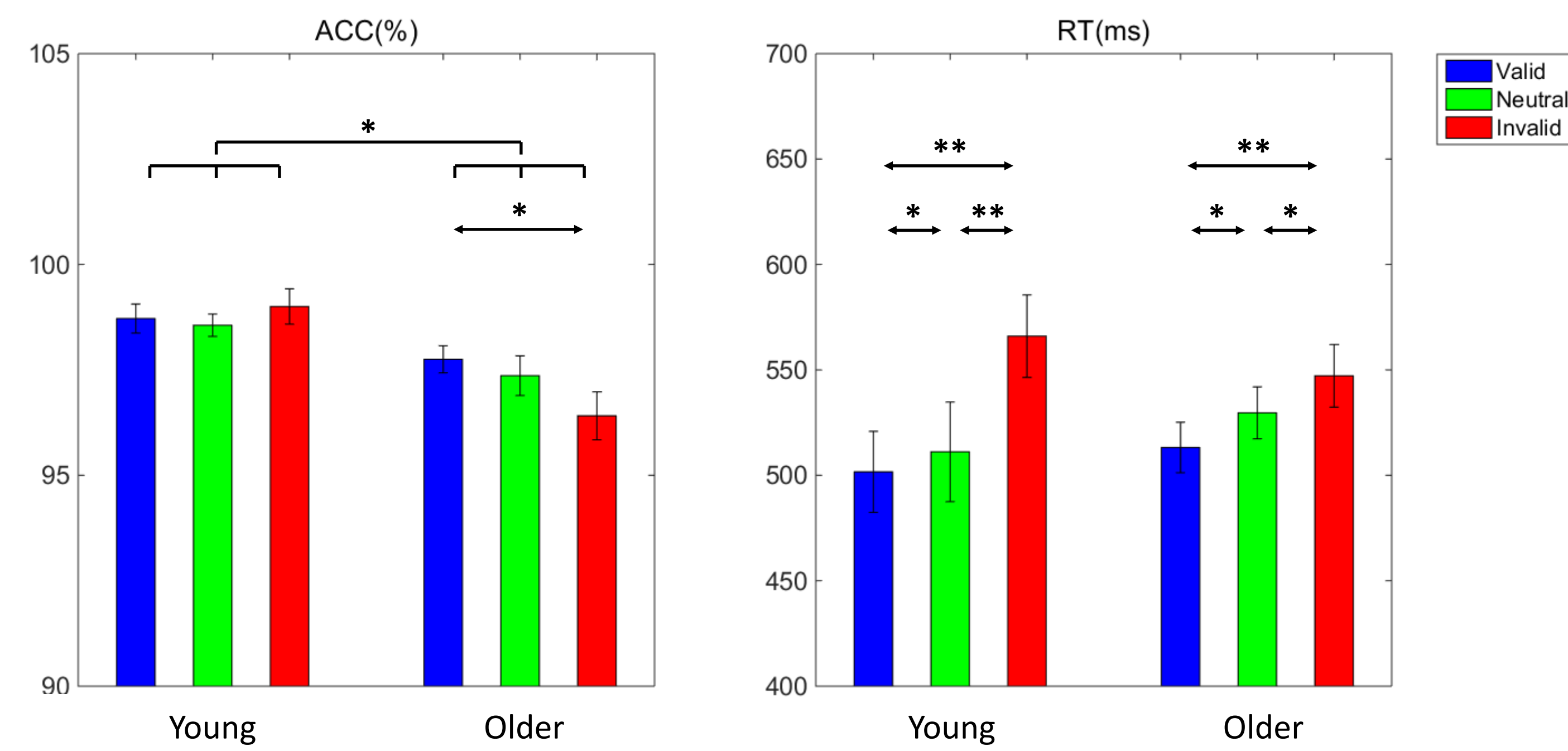
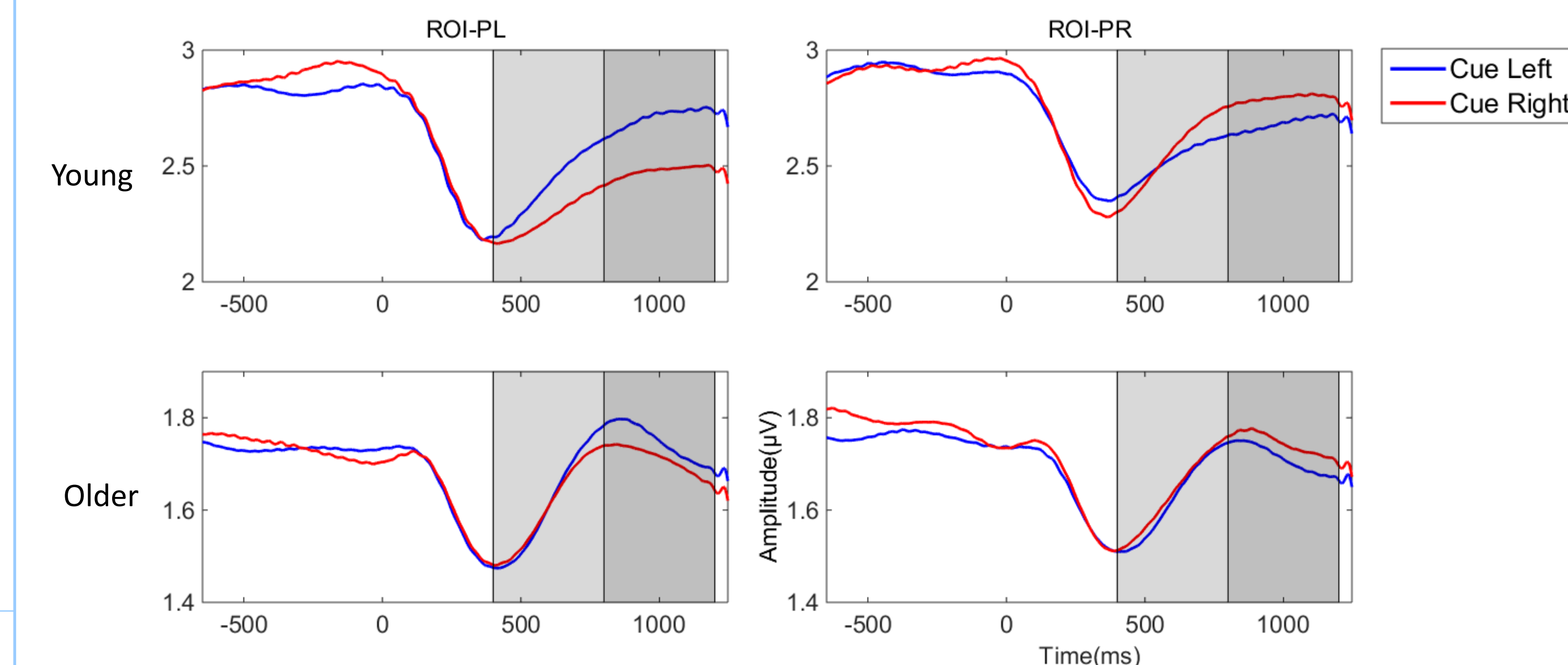
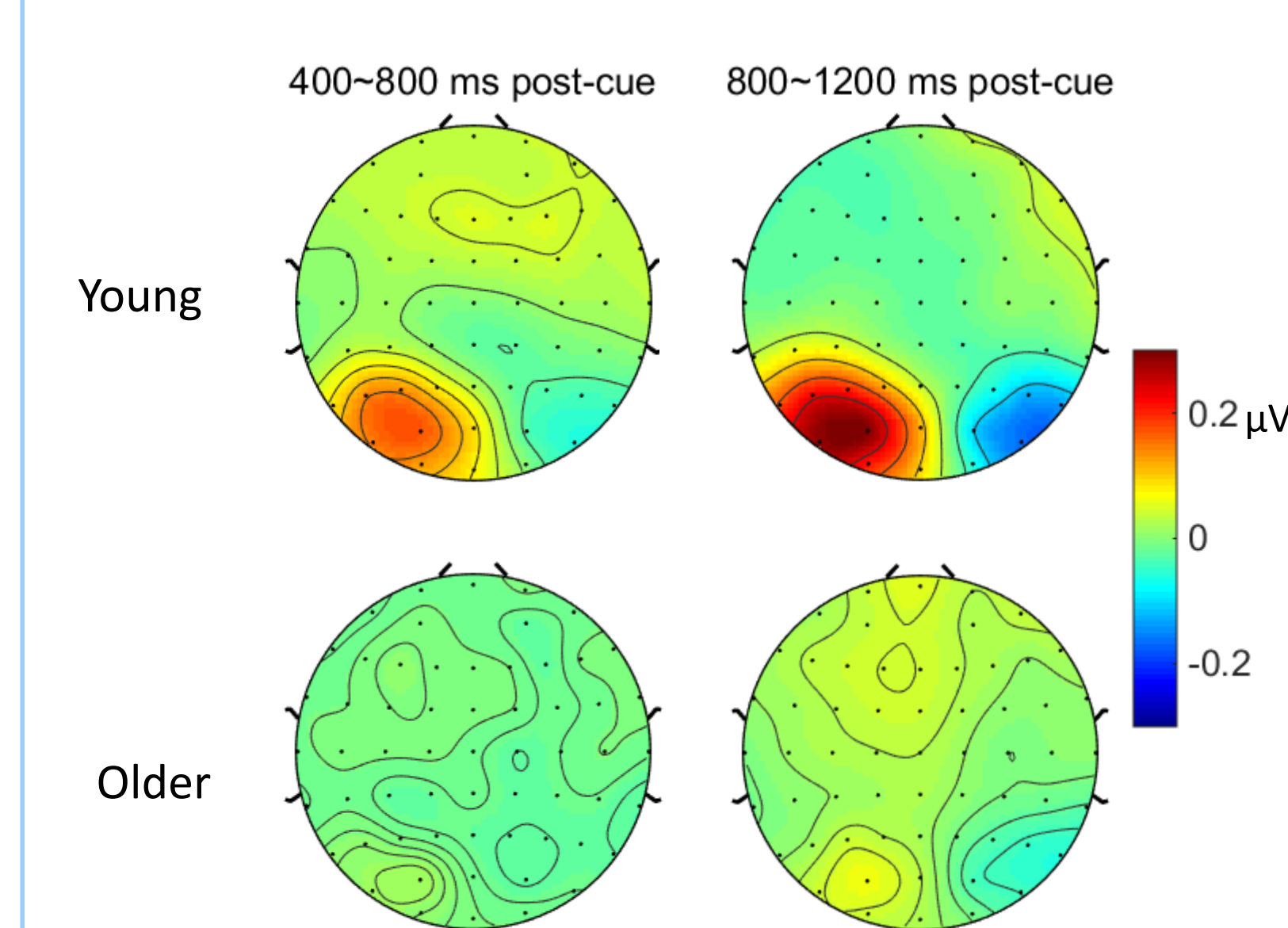


Figure 2. Behavioral performance. Both young and older adults performed the task with high accuracy and showed significantly longer reaction time (RT) in invalid trials than in valid trials, suggesting a robust spatial attention cueing effect. The comparable behavioral performance between young and older adults indicates that the later group guaranteed the response time as fast as the former group by reducing the accuracy. (*: $p < 0.05$; **: $p < 0.001$).

(A) Cue-related alpha-band power



(B) Cue left minus Cue right



(C) Normalized alpha-band power

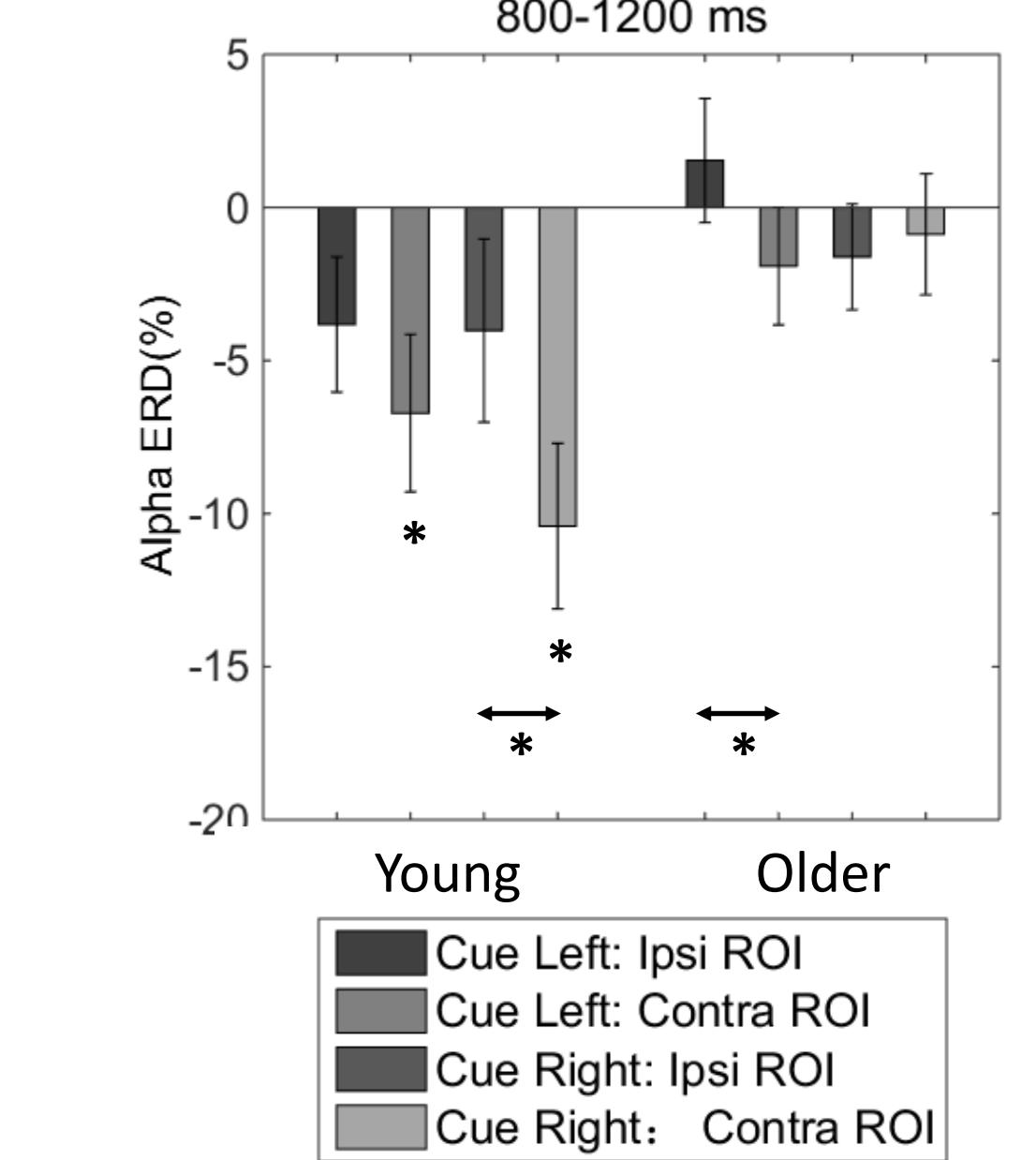
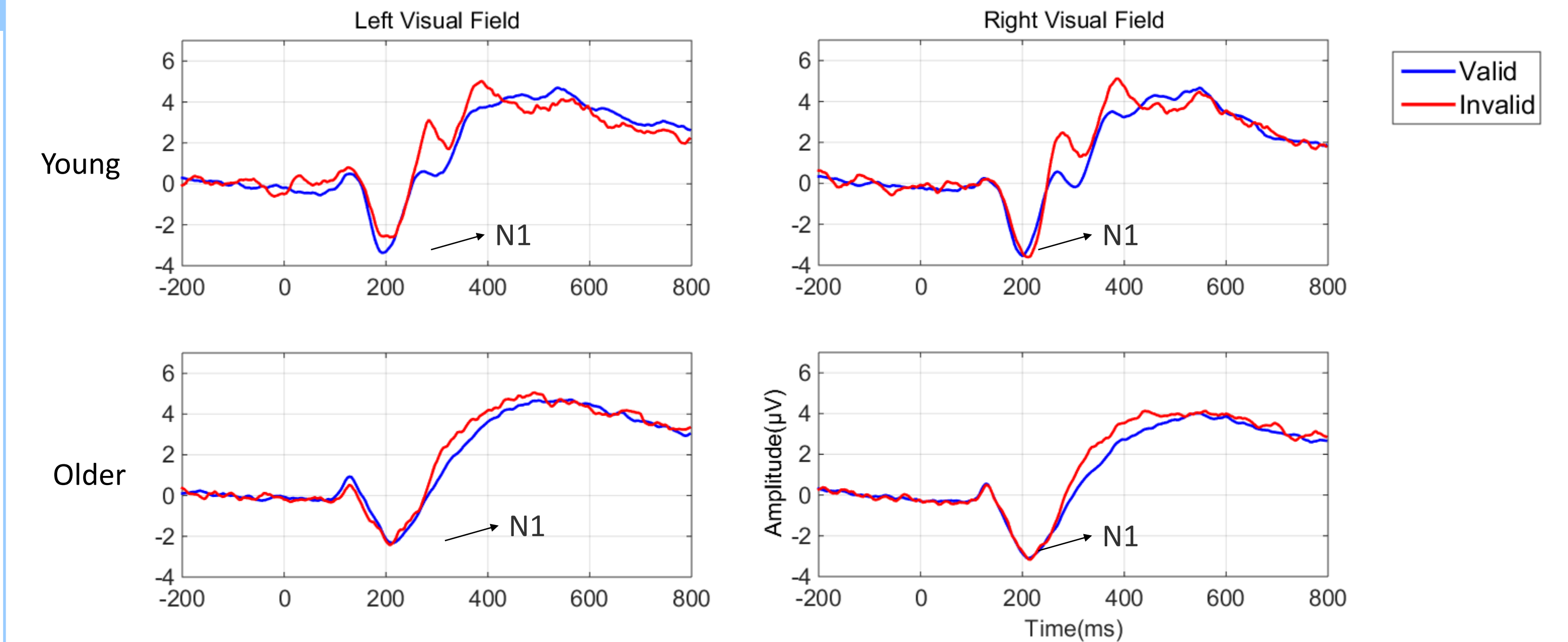
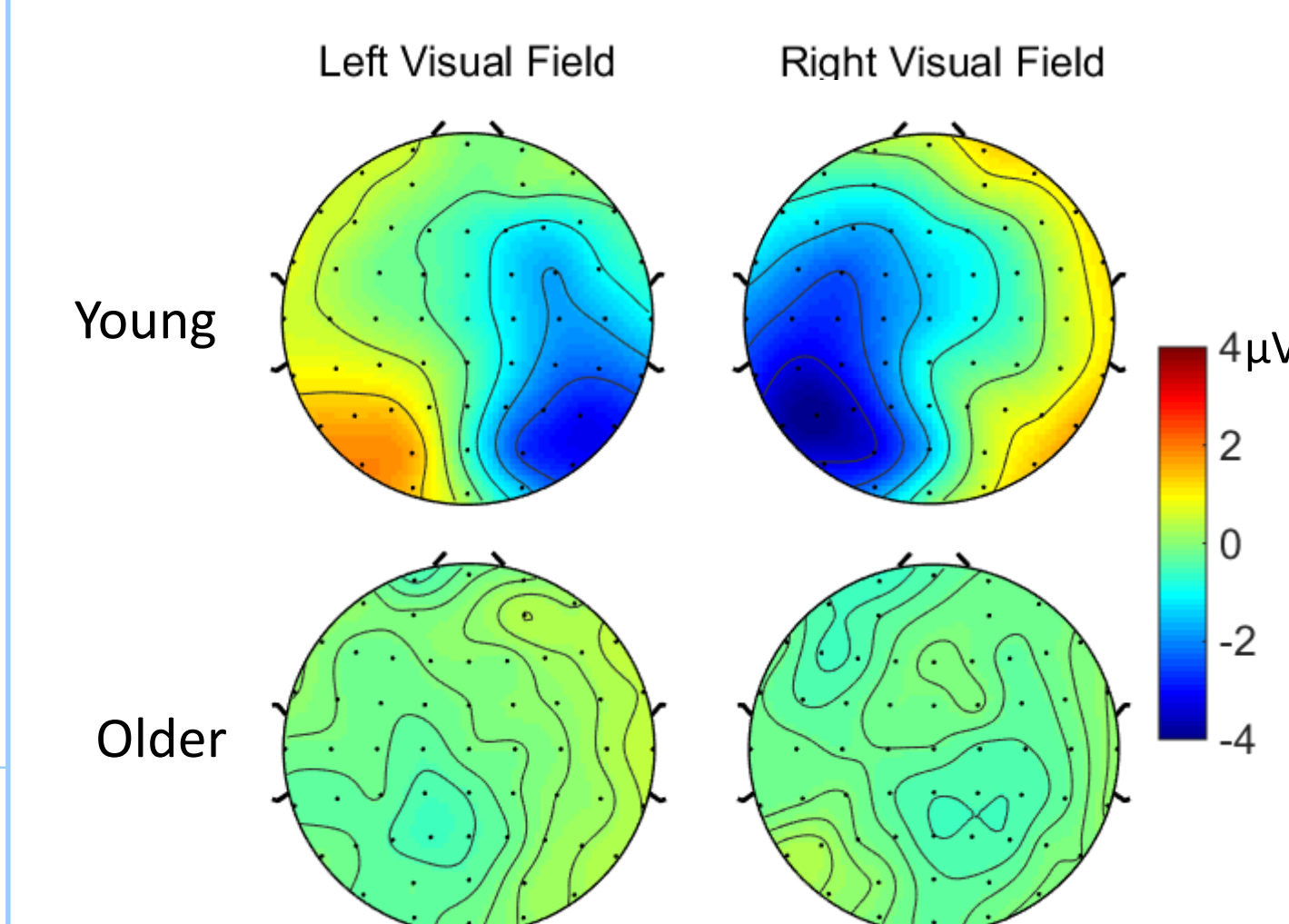


Figure 3. Young subjects showed significant alpha power lateralization over posterior areas during preparatory spatial attention, however, older adults showed the absence of alpha lateralization in the same time interval. Error bars indicate SEM in Panel C. (*: $p < 0.05$).

(A) Target-related ERP waveforms within contralateral posterior ROIs



(B) Target-related N1 (180-220 ms)



(C) Attentional modulation on N1 amplitude: Contralateral Valid-N1 minus Invalid-N1

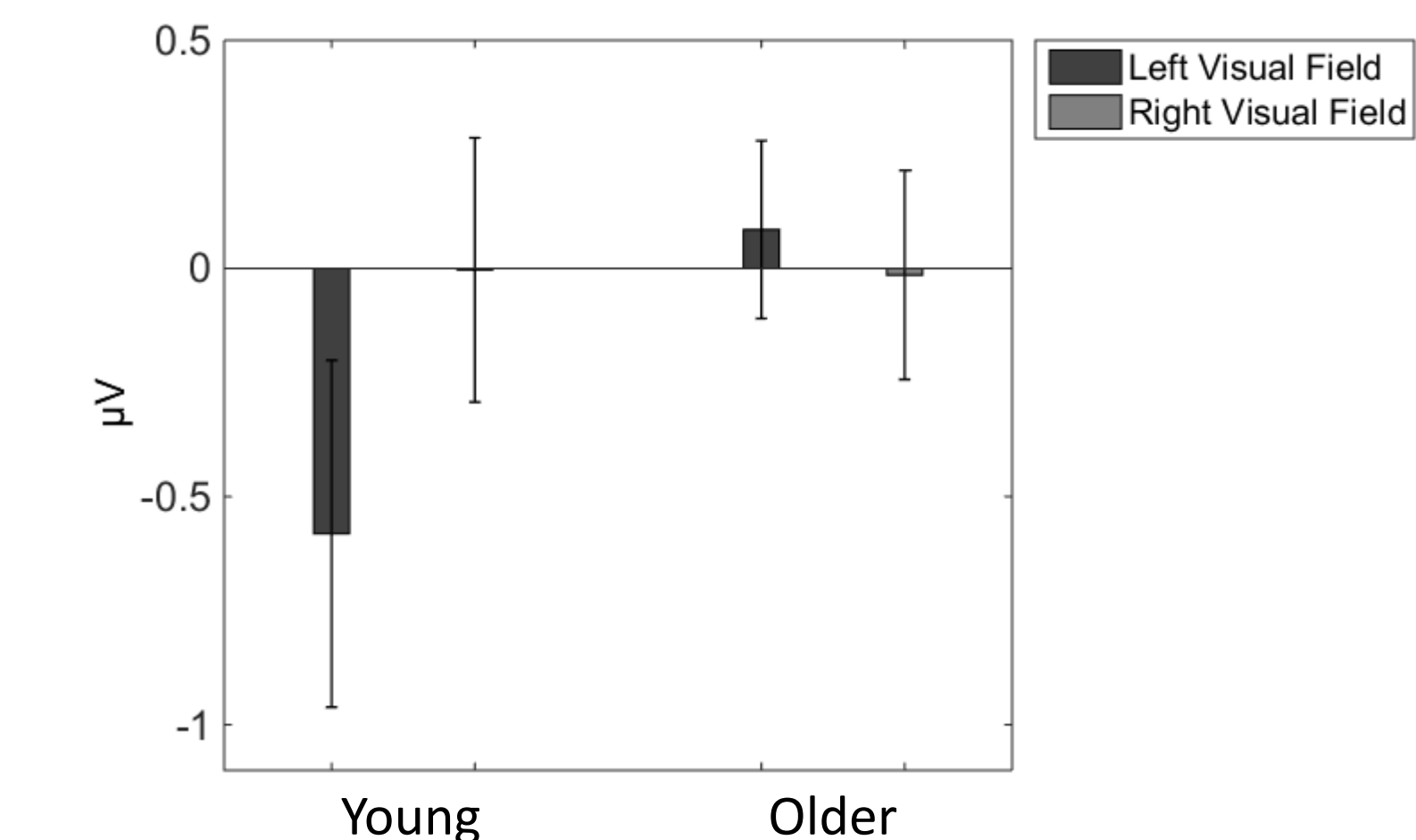


Figure 4. Young adults showed greater N1 modulation, but older adults with lower alpha power showed little modulation on N1 amplitude. Error bars indicate SEM in Panel C.

Summary

- Both young and older adults showed significant attentional cueing effects, suggesting successful orienting of visual attention.
- The classical cue-related alpha modulation, especially the alpha lateralization that was robustly observed in young adults, declined significantly in older adults.
- The attentional modulation of target-evoked N1 amplitudes was reduced for older adults compared with young adults.
- The comparable behavioral performance between two age groups indicates that such age-related deficits might be compensated by other neural substrates of visual spatial attention in older adults.

References:

- Posner, M. I. (1980). Journal of Experimental Psychology 32: 3-25.
- Worden, M. S., et al. (2000). Journal of Neuroscience, 20(RC63), 1-6..
- Hong X, Sun J, Bengson J J, et al. (2015). Neuroimage 106: 353-363.
- Mangun GR, Hillyard SA. (1991). Journal of Experimental Psychology 17: 1057-1074.

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