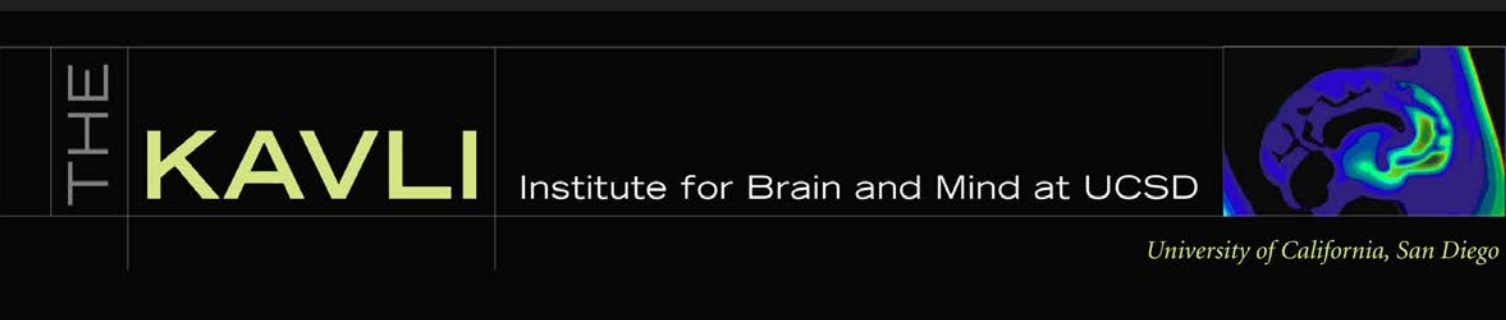# Contour integration and its independence from attention, awareness, and task-relevance

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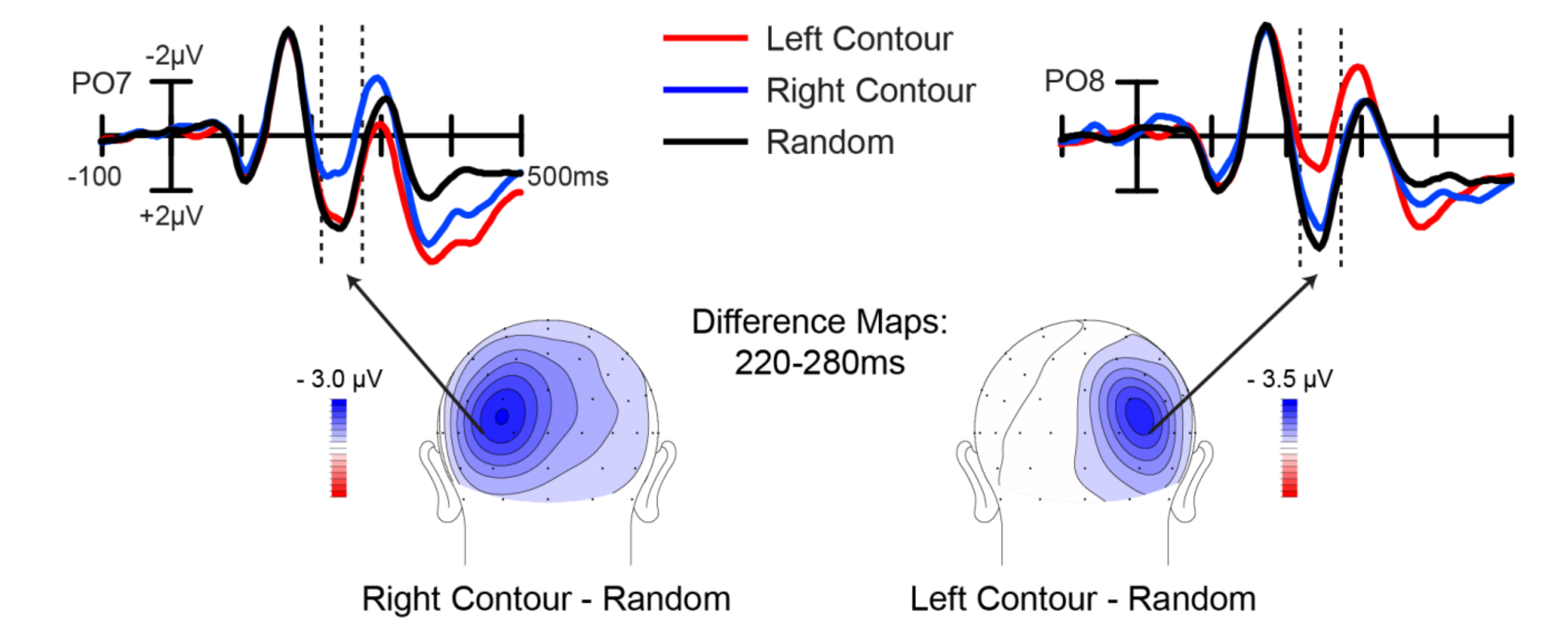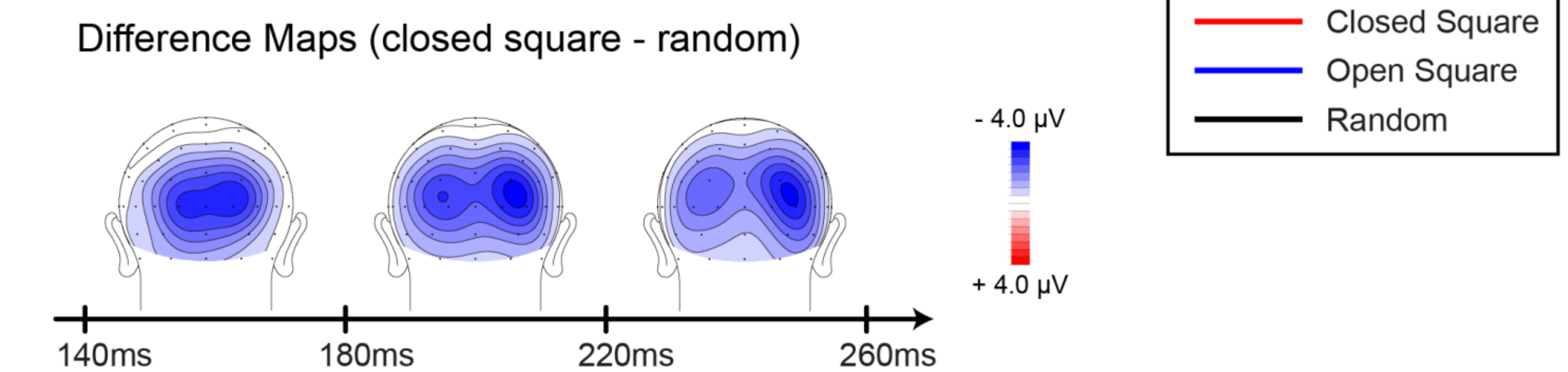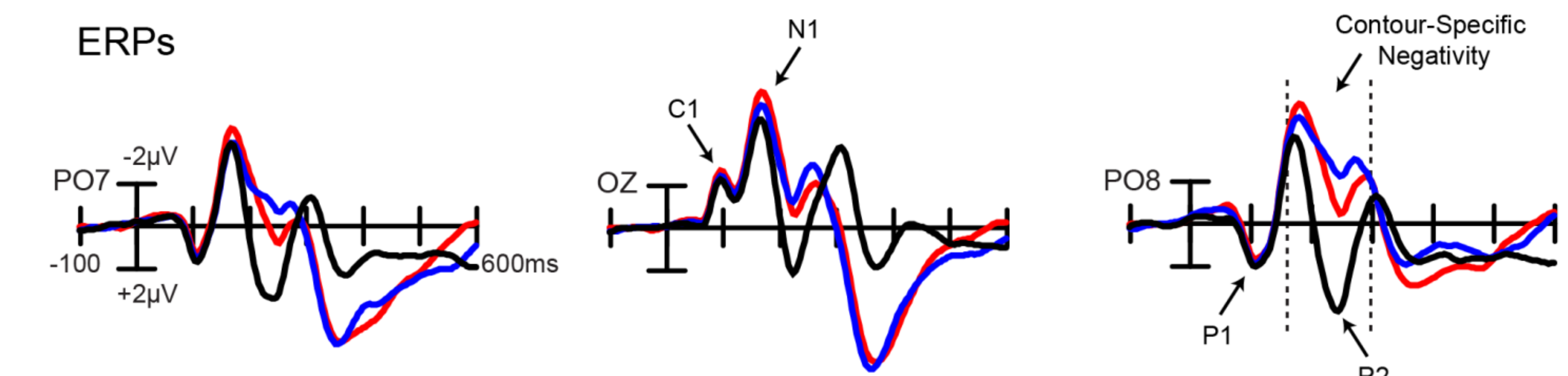
Introduction

- Whether contour integration occurs in the absence of attention and awareness is currently debated
- Previous ERP experiments have identified a possible index of contour integration:
  By comparing ERPs elicited by contour-present vs. contour-absent stimuli, a contour-specific negativity is evident over the posterior scalp from ~150-300ms
- Here we investigate the properties of this contour-specific ERP in a series of 5 experiments:
  1. Replicate basic effect, explore spatial specificity of contour-related ERP
  2. Distinguish sensory vs. task-based effects
  3. Is spatial attention and/or task-relevancy necessary?
  4. Is perceptual awareness necessary?
  5. How do stimulus and task-based factors modulate contour processing?

Experiment 1

Stimuli:

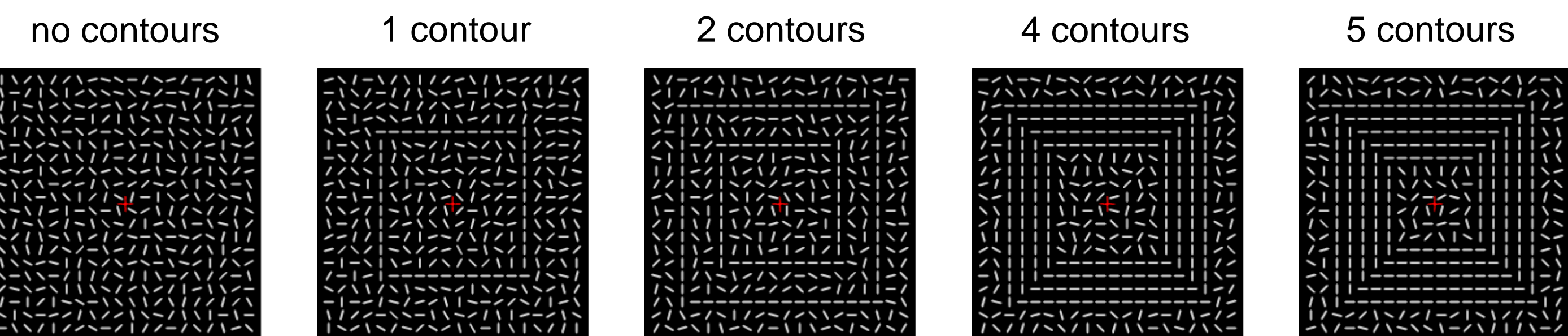random | closed-square | open-square | one-line left | one-line right
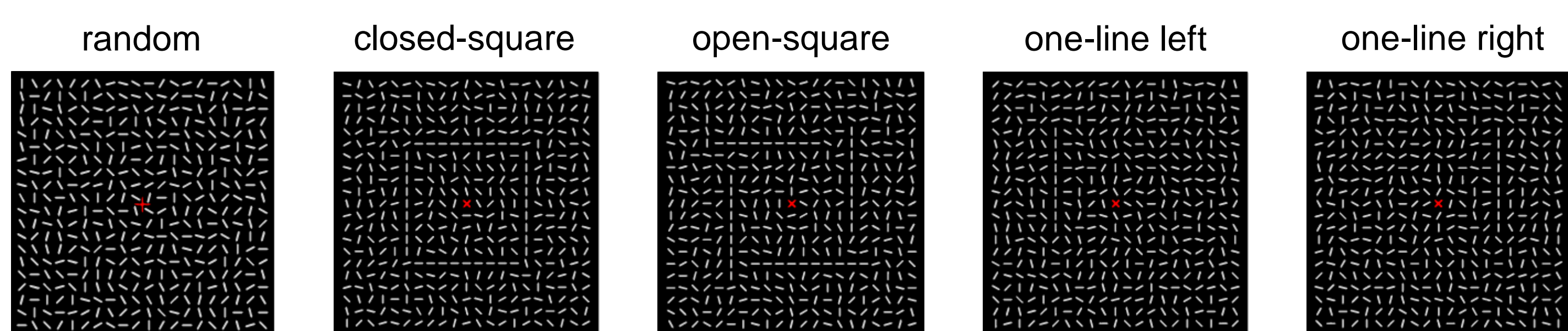
Task: One of 4 stimulus-types designated as target on separate blocks
possible targets = random, closed-square, open-square, one-line
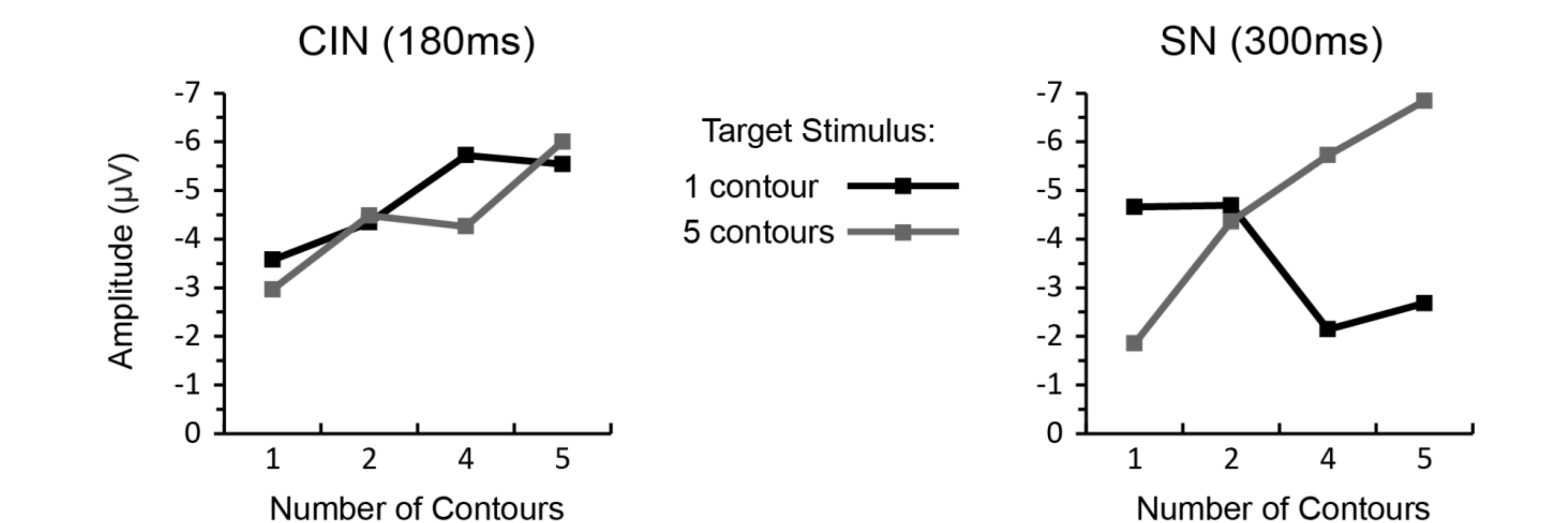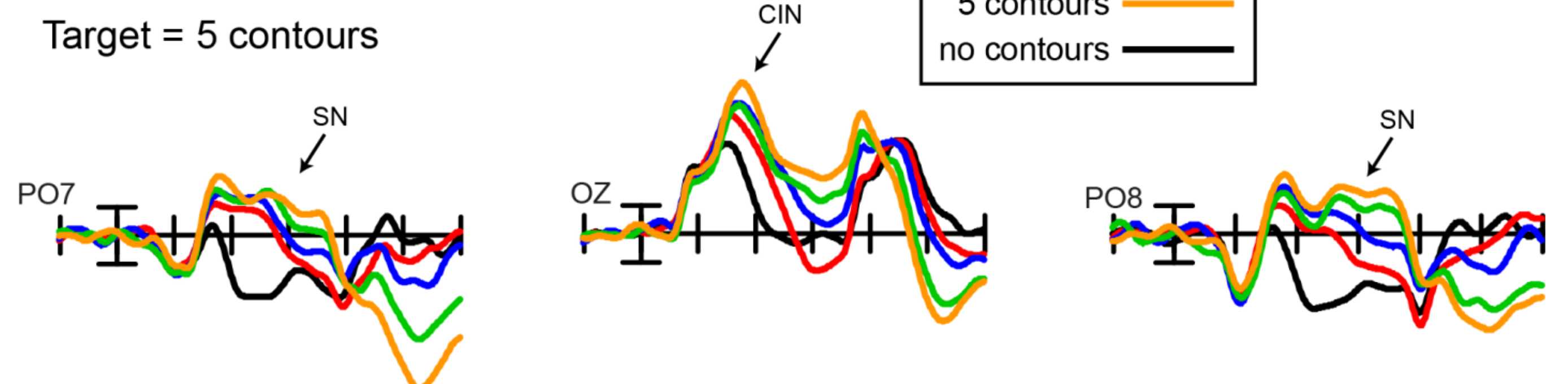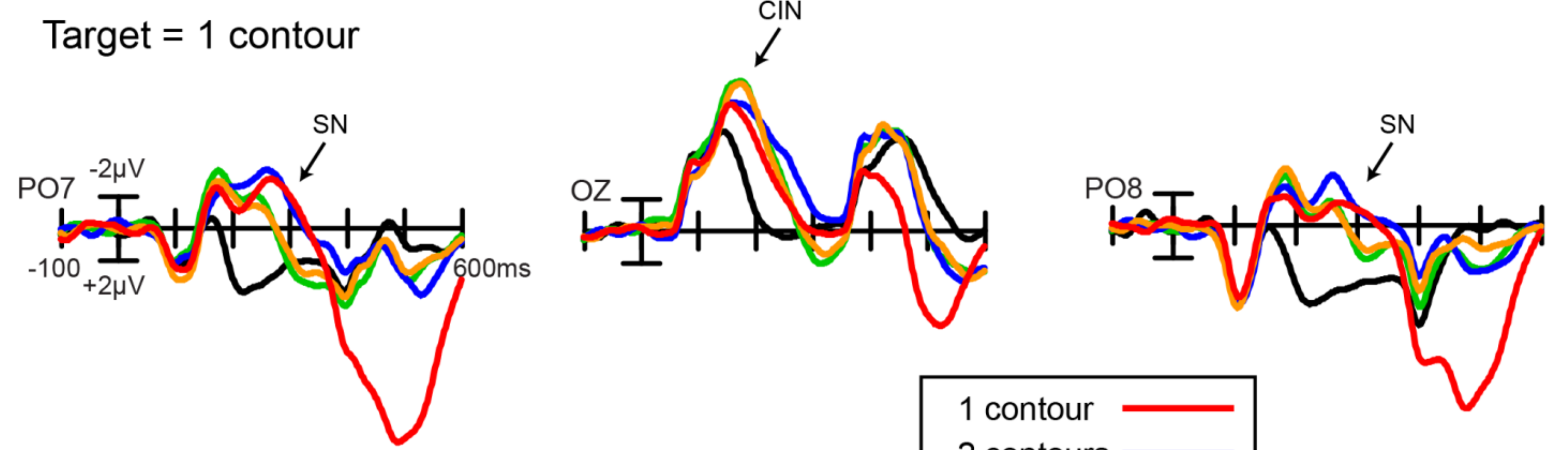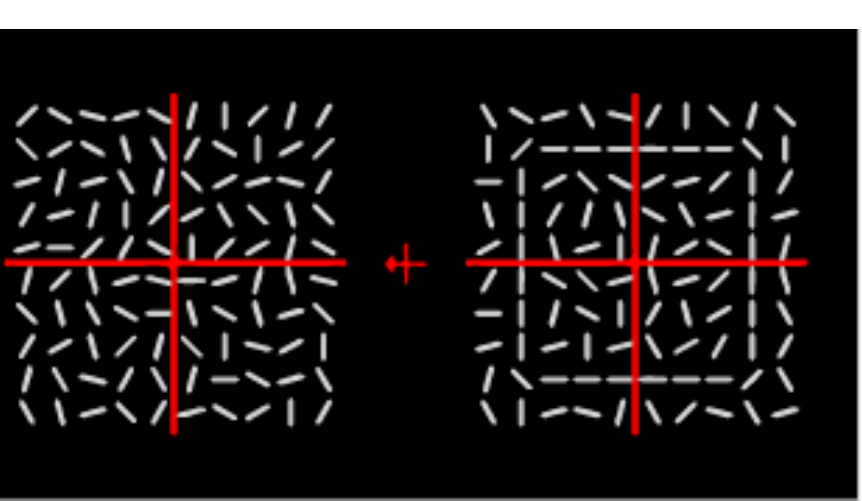*ERPs assessed for all trials in which a stimulus was a non-target

Difference Maps (closed square - random)

140ms 180ms 220ms 260ms

- Closed Square
- Open Square
- Random

- Left Contour
- Right Contour
- Random

Difference Maps: 220-280ms

Right Contour - Random   Left Contour - Random

Experiment 2

Stimuli:

no contours | 1 contour | 2 contours | 4 contours | 5 contours

Task: On separate blocks of trials, 1-contour or 5-contour stimulus designated as target

Target = 1 contour

Target = 5 contours

- 1 contour
- 2 contours
- 4 contours
- 5 contours
- no contours

CIN (180ms)   SN (300ms)

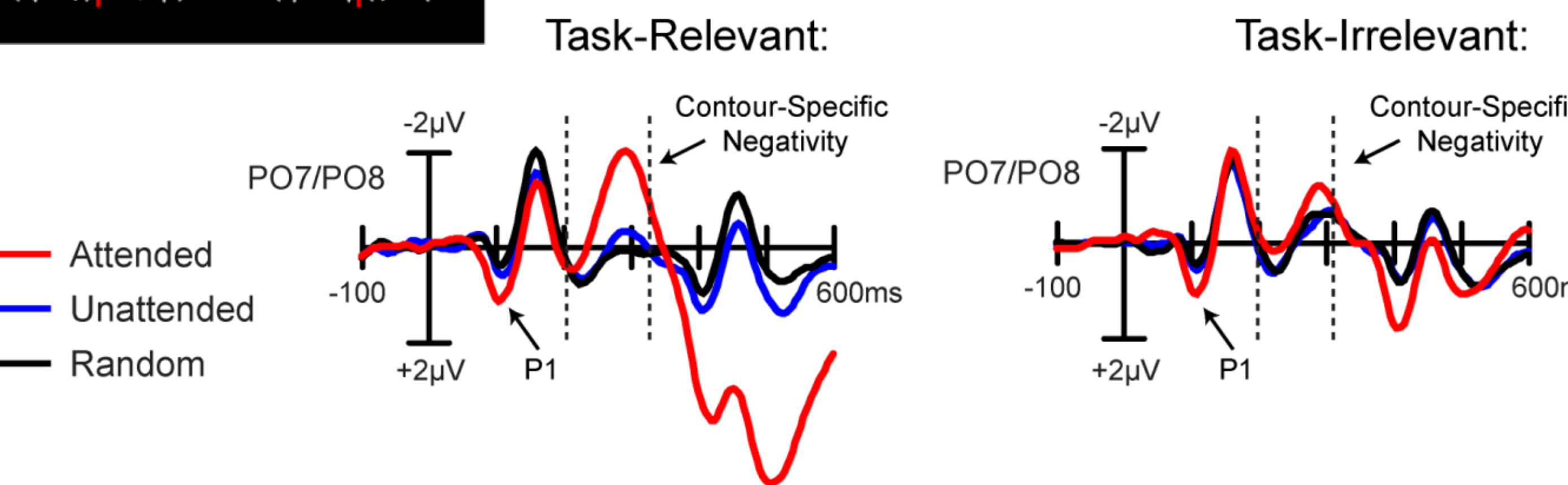Target Stimulus:
- 1 contour
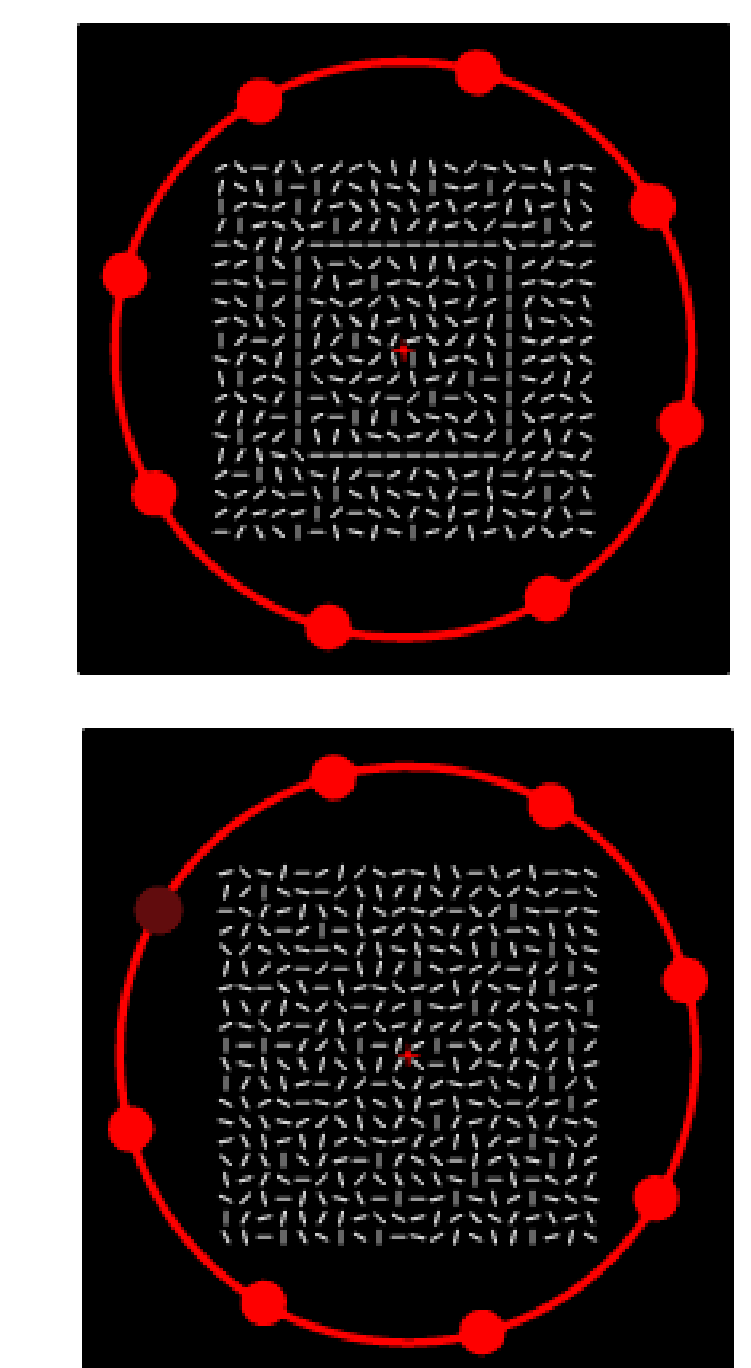- 5 contours

Experiment 3

Task: On separate blocks of trials, attend left or right and perform one of two tasks:
- detect short red-cross arms
- detect diamond-shaped contours

Task-Relevant: Task-Irrelevant:

- Attended
- Unattended
- Random

Experiment 4

Stimuli:

Condition 1: Contours Not Perceived

CIN

180ms 220ms 260ms 300ms 340ms 380ms 420ms

-1.2μV +1.2μV

Condition 2: Contours Perceived but Task-Irrelevant

CIN   VAN

180ms 220ms 260ms 300ms 340ms 380ms 420ms

-1.2μV +1.2μV

Condition 3: Contours Perceived and Task-Relevant

CIN VAN SN P3s

180ms 220ms 260ms 300ms 340ms 380ms 420ms
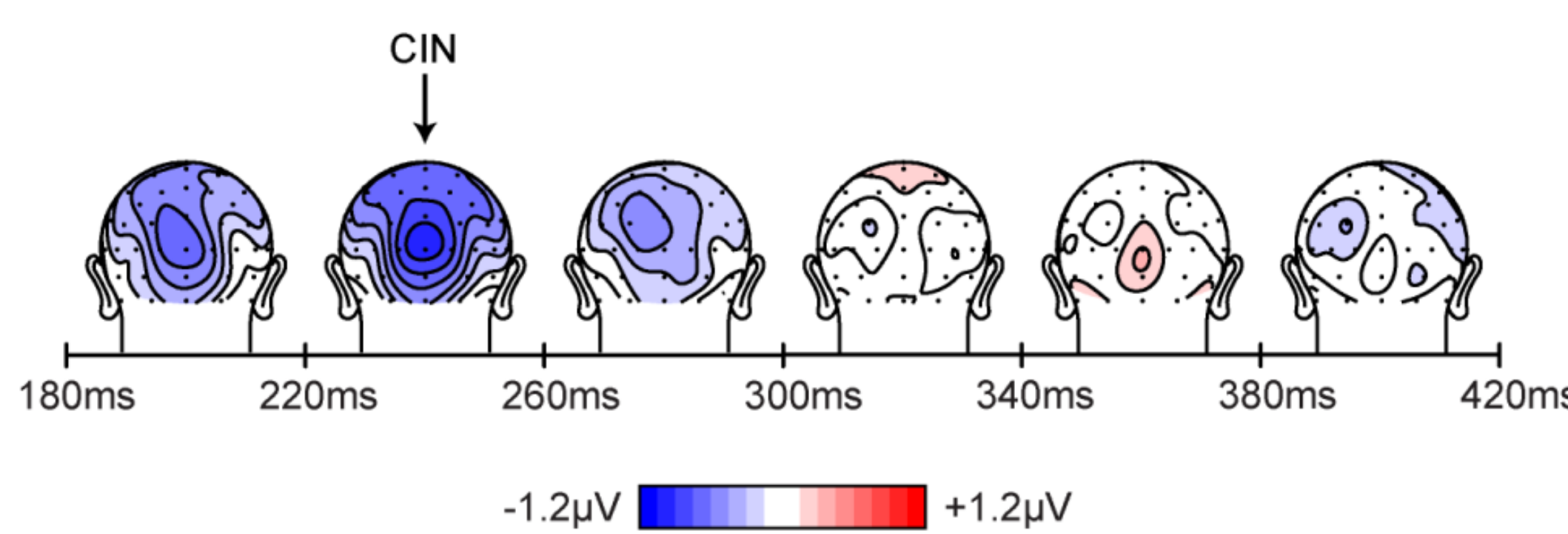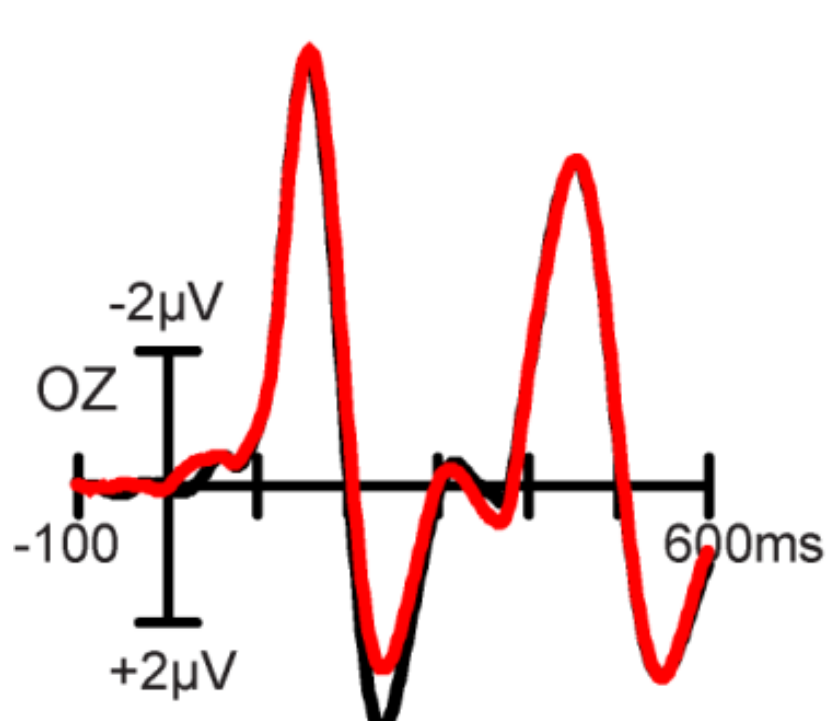
-1.2μV +1.2μV   -4.0μV +4.0μV

Tasks:
1. Attend to red ring of discs, detect dim targets
2. Attend to red ring of discs, detect dim targets
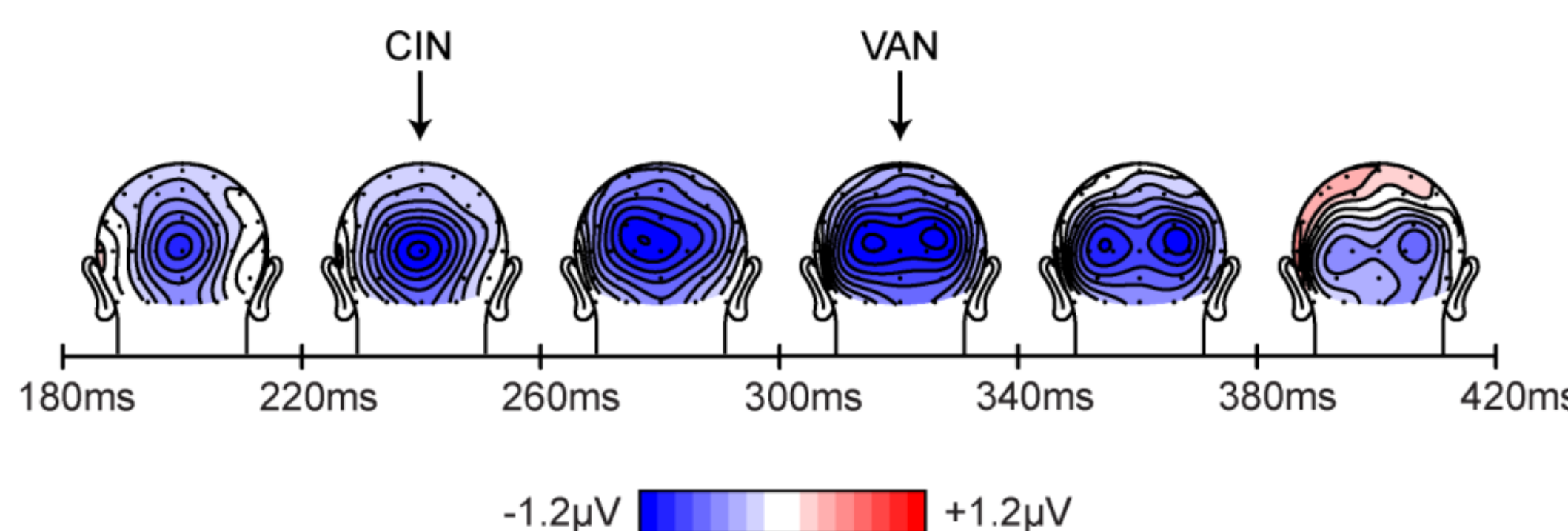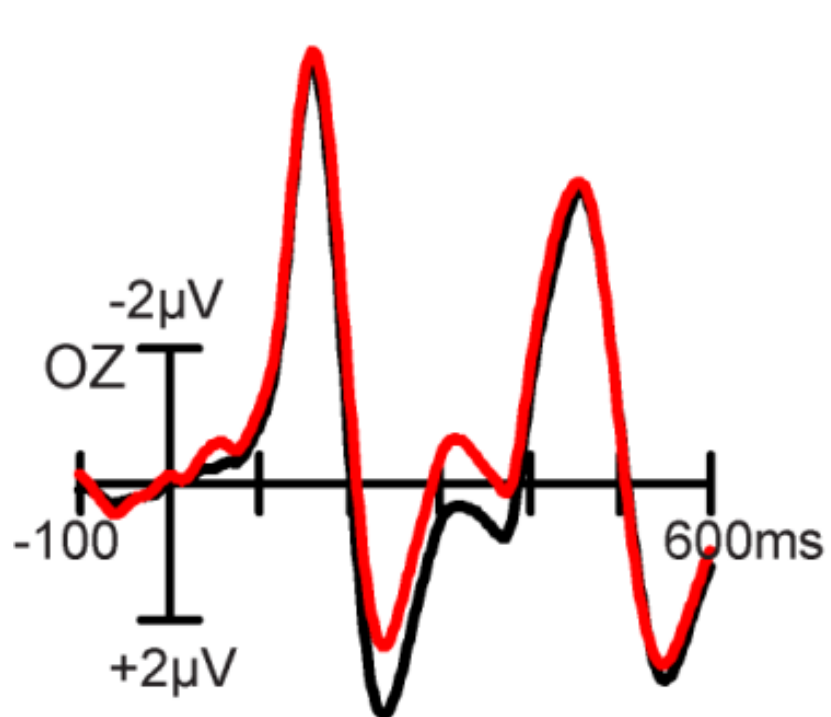3. Attend to line segments, detect diamond targets

*half of subjects inattentionally blind in condition 1 (data not shown for other half of subjects)
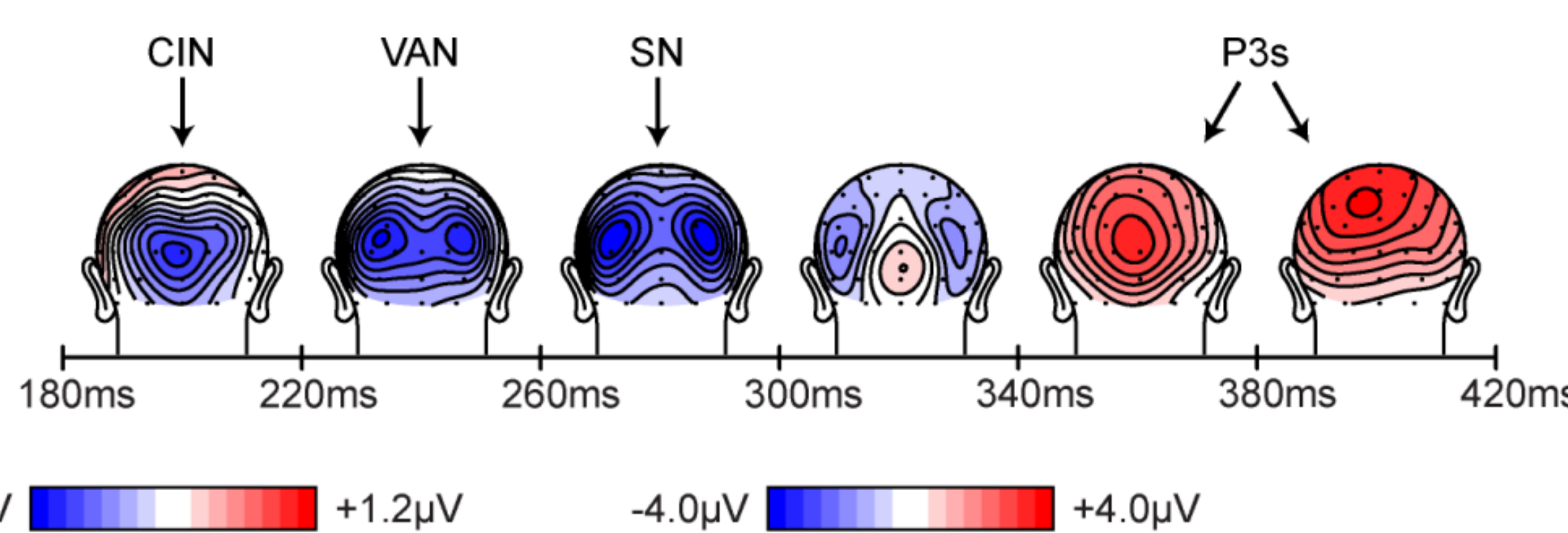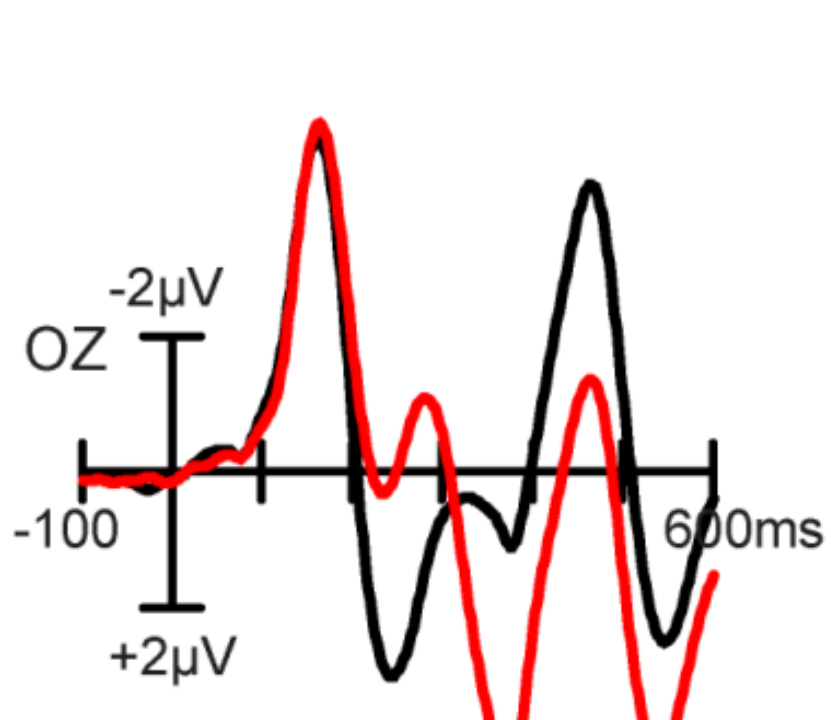
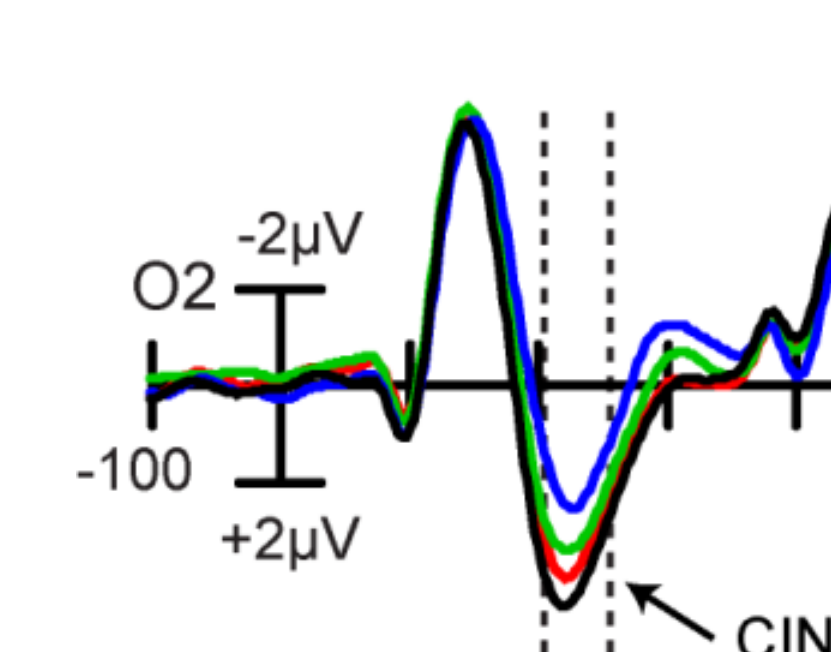- Square Pattern
- Random Array

Experiment 5

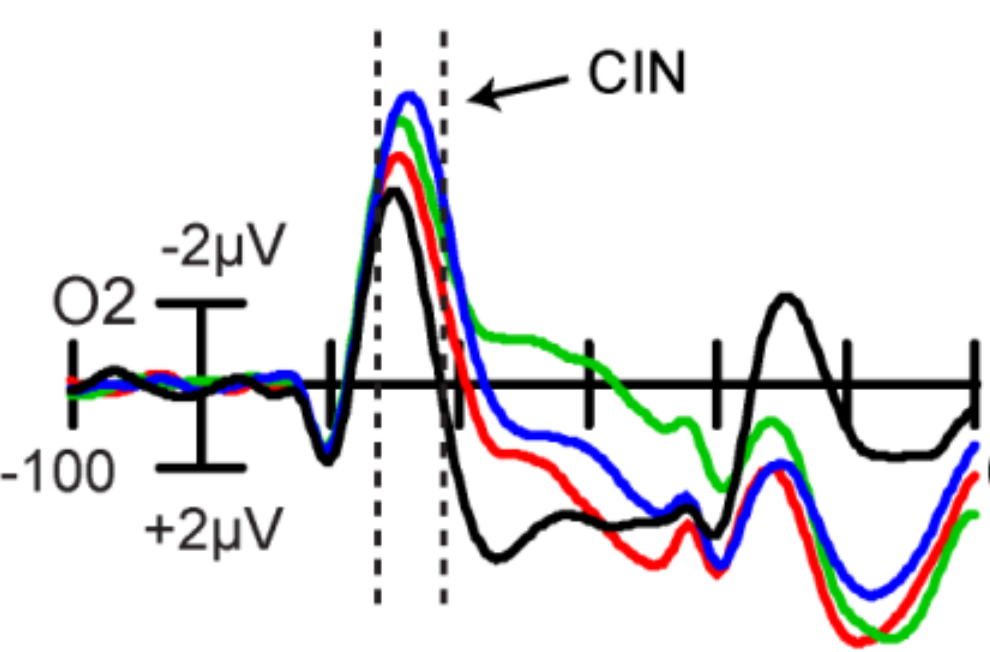**Stimuli:** Combination of those used in Exp 2 and Exp 4

Tasks: On separate blocks:
- attend to red ring of discs and detect dim targets
- attend to line segments and detect 2-contour targets

Contours Task-Irrelevant   Contours Task-Relevant

- 5 contours
- 3 contours
- 1 contour
- Random

Conclusions

- The "contour integration negativity" (CIN) was isolated from overlapping ERP components via manipulations of stimuli, attention, awareness, and task-relevance (Exps 2 & 4).

- Contour integration (indexed by the CIN) appears to require spatial attention (Exp 3) but is carried-out regardless of task-relevance (Exps 3, 4, 5) and occurs even in the absence of perceptual awareness (Exp 4).

- CIN latency is strongly modulated by the task, occurring ~40-60ms earlier when contours are task-relevant vs. irrelevant (Exps 4 & 5), while CIN amplitude varies according to physical characteristics of the stimuli, showing increased amplitudes for increased number of contours (Exps 2 & 5).