Difficulty of discrimination modulates attentional capture by regulating attentional focus

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Introduction

P3a reflects the neural response regarding attentional capture for deviant events.

Attentional capture for distractor is enhanced by difficulty of discrimination between standard and target in the three-stimulus oddball paradigm.


Purpose: to elucidate the cognitive mechanism of attentional capture modulation.

Hypothesis: attentional capture is modulated by top-down controlled attentional focus.

Attentional focus and cost-benefit:
Spatial attention is tightly focused on a selective location to improve stimulus processing.

BENEFIT: processing facilitation inside attentional focus
COST: processing impairment outside attentional focus

In the difficult task, attention is sharply focused on the central location, and the distractor falls inside this attentional focus (A).

>>> Attentional capture enhancement

If so, when distractors are presented in the surrounding location, distractors would fall outside the attentional focus in the difficult task (B).

>>> Attentional capture attenuation

Methods

Participants: 12 students (7m, 5f; 21-26 (M = 23, SD = 1.9) yrs.)

Task: Visual three-stimulus oddball task To make a quick button press by the right thumb to the target stimuli

Stimuli:

<table>
<thead>
<tr>
<th></th>
<th>Central</th>
<th>Surrounding</th>
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<tbody>
<tr>
<td>Standard</td>
<td>Easy</td>
<td>Difficult</td>
</tr>
<tr>
<td>Target</td>
<td>Easy</td>
<td>Difficult</td>
</tr>
<tr>
<td>Distractor</td>
<td>Easy</td>
<td>Difficult</td>
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</tbody>
</table>

SDA: 1.2 x 1.2
Duration: 120 ms
Viewing distance: 1 m
Visual angle: Frequent circle 12° x 12°; frequent triangle 13° x 13°; large rare circle 11° x 11°; small rare circle 6° x 6°; control rare square 17° x 17°; surrounding rare square 14° x 14°.

Surrounding stimuli (triangle & square) were placed with their center 2.1° to the left and right of the vertical meridian, and 2.1° above and below the horizontal meridian.

ERP recording:
EEG: 30 electrode sites, referred to the nose tip
Bandpass: 0.05 - 100 Hz; A/D: 500 Hz (50 Hz offline low-pass filter)
P300 peak: max. pos. pts. 300 - 700 ms at Pz (target), Cz (distractor)

Results & Discussion

Behavior

Figure 1. Reaction time.

Figure 2. Hit rate.

Figure 3. False positive rate.

Event-related potentials (ERPs)

Figure 4. Grand averaged ERPs (N = 12).

Figure 5. Topographic maps for P3a and P3b.

Figure 6. Mean P3 peak amplitude.

Target P3b Amplitude & Latency:
Amplitude: Easy > Difficult (both conditions)
Latency: Easy < Difficult (both conditions)

>>> Task difficulty was successfully manipulated.

Distractor P3a Amplitude:
Central condition: Easy < Difficult
Surrounding condition: Easy > Difficult

>>> Task difficulty had a contrasting effect on the P3a amplitude between central and surrounding conditions.

Conclusion

Attentional capture for distractor is modulated by top-down controlled attentional focus.

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