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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.

Katayama & Polich (1998); Sawaki & Katayama (2006, 2007)

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 in 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:

	Central		Surrounding	
	Easy	Difficult	Easy	Difficult
Standard ($p = .70$)				
Target ($p = .15$)				
Distractor ($p = .15$)				

SOA: 1.2 s
Duration: 120 ms
Viewing distance: 1 m
Visual angle:
frequent circle $1.32^\circ \times 1.32^\circ$
frequent triangle $1.32^\circ \times 1.15^\circ$
large rare circle $1.12^\circ \times 1.12^\circ$
small rare circle $0.57^\circ \times 0.57^\circ$
central rare square $1.72^\circ \times 1.72^\circ$
surrounding rare square $1.42^\circ \times 1.42^\circ$

Surrounding stimuli (triangle & square) were placed with their center 2.12° to the left and right of the vertical meridian, and 2.12° 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 (30 Hz off-line low-pass filter)
P300 peak: max. pos. pts. 300 - 700 ms at Pz (target), Cz (distractor)

Results & Discussion

Behavior

Figure 1. Reaction time.
Easy < Difficult (both conditions)

Figure 2. Hit rate.
Easy > Difficult (both conditions)

Figure 3. False positive rate.
N.S.

>>> Task difficulty was successfully manipulated.

ERP

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.

Top-down attentional control regulates the focus of spatial attention to detect difficult targets.

>>> Focused spatial attention facilitates deviant processing **inside** its small focus and attenuates **outside** the focus.

>>> Attentional capture is enhanced **inside** the focus whereas attentional capture is attenuated **outside** the focus.

Conclusion

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

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