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Difficulty of discrimination modulates attentional capture by regulating attentional focus

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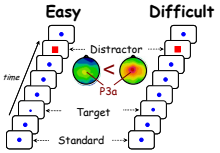
Introduction

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.

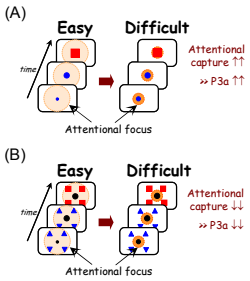
BENEFIT: processing facilitation inside attentional focus
COST: processing impairment outside attentional focus

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)	▲ ■	▲ ■	■ ■	■ ■

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.

SOA: 1.2 *s*
Duration: 120 ms
Viewing distance: 1 m
Visual angle:
frequent circle 1.32° x 1.32°
frequent triangle 1.32° x 1.15°
large rare circle 1.12° x 1.12°
small rare circle 0.57° x 0.57°
central rare square 1.72° x 1.72°
surrounding rare square 1.42 ° x 1.42°

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

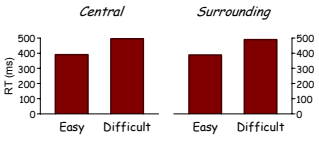


Figure 1. Reaction time.

Easy < Difficult (both conditions)

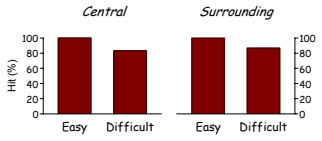


Figure 2. Hit rate.

Easy > Difficult (both conditions)

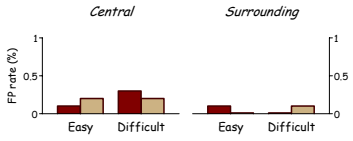


Figure 3. False positive rate.

N.S.

>>> Task difficulty was successfully manipulated.

ERP

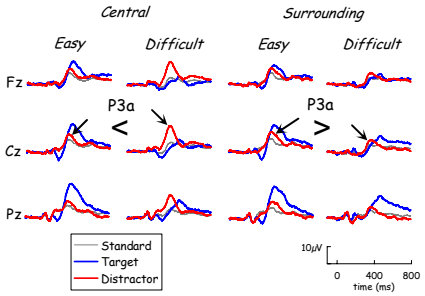


Figure 4. Grand averaged ERPs (*N* = 12).

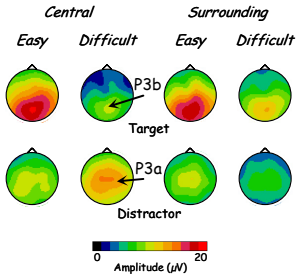


Figure 5. Topographic maps for P3a and P3b.

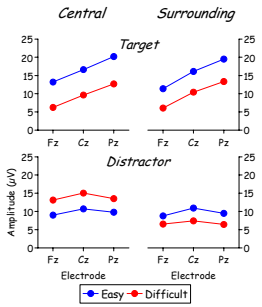


Figure 6. Mean P3 peak amplitude.

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

>>> Task difficulty was successfully manipulated.

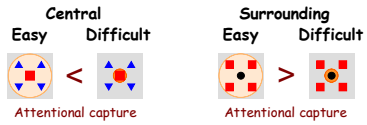
Distractor P3a Amplitude:
Central condition: Easy < Difficult
Surrounding condition: Easy > Difficult

>>> 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.

Acknowledgments: Risa Sawaki is now at the Center for Mind and Brain, UC Davis, 267 Cousteau Place, Davis, CA, 95618.