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Attentional shift within an object and between objects in 3D space

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Introduction

Object-based attention can be indexed by an advantage of attentional shift along the same object relative to that across different objects in the pre-cuing paradigm (Egly, Rafal, & Driver, 1994). There are two accounts of the effect: within-object benefit (WOB) and between-object cost (BOC). The former is explained by prior covert scanning of a cued object (Shomstein & Yantis, 2002); the latter is by a switching cost from the cued object to the other (Lamy & Egeth, 2002). So far, these accounts are indistinguishable because the object-based attention effect is defined by relative difference in RTs between the within-object and between-object conditions. This study examined the WOB and BOC separately presenting stimuli in 3D space and showed that these can operate in different space/object coordinates respectively.

Methods

Subjects: Twelve healthy volunteers participated in Exp.1 (6 females, 19-25 years) and Exp.2 (5 females, 19-28 years). **Stimuli:** Fig.1 shows stimuli presented stereoscopically, using shutter goggles (frame rate: 60 Hz per eye) with a viewing distance of 57 cm. A square (16°×16°) was overridden by a bar (17.4°×3.6°) with horizontal or vertical orientation located in back of (segmented condition), the same as (flat condition), or front of (completed condition) the square. All stimuli had crossed binocular disparity, 27.4', 13.7', 41.0', and 45.6' (Exp.1, near space) or uncrossed disparity, -27.4', - 41.0', -13.7', and -9.1' (Exp.2, far space) relative to the CRT display for the square, bar in back, bar in front, and fixation, respectively. **Procedure:** An experimental block of each condition consisted of 640 target-present trials and 128 catch trials. After presentation of the bar and square for 1,000 ms, the cue (flashed at one corner of the square) was superimposed for 100 ms. After another 200 ms, a target (dot diminishment) was superimposed at one of the corners until the subject responded. The intertrial interval was 1000 ms with blank screen. The task was to detect a target as rapidly and accurately as possible by pressing a key. On target-present trials, the target appeared at the cued corner on 75 % (valid cue) and at an uncued corner on 25 % (invalid cue).

Results and Discussion

Mean hit and FA rates were 95.9 % and 5.4 % in Exp.1, and 97.9 % and 3.2 % in Exp.2. Summary of RT results is shown in Table 1. RTs for valid trials were faster than for

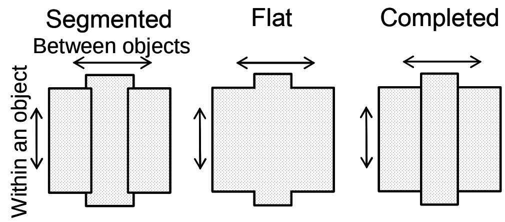

Fig.1 Schematic illustration of stimuli.

Table 1: Summary of mean RTs (ms).

	Valid	Invalid-Valid Within	Invalid-Valid Between	Object effect	WOB	BOC
Exp.1						
Segmented	300.8	3.4	12.9	9.5*	---	---
Flat	303.3	16.4	10.1	-6.3	13.0*	2.8
Completed	303.0	7.6	13.7	6.0	4.2	0.8
Exp.2						
Segmented	295.4	16.9	27.6	10.6*	---	---
Flat	293.4	17.5	20.0	2.5	0.6	7.6
Completed	297.6	17.0	19.7	2.7	0.1	7.9*

Note: WOB and BOC are shown for segmented display relative to flat and completed displays; * indicates significant effect ($p < 0.05$).

invalid trials, confirming pre-cueing effects. Attention shift (indexed by (invalid – valid)) were faster for the within-region than between-region conditions in the segmented condition, replicating a typical object-based attention effect. Comparing with the flat and completed conditions, the object-based effect was due to WOB in Exp. 1, but to BOC in Exp. 2.

The present results showed separable mechanisms for WOB and BOC of attention. The benefit and cost may be associated with habits in different space regions (Previc, 1998): analyses of object shapes for action in near space associated with a WOB; search and orienting of objects in far space associated with a BOC. Different mechanisms to scan visual field can be driven according to stimulus context.

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