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Short Report

Upper visual field advantage in localizing a target among distractors

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Abstract. Biases exist in many perceptual and cognitive functions. Since visual attention plays an important role in a wide range of perceptual and cognitive processes, any bias in the spatial distribution of attention is likely to be a significant source of perceptual and cognitive asymmetries. An attentional visual field task (AVF) requiring localization of a target among distractors was used to assess possible asymmetries in attentional processing in the vertical meridian. The results showed a bias favoring the upper visual field, suggesting a potentially important role of attention in perceptual and cognitive asymmetries.

Keywords: spatial attention, distribution of attention, attentional bias, individual difference.

Differences between the upper and lower visual fields in the performance of perceptual and cognitive tasks have been demonstrated in a wide variety of experimental contexts. Compared with the lower visual field, performance in the upper visual field is superior in visual search (Previc, 1990), categorical judgment (Niebauer & Christman, 1998), and word discrimination (Goldstein & Babkoff, 2001). In contrast, the lower visual field is associated with superior visual acuity and contrast sensitivity (Skrandies, 1987), spatial resolution (Rezec & Dohkin, 2004), orientation discrimination (Carrasco, Talgar, & Cameron, 2001), color (Gordon, Shapley, Patel, Pastagia, & Truong, 1997), and motion perception (Levine & McAnany, 2005).

It is possible that spatial attentional biases may cause or contribute to perceptual and cognitive biases; information from different areas of the visual field may be assigned different priorities for processing by attention (Rhodes & Robertson, 2002). One measure of spatial attentional processing is the attentional visual field. The attentional visual field is the area from which information can be extracted at a glance without eye movements (Hassan et al., 2008). Localizing a target among distractors demands attentional processing to discriminate the target from the distractors. It has been shown that the spatial distribution of attention has a significant impact on visual search efficiency (Chan & So, 2007) and is highly correlated with performance on a variety of daily activities such as walking (Broman et al., 2004) and driving (Clay et al., 2005). Understanding attentional bias across the extended visual field is not only of theoretical importance, but it also has great practical value. However, such possible bias has received little attention.

In this study we investigated vertical asymmetries in the ability to localize a target among distractors between the upper and the lower visual fields. An attentional visual field (AVF) task (Figure 1) was used to measure the spatial distribution of attention across an extended visual field within one fixation. In the AVF task, the ability to detect and localize the target among distractors relies on attention to perform the discrimination between the target and distractors. With a stimulus exposure of 80 ms, or shorter (and immediately followed by a mask), participants are neither able to execute an attentional shift (requiring about 120 ms, Johnson & Proctor, 2004) nor an eye movement (requiring about 200 ms, Johnson & Proctor, 2004).

Thirty undergraduates from the University of Toronto (17 men, 13 women, age range 17–26 years) completed 720 trials of the AVF task on a computer with a headrest to fix the viewing distance through-

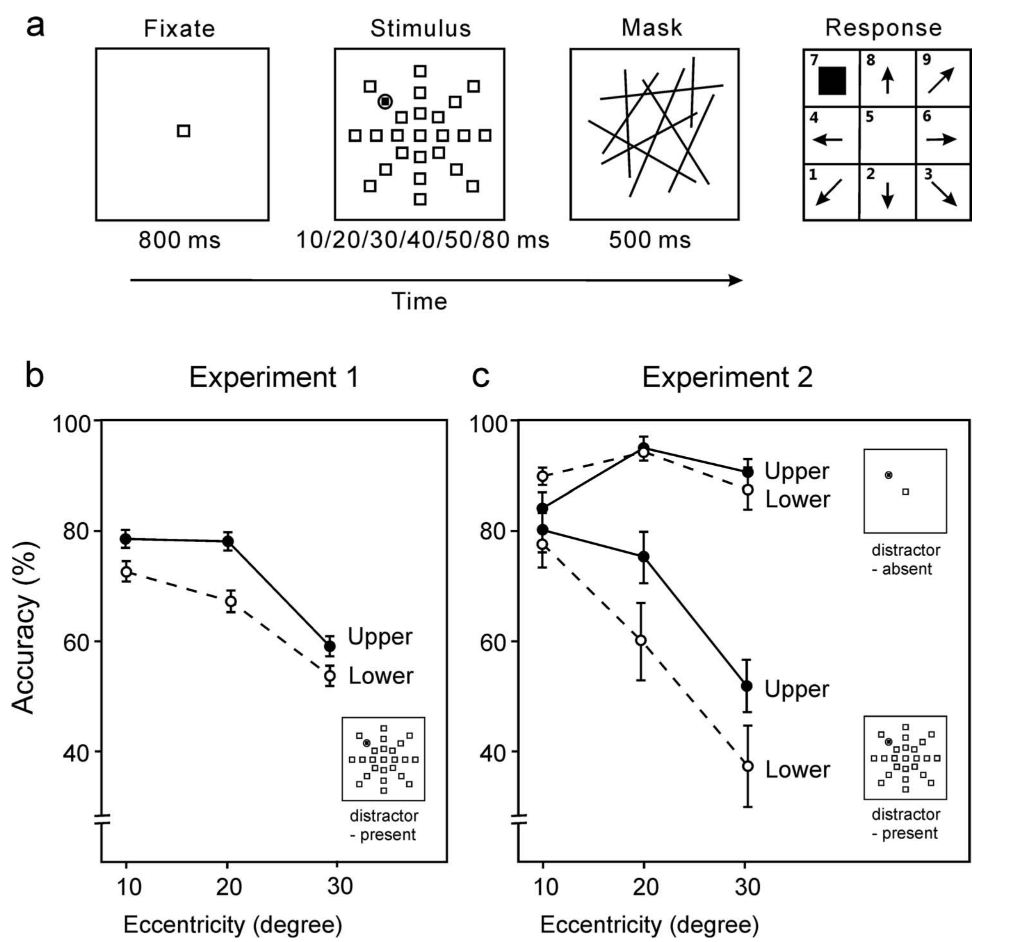

Figure 1. (a) A sample trial of the attentional visual field (AVF) task in the distractor-present condition. (b) Accuracy in Experiment 1 (distractors present). (c) Accuracy in Experiment 2 (distractor-present and distractor-absent trials). The error bars represent ±1 standard error.

out the experiment. Accuracy fell with increasing eccentricity, $F(2, 1044) = 86.71, p < .001, \eta^2 = .17$, and shorter exposures, $F(5, 1044) = 79.48, p < .001, \eta^2 = .38$. Accuracy was higher in the upper half of the visual field (upper: 72%, lower: 65%; Figure 1b), $F(1, 1044) = 33.91, p < .001, \eta^2 = .03$.

To rule out the possibility that the upper visual field advantage in the AVF task was due to perceptual differences, we conducted a second experiment including both a distractor-present condition (the same as in our first experiment) and a distractor-absent (target-only) condition. Ten undergraduates from North Carolina State University (3 men, 7 women, age range 17–24 years) completed 144 distractor-present trials and 144 distractor-absent trials of the AVF task with a stimulus exposure of 30 ms to allow a full range of performance (accuracy) across a variety of conditions. A longer (or shorter) exposure would have resulted in some performances at ceiling (or floor). There was a significant upper field advantage in the distractor-present condition (upper: 70%, lower: 59%; Figure 1c), $F(1, 54) = 4.06, p = .049, \eta^2 = .05$; but no difference between the visual fields in the distractor-absent condition (upper: 91%, lower: 90%; Figure 1c), $F(1, 54) = .13, p = .720, \eta^2 = .002$.

Our results suggest a bias toward the upper visual field in early attentional processing as measured by an AVF task. The upward attentional bias is likely also reflected in the upper field advantage observed in other tasks such as searching for a target among distractors (Previc, 1996). Attention plays a critical role throughout the entire spectrum of information processing that is carried out by the human brain (for a review, see Chun, Golomb, & Turk-Browne, 2011). It modifies fundamental perceptual functions such as contrast sensitivity (Pestilli and Carrasco, 2004) and motion perception (Cavanagh, 1992), and serves as a building block for higher-level functions like working memory (Feng, Pratt, & Spence, 2012), spatial cognition (Feng, Spence, & Pratt, 2007), and language comprehension (Goelman, 1992). Therefore, bias in spatial attentional processing is likely to contribute to bias in the performance of perceptual and cognitive tasks that depend on spatial attentional input.

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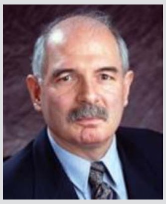

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