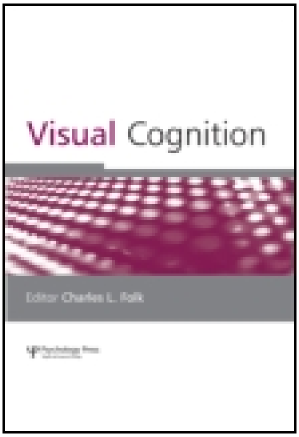

Visual Cognition
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/pvis20

The attentional window configures to object boundaries

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Version of record first published: 08 Nov 2012.

To cite this article: Daniel Vatterott & Shaun Vecera (2012): The attentional window configures to object boundaries, Visual Cognition, 20:9, 1044-1047

To link to this article: http://dx.doi.org/10.1080/13506285.2012.726481

The attentional window configures to object boundaries

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Research on attentional capture has shown the efficiency of task-relevant target selection is often affected by salient task-irrelevant events. The *attentional window hypothesis* (Belopolsky, Zwaan, Theeuwes, & Kramer, 2007) offers one explanation for why targets are, at times, selected efficiently in the face of more salient events. In this hypothesis, observers' attention can be diffuse or focused and only irrelevant events within this window-like space can capture attention. One unanswered question is whether the attentional window can be configured to noncontiguous spatial locations within an object or functions as a zoom-lens, which must maintain a spotlight like distribution (Eriksen & St. James, 1986).

Object-based attention research has shown objects control attentional selection (e.g., Egly, Driver, & Rafal, 1994; Vecera, 1994). In fact, Cosman and Vecera (2012) demonstrated object-based attention modulates the extent of distractor processing. These findings suggest an observer's attentional windows may naturally configure to objects. For example, Figure 1b represents a situation where attention might spread through a cued object. If the attentional window functions like a zoom-lens and is unable to configure to object boundaries, then colour singletons at all the locations will capture attention. On the other hand, if the attentional window accommodates object boundaries, then only colour singletons on the cued object will capture attention. Kerzel, Born, and Schonhammer (in press) recently found observers were able to constrain the attentional window to only an inner or outer ring of items, but observers were not able to constrain capture to a set of items without this spatial separation between the relevant groups. We suggest that observers were not able to constrain capture to the relevant groups because there were not strong enough perceptual grouping cues (e.g., object boundaries).

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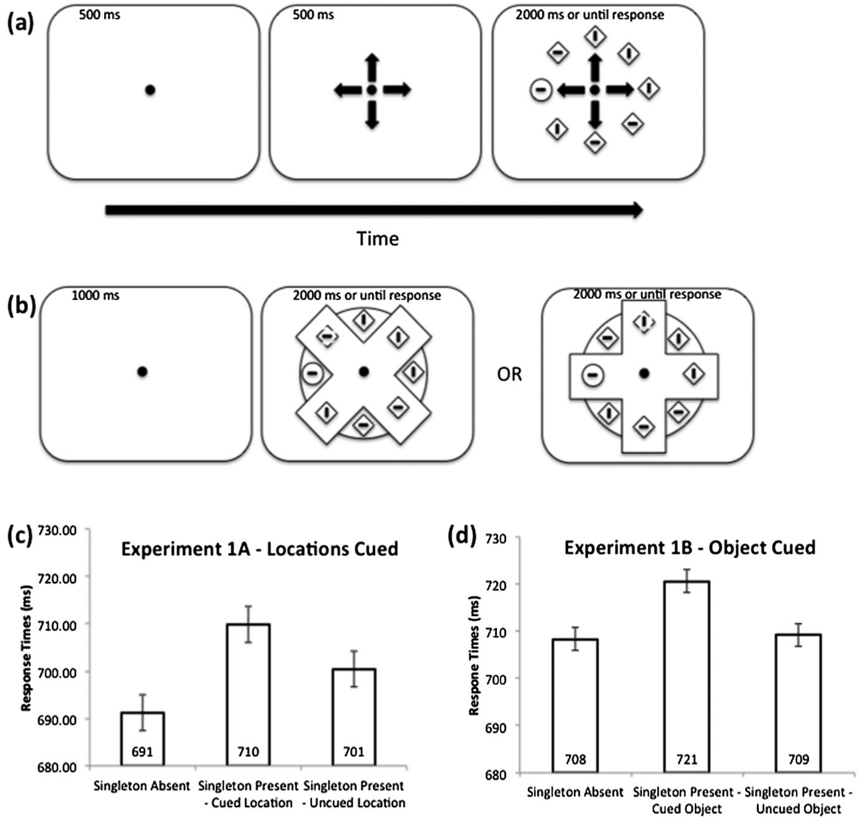

Figure 1. (a) Example trial of experiment 1a. The colour singleton is absent and arrows are cueing the cardinal positions. (b) The event sequence of Experiment 1B. Note that a colour singleton is present in both examples. In one example the colour singleton is on the uncued object. In the second example, the colour singleton is on the cued object. (c) Mean RTs from Experiment 1A from the conditions colour singleton absent, present at cued location, and present at uncued location trials. Error bars represent 95% confidence intervals (Loftus & Masson, 1994). (d) Mean RTs from Experiment 1B from each condition.

In the current experiments, to test whether observers can constrain capture to an object, we used the additional singleton paradigm (Theeuwes, 1992) in which observers search for a shape singleton among homogeneously shaped distractors and respond to the orientation of a line within the target shape. Critically, on half the trials, one of the distractors is a different colour (colour singleton). This additional singleton is irrelevant to the search task since the colour singleton is never the target. Nonetheless, observers' response times (RTs) to the target are slowed by the presence of the colour singleton (attentional capture). Importantly, according to the attentional window hypothesis, if colour singletons only capture attention at cued locations, the window is constrained to these locations. In Experiment 1A, replicating Kerzel et al. (in press), before each trial, observers were cued to which four locations (of eight) were possible target locations (see Figure 1a). Because there are no perceptual grouping cues, we predict that observers will not be able to able to constrain capture to the four cued locations, and colour singletons at both cued and uncued locations will slow RTs to the target. In Experiment 1B, we sought to test if object boundaries constrained the attentional window by informing observers in each block which one of two objects the target would appear upon (see Figure 1b). If the attentional window is able to use object boundaries to constrain capture, then RTs to the target should only be slowed by singleton distractors on the cued object and not singleton distractors on the uncued object.

METHODS

Twelve University of Iowa undergraduates participated in both experiments. All observers completed the additional singleton paradigm with a red target circle among seven red distractor diamonds. On trials with a colour singleton, one distractor was green. Stimuli appeared equally spaced around an imaginary circle with a radius of 8.12°. The items were all roughly 1.4° and the lines within them were .65° × .15°. All items appeared on a grey background for 2000 ms or until response. After completing 64 practice trials, observers completed eight blocks of 112 trials. In Experiment 1A, a fixation dot appeared for 500 ms followed by four arrow cues, which appeared for 500 ms (see Figure 1a). In half the blocks, the arrows pointed at the four cardinal locations; they pointed at the four diagonal locations in the other half. Block order was counterbalanced. In Experiment 1B, the fixation point appeared for 1000 ms followed by the search display superimposed upon a large cross and circle (see Figure 1b). The orientation of the cross ("plus" or "x") and the colour of the two objects changed randomly from trial to trial. The target appeared on the cross in half the blocks and the circle in the other half. Again, block order was counterbalanced.

RESULTS AND DISCUSSION

A one-way repeated measure analysis of variance (ANOVA) with three factors—colour singleton absent, present at a cued location (object in Experiment 1B), and present at an uncued location (object in Experiment 1B)—was performed on correct RTs of less than 2000 ms. In Experiment 1A, the ANOVA found a significant effect, $F(2, 22) = 5.88$, $p < .01$ (see Figure 1c). Indicating that observers' attention was captured by colour singletons at uncued locations, planned comparisons showed search RTs were slower when the singleton was present at an uncued location than when it was absent, $t(11) = 2.07$, $p = .06$. Additionally, search RTs were not statistically different when the colour singleton appeared at cued and uncued locations, $t(11) = 1.52$, $p > .15$. In Experiment 1B, the ANOVA also found a significant effect, $F(2, 22) = 8.02$, $p < .005$ (see Figure 1d). Supporting the hypothesis that objects allow the attentional window to be configured to object boundaries, planned comparisons confirmed search RTs were not significantly slower when the colour singleton appeared on the uncued object than when it was absent, $t(11) < 1$. Also, search RTs to the target were significantly slower when the colour singleton appeared on the cued object than when it appeared on the uncued object, $t(11) = 2.80$, $p < .05$. Interestingly, RTs were generally slower in Experiment 1B, possibly because the objects increased visual clutter. These results are the first to demonstrate that, given sufficient perceptual grouping cues, observers are able to constrain capture to relevant noncontiguous (alternating) locations.

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