Object-based selection is contingent on attentional control settings

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Abstract

The visual system allocates attention in object-based and location-based modes. However, the question of when attention selects objects and when it selects locations remains poorly understood. In this paper, we present variations on two classic paradigms from the object-based attention literature, where object-based effects are observed only when the object feature matches the task goal of the observer. In Experiment 1, covert orienting was influenced by task-irrelevant rectangles, but only when the target colour matched the rectangle colour. In Experiment 2, the region of attentional focus was adjusted to the size of task-irrelevant objects, but only when the target colour matched the object colour. In Experiment 3, we rule out the possibility that contingent object-based selection is caused by colour-based intra-trial priming. These demonstrations of contingent object-based attention suggest that object-based selection is neither mandatory nor default, and that object-based effects are contingent on simple, top-down, attentional control settings.

The visual system deals with the world's impractically large sum of information by deploying selective attention to process the important bits. Generally speaking, attention is allocated by selecting locations like a spotlight (Posner, 1980), as the classic metaphor goes, or by selecting objects (Kanwisher & Driver, 1992). The interaction of these modes has been the subject of longstanding debate (Kahneman & Henik, 1980), and while it is established that both modes of selection guide attention under different circumstances, the principles determining the interplay between location-based and object-based selection remain unclear. In this article, we report three experiments demonstrating that object-based effects (OBEs) are contingent on feature-based attentional control settings. That is, object-based selection depends on objects possessing features that match the observer's top-down attentional set.

Object-based selection is typically demonstrated by showing that attending to part of an object facilitates attending to the whole. Two classic examples of this are that it is easier to process two features of the same object rather than two features of separate, but overlapping objects (Duncan, 1984; Baylis & Driver, 1993), and response selection is harder when the target is perceptually grouped with flanking distractors (Kramer & Jacobson, 1991). Perhaps the most famous demonstration of object-based attention is Egly, Driver, & Rafal's (1994) finding that targets are detected faster if they appear on the same object as a cue, compared to when targets appear on a different object. This is true even when same- and different-object target locations are equidistant from the cue, indicating that attention – summoned to the cued end of the rectangle – spreads preferentially throughout the object.

Because the objects in Egly et al.'s paradigm are task-irrelevant, the spontaneous generation of an OBE implies that the same-object selection occurs automatically (Chen & Cave, 2008; Yeari & Goldsmith, 2010). The basic idea is that objects are parsed pre-attentively; when attention is deployed to a location containing an object, it will spread according to object boundaries (de-Wit, Cole, Kentridge, & Milner, 2011). This automatic, within-object attentional spreading is central to the idea that object-based selection is a default mode. Consistent with this idea, OBEs have been demonstrated under various conditions that are assumed to be automatic (e.g. Kimchi, Yeshurun, & Cohen-Savransky, 2007; Norman, Heywood, & Kentridge, 2013), indicating mandatory object-based selection.

In contrast, others have proposed that the visual system uses object-based selection flexibly, according to the needs of the observer (Shomstein, 2012). A core tenet of this view is that OBEs should emerge when there is considerable uncertainty in the environment, but confirming this prediction has proven contentious. For example, OBEs are not observed when target location is known with certainty (Shomstein & Yantis, 2002; Drummond & Shomstein, 2010), but re-emerge when object distinctions are emphasized (Chen & Cave, 2006), or when perceptual objecthood is accentuated (Richard, Lee, & Vecera, 2008). OBEs are flexibly foregone when cue reliability is high (Shomstein & Yantis, 2004; Yeari & Goldsmith, 2010), or when target location is incentivized with reward (Shomstein, & Jonson, 2013), supporting the idea that observers adapt to location-based selection when there is strong incentive. In this paper, we selectively elicit OBEs under conditions of equal uncertainty, incentive, object structure, and perceptual stimulation. Object-based selection was observed only when objects incidentally matched the top-down filters participants adopted for target processing, demonstrating that object-based selection is contingent on goal-driven attentional control settings (ACS).

The logic of our method is adapted from the contingent attentional capture literature. Early studies on attentional orienting demonstrated that abrupt visual onsets captured attention in a mandatory way (Jonides & Yantis, 1988). To demonstrate that top-down constraints could filter out this ostensibly mandatory capture, Folk and colleagues tested whether onsets would capture attention when the target was not an onset (Folk, Remington, & Johnston, 1992). They found that onsets captured attention when observers were looking for an onset target, but not for a colour-defined target. Likewise, colour cues captured attention for the colour target, but not the onset target; attentional control settings filter irrelevant cues. In this paper, we used ACSs to filter irrelevant objects and demonstrate that OBEs reflect a non-mandatory, non-default mode for attentional selection.

Experiment 1

In our first experiment, we adapted Egly et al.'s (1994) two-rectangle paradigm so that the rectangles were presented in the same or different colour as the target. Participants updated their ACS to the target colour on a trial-by-trial basis. The question was whether the same-object advantage would emerge regardless of the object-target colour relationship.

Method

Participants

Twenty-five students (16 female) participated in exchange for course credit. All students gave informed consent according to the University of Toronto's IRB. Twenty-five participants was deemed an ample sample given the similar or smaller samples used in many replications of this paradigm in the literature. All participants had normal or corrected-to-normal vision. All participants were naïve to the purpose of the study and its hypotheses.

Apparatus & Materials

Stimuli were presented on a Dell computer with a CRT monitor using MATLAB software with Psychtoolbox. Viewing distance was controlled with a chin rest. All stimuli were presented on a dark grey background. Stimuli were a light grey dot subtending 1.0˚, and two parallel rectangles subtending 14.9˚ on the long edge and 5.1˚ on the short edge. These rectangles could be presented horizontally or vertically, but were always parallel. The rectangles were drawn with a composite, two-layer line. Each line was 0.3˚ thick. The outer layer was presented in black. The inner layer was presented in red (RGB: 255, 0, 0) or green (RGB: 0, 176, 80), depending on the trial. The target array consisted of three circles, coloured red or green, each subtending 2.0˚. These circles randomly contained either a 'T' or an 'L', printed in white, in size 36 Arial font.

Procedure

Trials began with the central fixation dot presented in light grey. After 500 ms, the fixation changed colour to red or green for 1000 ms, indicating the target colour at the end of trial and establishing the ACS. The fixation returned to light grey for 500 ms. The rectangles were presented for 500 ms, and were displayed horizontally or vertically, depending on the trial. The inner layer of both rectangles could be red or green. The cue was a transient colour change of one end of the outer, black layer of one of the rectangles, lasting 100 ms. The colour changed from black to red or green. The cued end of the rectangle then returned to black for 100 ms before target onset. The three circles of the target array appeared at the cued location and the two adjacent locations (the invalid-within and invalid-between locations). One of the circles was presented in the target colour (the same colour as the fixation at the beginning of the trial), and the other circles were presented in the distractor colour. Participants responded by pressing the 'T' or 'L' buttons on a computer keyboard, indicating the target identity. Stimuli remained onscreen until response. See Figure 1 for an illustration of the trial sequence.

The experiment was a 3 (Cue Validity: Valid, Invalid-Within, or Invalid-Between) X 2 (ACS: Object-Target Match or Object-Target Mismatch) repeated-measures design. The cue was informative: There was a 75% chance that the target would appear at the cued location, and a 12.5% change that it would appear at either of the other possible locations. The fixation colour always matched the target colour to indicate the appropriate ACS for the subject. Importantly, the cue also always matched the target colour, so that it would capture attention (Folk et al., 1992). The object-target ACS match was balanced across levels of cue validity, such that the object matched or mismatched the target colour on an equal numbers of trials. The object orientation (vertical or horizontal) was balanced across trials, as was the target and object colours (red or green). Participants completed 12 practice trials and 480 experimental trials.

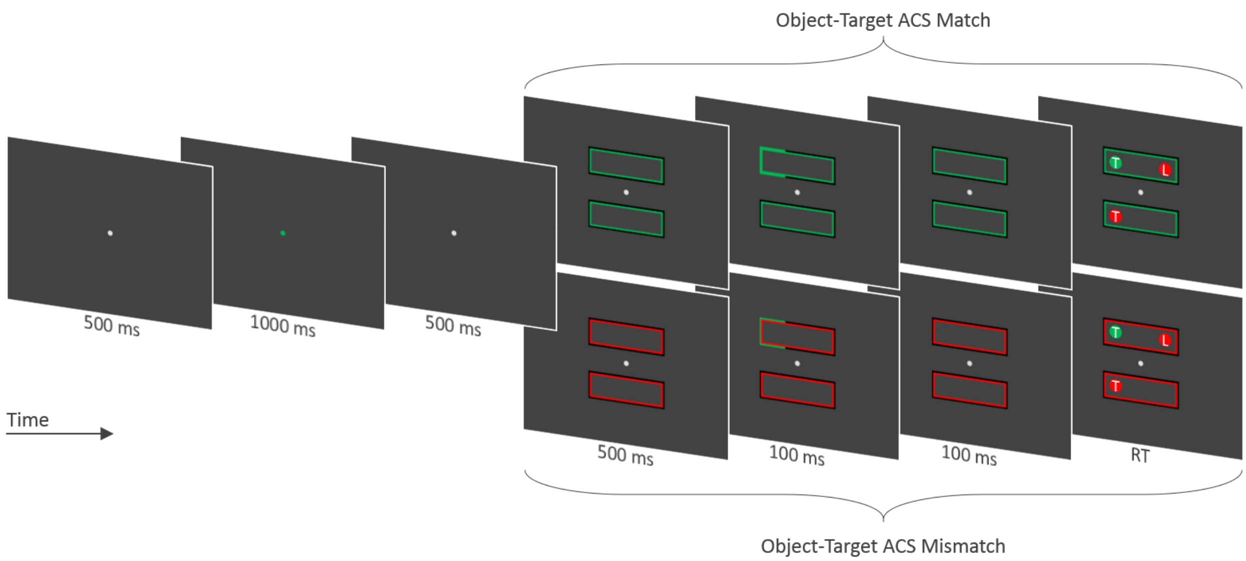

Figure 1. Time course of a trial in Experiment 1. At the beginning of the trial, the fixation indicates the colour of the target, establishing the colour-based ACS. The objects can be presented in the same (match) or different (mismatch) colour as the target. The task is to identify the target letter in the same colour as the fixation. The target was always presented with two non-target-colour distractors. The top row shows a trial with a valid cue and rectangles that match the target ACS. The bottom row shows a trial with a valid cue and rectangles that mismatch the target ACS.

Results

Trials faster than 150 ms were discarded as anticipations, and trials slower than 3 *SD*s from the participant mean for every condition were discarded as outliers (2.2%). Incorrect responses were also discarded (6.4%) for RT analyses. Mean RTs were submitted to a 3 (Cue Validity: Valid, Invalid-Within, or Invalid-Between) X 2 (ACS: Object-Target Match or Object-Target Mismatch) repeated-measures ANOVA. There was a significant main effect of cue validity, replicating the conventional effect of peripheral cues: $F(2,48) = 111.37$, $p < .001$, $\eta_p^2 = .82$. There was also a main effect of ACS, $F(1,24) = 6.18$, $p = .020$, $\eta_p^2 = .20$, as participants were slower to respond in the match condition. The main effect of ACS match is likely due to more information being processed (i.e., the task-irrelevant objects) when the objects match the ACS. The interaction between ACS and cue validity did not reach significance: $F(2,48) = 0.62$, $p = .540$.

The critical test of the OBE is whether the cost to orienting to an invalidly cued location is greater in the different-object versus same-object conditions. To test this, we calculated RT costs by subtracting the valid RT from the invalid-same object and invalid-different object conditions for each participant, and submitted these means to a 2 (Cue Validity: Invalid-Same Object, or Invalid-Different Object) X 2 (ACS: Object-Target Match or Object-Target Mismatch) repeated-measures ANOVA. We also planned separate comparisons of the same-different object cost in the match and mismatch conditions with paired-samples *t*-tests. The ANOVA revealed no significant effects: Fs < 2.59, ps > .121. Consistent with our predictions, there was a significantly greater cost to orienting between objects versus within objects when the object feature matched the target ACS: $t(24) = 2.43$, $p = .023$, $d = .64$ (see Figure 2). There was no difference when the object and target ACS did not match, $t(24) = .35$, $p = .732$.

Discussion

Classic OBEs were observed only when participants adopted an ACS that was congruent with the task-irrelevant objects' color. Note that the objects were present and salient in the mismatch condition (in fact, during object preview they were the only stimuli besides the fixation), but they remained unused for attentional selection. Because object segmentation occurs pre-attentively (de-Wit et al., 2011; Qiu, Sugihara, & Von der Heydt, 2007), the objects in the mismatch condition should have been available to guide attention, yet they did not. We conclude that OBEs are not mandatory, and that goals mediate the influence of objects on the distribution of attention. This provides an explanation for why object-based selection in the two-rectangle paradigm is inconsistent across observers (Pilz, Roggeveen, Creighton, Bennett, & Sekuler, 2012); perhaps only some observers demonstrate OBEs because they depend on the subjective adoption of top-down settings.

The results also have implications for the flexibility of top-down ACSs. Specifically, there is some debate regarding whether feature-based ACSs can be established on a trial-by-trial basis (Lien, Ruthruff, & Johnston, 2010; Belopolsky, Schreij, & Theeuwes, 2010). The present results support this idea.

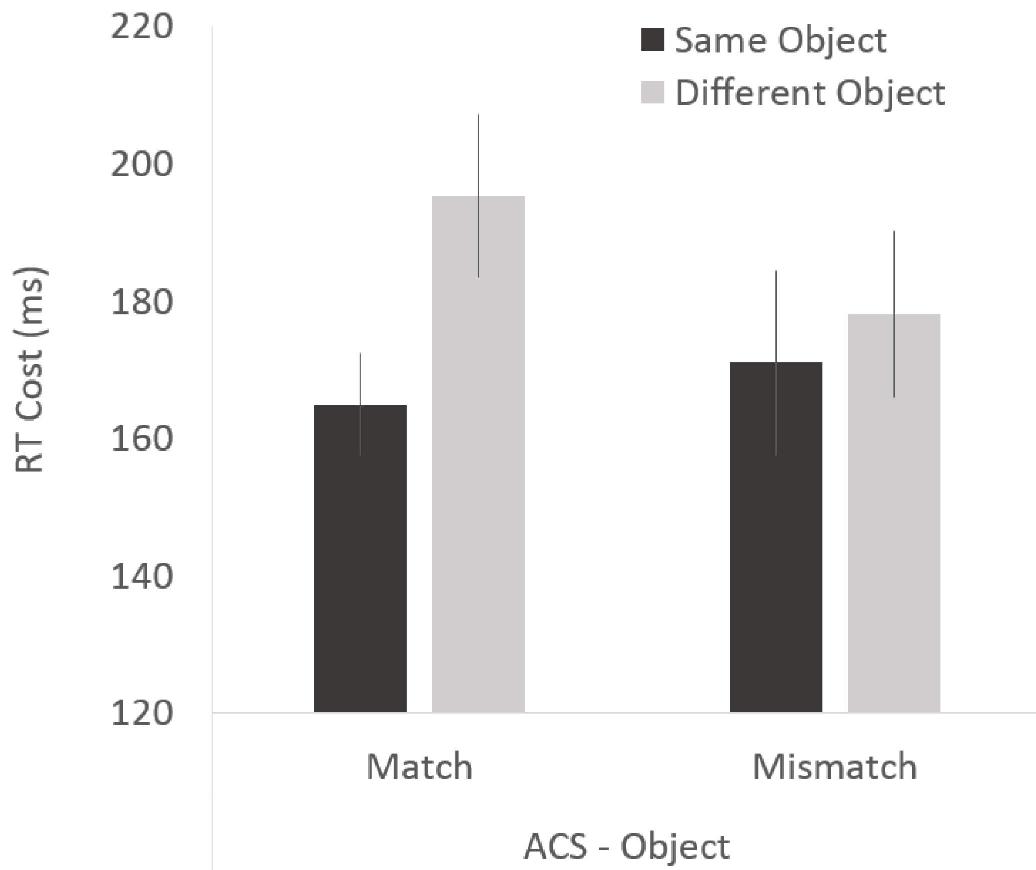

Figure 2. Mean RT cost ($RT_{Invalid}$ - RT_{Valid}) to identify targets presented in the same or different objects as the cue, for match and mismatch conditions. When the objects are presented in a colour matching the target ACS, the conventional same-object advantage is observed. When the objects are presented in the non-matching colour, there is no object-based influence on orienting. Error bars represent 1 SEM, within-subjects.

Experiment 2

For our second demonstration of contingent object-based selection, we wanted a paradigm not involving orienting to peripheral cues. These rapid luminance onsets are visually complicated events that automatically recruit multiple processes (Luck & Thomas, 1999). Moreover, the cues in Experiment 1 are possibly differentially salient in the match and mismatch conditions because they abut onto rectangles of the same or different colour. While this is unlikely to have driven the ACS effect, it would be advantageous to use a paradigm without cues, avoiding their perceptual baggage altogether (West, Pratt, & Peterson, 2013).

Although not typically cited as an exemplar of object-based attention (Kanwisher & Driver, 1992; Scholl, 2001), Castiello and Umiltà's (1990) use of different-sized objects to modify the size of the attentional focus is a clear example of objects modulating the distribution of attention. They presented objects of different sizes with a five-element, radial target array (one central element and four eccentric elements); when the objects were small, the centre element appeared within the object and the eccentric elements appeared outside; when the objects were large, all elements appeared within. The results showed a processing advantage for the central element only when the objects were small, indicating that the size of attentional focus adjusted to match the size of the objects; small objects excluded selection of the stimuli outside the box. Although not couched in the parlance of the literature (perhaps because it was contemporary with and not subsequent to its most influential findings), this result is a clear example of object-based attention.

In our second experiment, we adapted this paradigm within our ACS framework so that the objects could match or mismatch the target colour. The target array was always presented with a target-colour element and a non-target-colour element. Consequently, all trials exhibited equal perceptual structure: two objects (both red or green) and a target array with one red, one green, and three grey elements. The question was whether the within-object advantage for small objects would emerge under conditions where the object colour did not match the target colour.

Method

Participants

A new sample of twenty-five students (17 female) participated in exchange for course credit. All students gave informed consent according to the University of Toronto's IRB. All participants had normal or corrected-to-normal vision. All participants were naïve to the purpose of the study and its hypotheses.

Apparatus & Materials

The setup was the same as Experiment 1. All stimuli were presented on a dark grey background. The stimuli consisted of a small, grey fixation point subtending 1˚, and two peripheral circles, 3.6˚ or 9.6˚ in diameter, centred 6.0˚ to the left and right of fixation. The circles were empty, with a stroke of 0.4˚, and could be coloured red or green. The target array consisted of five letters, which were each randomly designated to be 'H' or 'E'. The target array would appear on the left or right side of fixation. The central letter was 6.0˚ to the left or right of fixation, so that it would appear within the circle on that side. The other letters were displaced 3.0˚ in either direction along the vertical and horizontal axes, such that the eccentric letters would appear outside the small circle, but that all letters would appear inside the large circle. The letters of the target array were printed in size 40 Arial font. On all trials there would be one red letter, one green letter, and three grey letters.

Procedure

Trials began with the central fixation dot presented in light grey. After 500 ms, the fixation changed colour to red or green for 1500 ms, indicating the target colour at the end of trial and establishing the ACS. The fixation returned to light grey for 500 - 1000 ms, whereupon two circles would appear to the left and right of fixation for 500 ms. The target array then appeared until response. Participants were instructed to respond to the identity, ‘H’ or ‘E’, of the letter in the same colour as the fixation at the beginning of the trial. See Figure 3 for an illustration of the trial sequence.

The experiment was a 2 (Object Size: Small or Large) X 2 (Target Location: Central or Eccentric) X 2 (ACS: Object-Target Match or Object-Target Mismatch) repeated-measures design. The fixation colour always matched the target colour to indicate the appropriate ACS. The target array was presented equally often on the left and right sides of the display. The target was presented equally often at all five possible locations of the array. Participants completed 12 practice trials and 320 experimental trials.

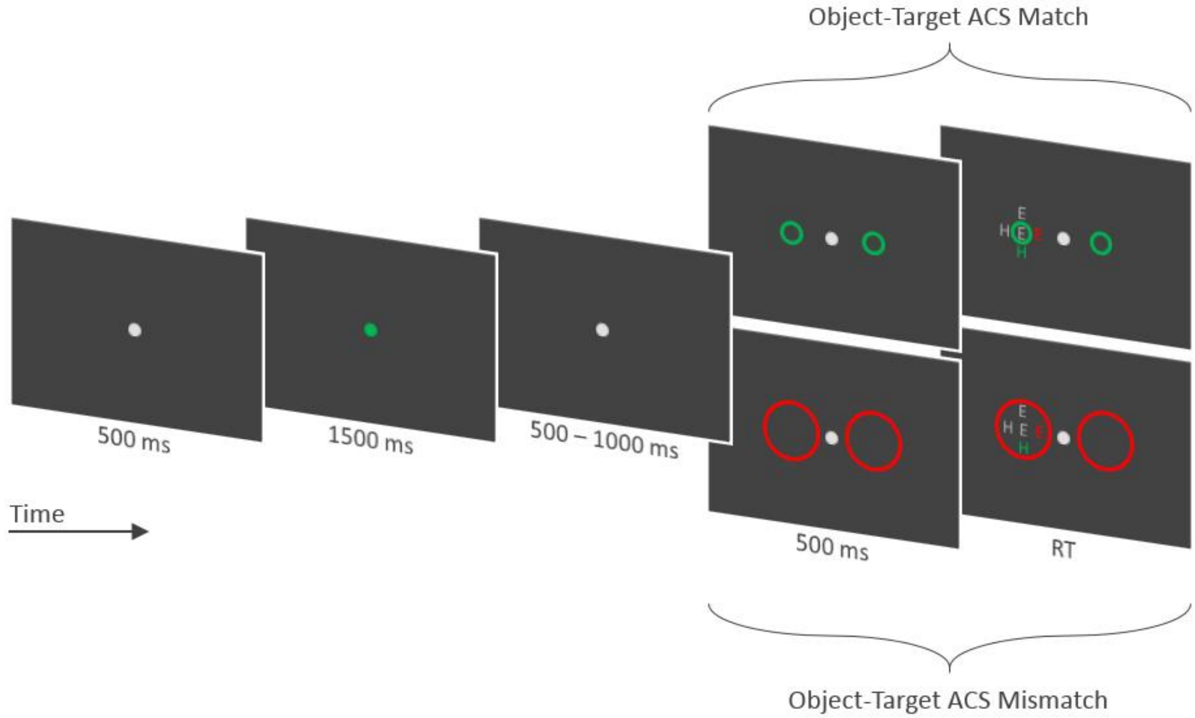

Figure 3. Time course of a trial in Experiment 2. At the beginning of the trial, the fixation indicates the colour of the target, establishing the colour-based ACS. The objects can be presented in the same (match) or different (mismatch) colour as the target. The top row shows a trial with small objects that match the target ACS. In this case, the target is situated outside the circle. The bottom row shows a trial with large objects that mismatch the target ACS. In this case, the target is inside the circle.

Results

Trials faster than 150 ms were discarded as anticipations, and trials slower than 3 *SD*s from the participant mean for every condition were discarded as outliers (2.9%). Incorrect responses were also discarded (9.7%) for RT analyses. Mean RTs were submitted to a 2 (Object Size: Small or Large) X 2 (Target Position: Central or Eccentric) X 2 (ACS: Object-Target Match or Object-Target Mismatch) repeated-measures ANOVA. There was a significant main effect of ACS, as participants were slower to respond when the object colour matched the target ACS: $F(1,24) = 39.82$, $p < .001$, $\eta_p^2 = .62$. Critically, there was a three-way interaction between all factors, as predicted: $F(1,24) = 9.55$, $p = .005$, $\eta_p^2 = .28$. There were no other reliable sources of variance: all *F*s < 3.05, all *p*s > .093.

Castiello and Umiltà's original effect was observed in a two-way interaction between object size and target position. We predicted that we would observe the same effect when the object matched the target ACS, and observe no two-way interaction when the object was presented in the non-matching colour. So to probe the observed three-way interaction further, we conducted separate 2 (Object Size: Small or Large) X 2 (Target Position: Central or Eccentric) repeated-measures ANOVAs on mean RT in the ACS match and mismatch conditions. When the object colour did not match the target ACS, there were no significant sources of variance: all *F*s < 1.33, all *p*s > .260.

When the object colour matched the target ACS, we observed a significant interaction between object size and target position, replicating Castiello and Umiltà's original effect (1990): $F(1,24) = 7.42$, $p = .012$, $\eta_p^2 = .24$ (see Figure 4). Further support for the replication comes from a planned comparison of mean RT for central versus eccentric targets presented with small objects, $t(24) = 2.04$, $p = .026$, one-tailed, $d = .59$, confirming that identification of target letters was slower outside versus inside the small objects. In addition to the significant interaction, there was a marginal effect of object size, $F(1,24) = 3.57$, $p = .071$, $\eta_p^2 = .13$, and no effect of target position, $F(1,24) = 0.54$, $p = .468$.

A further test of the idea that OBEs should emerge only when the object colour matches the ACS is to compare RTs to eccentric targets presented with small objects in the match and mismatch conditions; the objects should restrict the spread of attention within in the match condition, and they should not affect the allocation of attention when they mismatch. Confirming this prediction, RTs were significantly slower to eccentric targets presented with small objects in the match versus mismatch conditions: $t(24) = 7.99$, $p < .001$, $d = 2.26$.

Discussion

OBEs emerged only when participants' ACS compelled them to attend to the objects, confirming the conclusion that object-based selection is contingent on top-down control. In Experiment 1, the cues abutted onto the rectangles, such that the mismatch condition presented a two-colour contrast whereas the match condition did not. While it is unlikely that the contrast caused the effect – because the cue was effective in both ACS conditions as evidenced by the large location-based cueing effect– Experiment 2 did away with this contrast. Consequently, the match and mismatch trials presented equal perceptual stimulation.

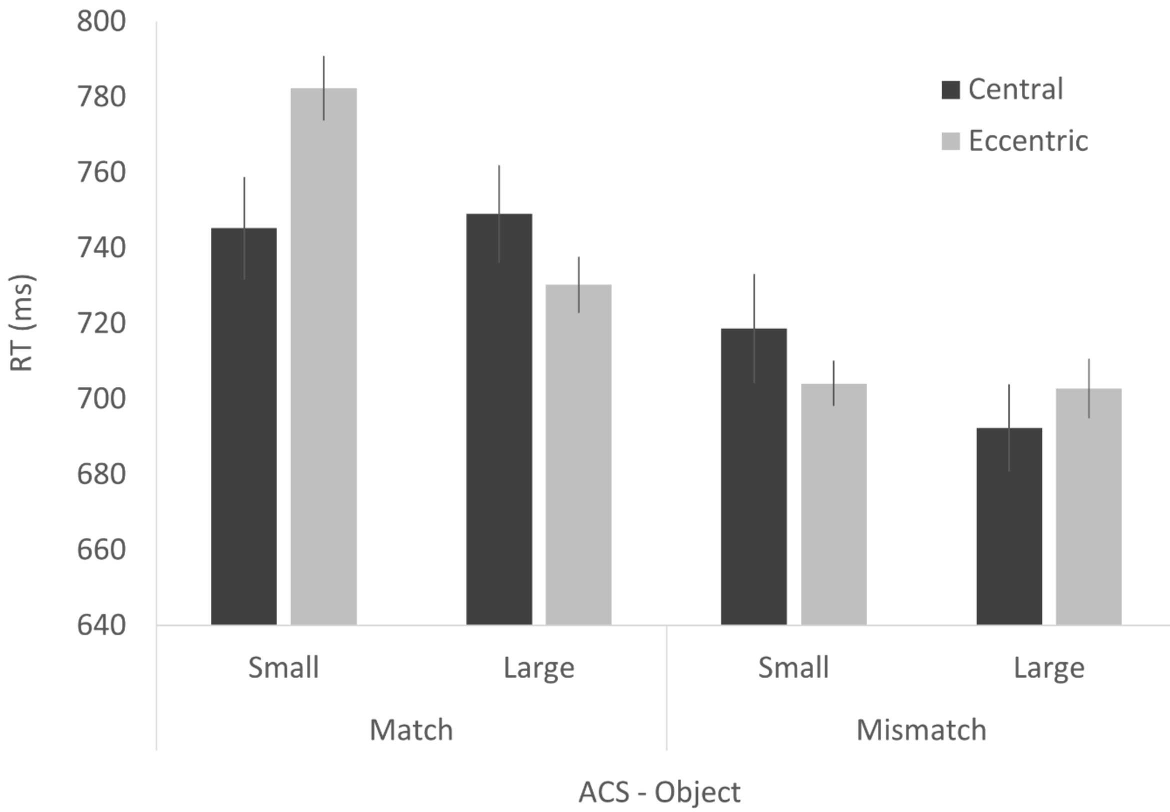

Figure 4. Mean RT to identify targets presented as central or eccentric elements of a search array with small or large objects. The object colour could match or mismatch the target ACS. When the objects are presented in a colour matching the target ACS, there is a within-object processing advantage. When the objects are presented in the non-matching colour, there is no object-based influence on target processing. Error bars represent 1 SEM, within-subjects.

Experiment 3

In Experiments 1 and 2, we established an ACS for the target colour by briefly changing the fixation colour prior to object onset. Consequently, the fixation may have acted as an intra-trial feature prime for objects in the match conditions (Awh, Belopolsky, & Theeuwes, 2012). In other words, seeing a red fixation could facilitate processing of subsequent red objects and produce the observed object-based effects in the match conditions. To test this possibility, we replaced the colour fixation instruction with a word.

Method

Participants

A new sample of twenty-five students (19 female) participated in exchange for course credit. All students gave informed consent according to the University of Toronto's IRB. All participants had normal or corrected-to-normal vision. All participants were naïve to the purpose of the study and its hypotheses.

Procedure

Experiment 3 was identical to Experiment 2 with two exceptions. First, the fixation display formerly used to indicate the target colour (thereby establishing an ACS for red or green) was replaced by a display containing the word "RED" or "GREEN", centered, and printed in grey size 40 Arial lettering; and second, the large object condition was removed. For our purposes, the OBE involved in Castiello & Umiltà's paradigm is ascertained by comparing RTs to targets appearing at central versus eccentric locations in the small object condition. By eliminating the large object condition, we doubled the number of trials in the small object condition, increasing the power of our critical comparison. The total number of trials remained 320.

Results

Trials faster than 150 ms were discarded as anticipations, and trials slower than 3 *SD*s from the participant mean for every condition were discarded as outliers (2.2%). Incorrect responses were also discarded (6.2%) for RT analyses. One subject was removed prior to analysis because their mean RT was greater than 3 *SD*s from the group mean; no other subject was greater than 2 *SD*s from the mean. Mean RTs were submitted to a 2 (Target Position: Central or Eccentric) X 2 (ACS: Object-Target Match or Object-Target Mismatch) repeated-measures ANOVA. There was a significant main effect of ACS, as participants were slower to respond when the object colour matched the target ACS: $F(1,23) = 4.30$, $p = .05$, $\eta_p^2 = .16$. There was no main effect of target location: $F(1,23) = 0.44$, *ns*. Critically, we observed an interaction between ACS and target location: $F(1,24) = 8.19$, $p = .009$, $\eta_p^2 = .26$ (see Figure 5). The critical test of OBEs in this paradigm is whether RTs to detect targets appearing at the centre location were faster than the eccentric locations. Confirming our prediction, a paired-samples *t*-test comparing mean RTs for centrally and eccentrically presented targets in the match condition showed a significant within-object advantage: $t(23) = 2.14$, $p = .044$, $d = 0.67$. Surprisingly, we also observed a reversal of this effect in the mismatch condition: $t(23) = 2.26$, $p = .033$, $d = 0.69$.

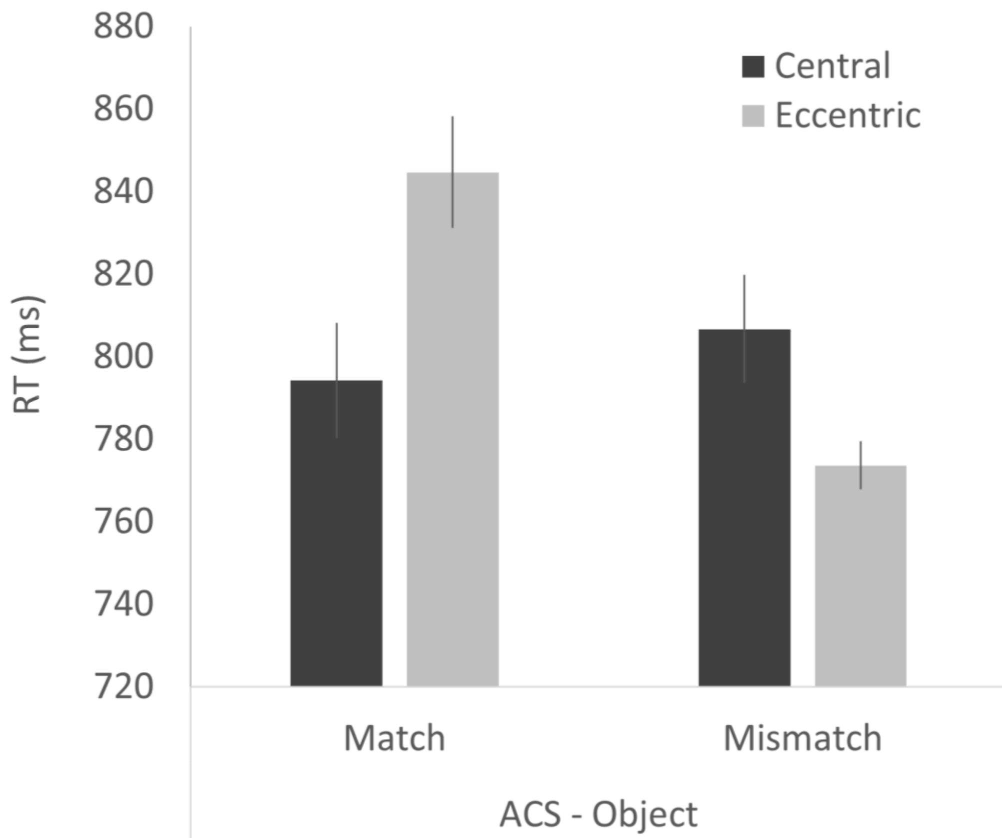

Figure 5. Mean RT to identify targets presented as central or eccentric elements of a search array with small. The object colour could match or mismatch the target ACS. When the objects are presented in a colour matching the target ACS, there is a within-object processing advantage. Error bars represent 1 SEM, within-subjects.

Discussion

Results showed a within-object processing advantage only when the object feature matched the target ACS, replicating Experiments 1 and 2. Because the ACS instruction was presented as a grey word, it could not have primed object processing at a feature level, falsifying an intra-trial feature priming account of Experiments 1 and 2.

General Discussion

In three experiments, we show that object-based selection is contingent on top-down attentional control settings. We modified two classic tasks where objects are known to affect the distribution of attention such that the objects were presented in a colour matching or mismatching the ACS. OBEs emerged only when the object colour matched the ACS, indicating that object-based attention requires selection of the objects in question.

It is important to note that our results do not suggest that an object-target feature match is necessary condition for OBEs to emerge. Indeed, that claim cannot be true given the range of non-matching object and target stimuli used in existing demonstrations of object-based attentional orienting (e.g. de-Wit et al., 2011). However, existing demonstrations with the two-rectangle paradigm have never employed feature-based ACSs with non-matching elements. Without an active feature-based ACS to filter non-matching objects, all objects and targets should be processed and are therefore available for object-based processing. In contrast, the present study used feature-based ACSs to gate object processing. In other words, an object-feature match is not required for OBEs, but rather that OBEs proceed at the behest of the observer's top-down, feature-based control settings.

This conclusion speaks to the contentious dichotomy of flexible versus mandatory object-based selection. In order to demonstrate flexible object-based selection, researchers usually modify the task, the stimuli, or the outcome across conditions to incentivize object-based selection (e.g. Shomstein & Jonson, 2013). Results from such experiments have led to the important notion that object-based selection is flexible, but under engineered circumstances. Predictably, other researchers generate different circumstances under which OBEs return (e.g. Chen & Cave, 2006). In the present experiments, the critical conditions– whether the ACS matched the object feature or not – were presented with equal uncertainty, structure, incentive, and perceptual stimulation. In other words, there was nothing in the physical circumstances to bias location-based selection over object-based selection, or vice versa.

Like object or scene parsing, feature-based modulation of visual processing has been shown to occur at very early, supposedly pre-attentive levels (Saenz, Buracas, & Boynton, 2002; Liu, Larsson, & Carrasco, 2007). It is not surprising, then, that a feature-based ACS should prevent selection and processing of objects and subsequent OBEs, or otherwise modulate the orienting of attention (Folk et al., 1992). It is surprising, though, that a simple, top-down setting could so completely disrupt object-based attention given the frequent demonstration of OBEs under conditions that are assumed or implied to be powerfully automatic (e.g. Kimchi et al., 2007; de-Wit et al., 2011) and even below conscious awareness of the objects in question (Norman et al., 2013).

The present findings argue strongly against the notion that object-based selection is mandatory, otherwise OBEs would have emerged regardless of the colour-based ACS. Attentional capture despite colour-based settings has been demonstrated for other phenomena (Al-Aidroos, Guo, & Pratt, 2010), so it is reasonable to expect that object-based selection could overcome the ACS in mismatch conditions. The present study, however, clearly shows that OBEs are contingent on top-down settings. If object-based selection is a default mode under circumstances of location-based uncertainty (Yeari & Goldsmith, 2010), OBEs should emerge even in the mismatching condition, as there was no incentive to ignore the task-irrelevant objects, and location-based uncertainty was equivalent to the original tasks. If object-based selection is a default mode, as others have suggested, it is default only in a very weak sense of the word. This position raises the question: If object-based selection is not a default mode of selection, why do OBEs emerge under conditions similar to our mismatch condition, as in the original experiments (Egly et al., 1994; Castiello & Umiltà, 1990)? We propose that, without any other instruction or motivation, observers participating in these object-based selection experiments spontaneously adopt top-down settings for the only static visual stimulus provided – the objects – eliciting OBEs in a manner that seems default. The question of default modes is reminiscent of Bacon and Egeth's (1994) investigation into why attentional capture can appear stimulus-driven (Theeuwes, 1992) or goal-driven (Folk et al., 1992) under different circumstances. They proposed a stimulus-general singleton detection mode that caused any perceptual singletons to capture attention. In their words, observers defaulted to a setting that prioritized anything perceptually interesting, "because it was *easier* and because they *could*." (Bacon & Egeth, 1994, pg. 493). We propose that the seemingly-default adoption of object-based selection follows the same principles.

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