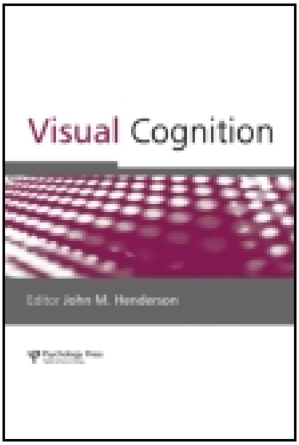

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Prioritizing new objects for eye fixation in real-world scenes: Effects of object-scene consistency

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Prioritizing new objects for eye fixation in real-world scenes: Effects of object–scene consistency

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Recent research suggests that new objects appearing in real-world scenes are prioritized for eye fixations and by inference, for attentional processing. We examined whether semantic consistency modulates the degree to which new objects appearing in a scene are prioritized for viewing. New objects were added to photographs of real-world scenes during a fixation (new object with transient onset) or during a saccade (new object without transient onset). The added object was either consistent or inconsistent with the scene's meaning. Object consistency did not affect the efficacy with which transient onsets captured attention, suggesting that transient motion signals capture attention in a bottom-up manner. Without a transient motion signal, the semantic consistency of the new object affected its prioritization with new inconsistent objects fixated sooner than new consistent objects, suggesting that attention prioritization without capture is a top-down memory-based phenomenon at least partially controlled by object identity and meaning.

Saccades, the eye movements that take the eyes from one locus of fixation to another, are among the most common behaviours humans exhibit, as the eyes are in flight three to four times every second. Foveal vision, corresponding to the centre of gaze, resolves high spatial-frequency and colour components of an image but only covers about two degrees of the visual world. Peripheral vision is tuned to lower spatial frequencies and derives degraded colour information. To view a scene in its entirety, the eyes are directed from place to place, with new information extracted at each fixation. Because it is the regions that are fixated that provide observers with most information about objects in the visual world, an important issue in visual cognition is what factors govern visual selection processes (Henderson, 2003).

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Recently, we have been investigating the mechanisms that underlie the selection of objects for viewing by studying the impact of appearing (and disappearing) objects on gaze control (Brockmole & Henderson, 2005a, 2005b). Although the ability of a new object to attract gaze in relatively simple search displays composed of coloured shapes has been known for some time (Irwin, Colcombe, Kramer, & Hahn, 2000; Theeuwes, Kramer, Hahn, & Irwin, 1998), the extent to which this effect extends to real-world scene viewing had been left unstudied. Scenes possess a degree of visual complexity and semantic coherence far greater than a simple stimulus array (Henderson & Ferreira, 2004), and, unlike the displays that have been used to study attention capture effects, scenes do not contain a single unique item among a set of homogeneous objects. The question remained, therefore, whether a new object in a scene is visually salient enough to drive attention and the eyes to it.

New objects may be visually salient in a real-world scene for a few reasons. One possibility is that attention is driven to low-level scene changes that are associated with the appearance of a new object such as a transient motion signal (Boyce & Pollatsek, 1992). For example, if a previously unseen car suddenly darts out in front of you from a side street, the sudden motion, not the car per se, captures your attention. Another possibility is that the attention system considers the appearance of a new object to be behaviourally relevant independently of the transient or abrupt changes that are introduced into a scene (Yantis & Hillstrom, 1994). That is, a car suddenly pulling out into the street in front of you remains relevant to your survival even if its manoeuvre is occluded by a passing lorry.

In our previous studies, to examine the influence of newly appearing objects on gaze with and without transient motion signals, objects were added to scenes either during a fixation so that the onset retained its transient status, or during a saccade so that the transient signal was suppressed[1] (Brockmole & Henderson, 2005a, 2005b). Attentional prioritization of new objects was measured by the propensity of the eyes to fixate the new object upon its appearance (Theeuwes et al., 1998). New objects that appeared during fixations were first fixated in half the time and subsequently fixated twice as often as those that appeared during saccades. However, new objects that appeared without a transient motion signal were also viewed at rates greater than expected by chance, indicating that, in scenes, this signal is not required for prioritization of a new object to occur (but see Franconeri,

[1] Although the extent to which perception is suppressed during a saccade may be a matter of some debate, we have demonstrated that under some circumstances objects that suddenly appear in (or disappear from) real-world scenes during a saccade are fixated no more often than expected by chance (Brockmole & Henderson, 2005a, 2005b). As such, in this context the transient motion signal was functionally eliminated by saccadic suppression.

Hollingworth, & Simons, 2005). The prioritization elicited by an object that appeared without a transient motion signal was affected by manipulations of memory for the scene. Specifically, reductions in viewing time prior to the appearance of the new object corresponded to reductions in the prioritization effect. We argued that reduced viewing time hinders an observer's ability to build a complete mental representation of a scene that includes identities and details of viewed objects (Castelhano & Henderson, 2005; Henderson & Hollingworth, 2003; Hollingworth & Henderson, 2000, 2002; Hollingworth, Williams, & Henderson, 2001; Tatler, Gilchrist, & Rusted, 2003; Torralba, Oliva, Castelhano, & Henderson, 2006). Because very early in the trial less information about the scene is encoded into memory, prioritization based on memory was stronger and more reliable later in viewing. These data patterns were identical whether or not observers were memorizing the scene without any instruction pertaining to new objects or searching for suddenly appearing objects.

Together these results indicate that visual selection processes in real-world scenes are guided by both exogenous and endogenous factors: New objects accompanied by a transient motion signal capture attention reflexively, whereas without a transient signal, new objects are prioritized across several fixations as memory processes are engaged. The purpose of the research reported here was to further explore factors that influence the prioritization of new objects in real-world scenes. Specifically, we examined whether the semantic consistency of a new object in a scene affects the degree to which it is prioritized for viewing.

An object presented in a plausible scene context is easier to process than that same object in an implausible context. For example, semantically consistent objects enjoy shorter gaze durations (Antes & Penland, 1981; de Graef, Christiaens, & d'Ydewalle, 1990; Friedman, 1979; Henderson, Weeks, & Hollingworth, 1999; Hollingworth et al., 2001; Loftus & Mackworth, 1978) and naming latencies (Boyce & Pollatsek, 1992) after they are selected for viewing. However, the effect of scene–object consistency on the attraction of fixations is more controversial. Some research has suggested that inconsistent objects "pop out" and attract attention and the eyes immediately (Loftus & Mackworth, 1978). Other research has failed to find any initial selection differences between consistent and inconsistent objects, although such effects are observed to appear over time (de Graef et al., 1990; Friedman & Liebelt, 1981; Henderson et al., 1999). Still other research, while not concerned with the attraction of the eyes per se, has provided evidence that extrafoveally presented consistent objects are detected more easily than inconsistent objects in briefly presented scenes, an effect that runs counter to the notion that inconsistent objects "pop out" (Biederman, Mezzanotte, & Ravinowitz, 1982; Boyce, Pollatsek, & Rayner, 1989). Instead, this later effect has been taken to suggest that the perceptibility of objects is facilitated when they appear in a consistent context as that context gives rise to expectations (i.e., activates a scene schema) about the objects and their component features that are likely to appear in the scene (Friedman, 1979). However, there is also evidence that inconsistent objects are more easily detected in very brief displays than consistent objects (Hollingworth & Henderson, 1998, 2000), perhaps because they are more likely to attract attention initially (Gordon, 2004).

In the present study, we examined whether scene–object consistency affects the degree to which new objects appearing in a scene are prioritized for viewing. One possibility is that new objects attract attention without regard to their semantic consistency. We expected this to be true in the case of new objects with transient onsets. Given the argument that it is the transient motion signal accompanying these new objects that captures attention in a bottom-up manner, the identity of the new object should be irrelevant to its ability to capture attention. However, the semantic consistency of a new object might affect its prioritization if it is not accompanied by a transient motion signal. Given the argument that memory guides the prioritization of newly appearing objects without transients (Brockmole & Henderson, 2005a, 2005b), prioritization of these objects should depend on their semantic consistency to the extent that the semantic consistency is related to memory. However, given previous equivocal results regarding the effect of semantic consistency on the selection of objects for fixation, one could predict that new semantically inconsistent objects would elicit greater or lesser degrees of prioritization than newly appearing consistent objects. If inconsistent objects "pop out" of natural scenes, then greater prioritization effects should be observed for new inconsistent objects. On the other hand, if the activation of a scene schema gives rise to expectations about the objects likely to be in a scene, then one might expect consistent objects to have a prioritization advantage over inconsistent objects. Therefore, our interest lies not only in whether consistency matters but also how consistency matters in memory-guided prioritization.

METHOD

Participants were divided into two main conditions. In the new object condition, a single critical object was added to the scene after scene viewing began. In the baseline condition, these same critical objects were present from the start of viewing. The baseline condition was included to assess whether a new object captures attention by enabling a determination of the rate at which the critical objects were viewed when they were not suddenly added to the scene. Within the new object and baseline conditions, participants were split into consistent and inconsistent conditions where the critical object was either consistent or inconsistent with the meaning of the scene in which it was placed. Within the new object condition, these critical objects appeared either during a fixation or during a saccade.

New object conditions

Twenty-four undergraduate students viewed full-colour photographs depicting 30 real-world scenes. During the course of viewing, a single object was added to each scene. For half of the observers, this new object was consistent with the gist of the scene, and for the other half, this object was inconsistent with the gist of the scene. Note that the same 30 critical objects were used in the consistent and inconsistent conditions (i.e., each critical object appeared in a consistent context and an inconsistent context). Three photographs were taken of each scene that (a) contained neither the consistent nor inconsistent critical object, (b) contained the consistent critical object, or (c) contained the inconsistent critical object (see Figure 1). New objects were added to the visual displays by first presenting the photograph that contained neither object and seamlessly replacing it with the photograph containing one of the critical objects. Photographs were digitally edited to remove any subtle changes in light and shadow that may have taken place between each shot as well as any "jitter" that might be perceptible when the photographs were alternated. Photographs were displayed at a resolution of 800 × 600 pixels by

Figure 1. An example scene. Top: The photograph in the left panel does not contain the critical objects. The photograph in the middle panel has the consistent critical object (egg carton) added. The photograph in the right panel has the inconsistent critical object (book) added. Bottom: Scenes in which the egg carton is inconsistent and in which the book is consistent. Photographs were presented in full colour.

24-bit colour and subtended 37 deg horizontally and 27.5 deg vertically at a constrained viewing distance of 57 cm. During viewing, an ISCAN ETL-400 pupil and corneal reflection tracking system sampled eye position at 240 Hz and was accurate to within 0.5 deg of visual angle.

Each participant viewed all 30 scenes in a different random order. On half the trials, objects appeared during a saccade, and on the other half, they appeared during a fixation. For each participant, scenes were randomly assigned to these saccade- and fixation-addition conditions. All participants were given a cover task of memorizing each scene in preparation for a memory test (in actuality this test was never given). Participants were given no instruction related to the appearance of new objects.

The experimental procedure followed that of Brockmole and Henderson (2005a, 2005b). Participants began the experimental session by completing a calibration routine. Calibration was monitored by the experimenter and adjusted when necessary. Participants began each trial by fixating a dot in the centre of the display; when they indicated they were ready to view the stimulus, a randomly selected scene was displayed for 10 s. The initial view of the scene did not contain the critical object. During viewing, this object was added to the scene by changing the displayed photograph to its associated counterpart containing the new object.

An eye-movement contingent display change technique was used to trigger the appearance of the new object. The onset was tied to the first time the eyes exited an invisible bounding region with a diameter of 2 deg of visual angle surrounding the centre fixation point at the start of the trial. When the new object was to appear during a saccade, it appeared as soon as the eyes exited the central bounding region. In this condition, the eyes were still moving when the object appeared. When the object was to appear during a fixation, it was added 100 ms after the eyes exited the central bounding region. In most cases, this 100 ms delay was long enough to allow the critical saccade to terminate, but short enough that a subsequent saccade could not be launched. In this condition, the object was added when the eyes were still. The new object remained in the scene until the conclusion of the trial.

Baseline condition

Sixteen undergraduate students participated in the baseline condition. These participants studied the same scenes in preparation for a future memory test as those in the new object conditions; however, the critical objects were visible from the beginning of the trial and no object additions occurred. All aspects of the experimental apparatus were the same in the new object and baseline conditions. The baseline conditions enabled us to determine the rate at which critical objects were fixated when they did not constitute an abruptly presented new object and to replicate previous research showing that under these conditions inconsistent objects are viewed sooner than consistent objects during the normal course of scene viewing.[2]

RESULTS AND DISCUSSION

For each scene, a region of interest was defined by an imaginary bounding box surrounding the critical object. Because the critical objects used within each scene were matched for size, these bounding boxes were equal in area between the consistent and inconsistent conditions. Fixations were sorted according to whether or not they fell within this region. Analyses considered the effect of object consistency on the speed with which the critical object was fixated. Because attention capture effects should be observed very soon after an object's sudden appearance in a scene, analyses focused on viewing behaviour in the first 2000 ms following the presentation of the critical object. To characterize the deployment of attention to the critical objects over the course of that time window, trials were divided into 500 ms viewing bins, and we calculated the cumulative probability of having fixated the critical objects in each viewing bin by consistency. Fixations were allocated to a particular bin with the start of viewing bin 1 defined as the moment the eyes first exited an imaginary bounding region with a diameter of 2 deg of visual angle surrounding the centre fixation point at the start of the trial (fixations that spanned bins were assigned to the bin in which the fixation began). In the onset conditions, this is the criterion that elicited the appearance of the new object. Retaining this criterion in the baseline conditions generated *baseline rates of viewing* that were anchored to the same point in time as the analyses for the newly appearing objects. Trials in the baseline conditions on which the very first eye movement away from the initial experimenter-determined fixation point landed on the critical object were excluded from determining these baseline viewing rates as such an event was not possible in the new object conditions (where a minimum of two eye movements were necessary to fixate the critical object). This trim excluded 12% of inconsistent trials and 9% of consistent trials, $t(14) = 1.03$, $p = .32$.[3]

[2] We note that in the baseline condition, compared to consistent critical objects, inconsistent critical objects enjoyed reliably longer individual fixation durations (463 ms vs. 326 ms), first pass gaze durations (853 ms vs. 441 ms.), and total fixation time (1862 ms vs. 996 ms), replicating previous research.

[3] In a previous report using the same consistent scenes used here, Brockmole and Henderson (2005a) found that in a condition where no onsets where used, 10% of fixations were directed to the critical objects. It would therefore be expected that the first object selected for fixation by the observer would be the critical object on approximately 10% of the trials, as observed here.

In the scene-consistent conditions, the new object was added, on average, 584 ms into viewing, and in the scene-inconsistent conditions, 475 ms into viewing. Although an effect of consistency was not observed, $t(22) = 1.65$, $p = .11$, on average, observers in the consistent condition viewed the scene for an additional 109 ms prior to the onset of the critical object than those in the inconsistent condition. Note, however, that this situation disadvantages any benefit observed for inconsistent objects, as less time was available to process the semantic information in the scene prior to the appearance of the inconsistent object. The new object was successfully onset during a fixation on 95% of fixation onset trials and during a saccade on 85% of the saccade onset trials (remaining trials were excluded from the reported analyses). On average, the critical object was viewed at least once on 76% of consistent trials and on 83% of inconsistent trials.

Ultimately, separate 2 (trial type) × 2 (consistency) × 4 (viewing bin) mixed model analyses of variance were conducted on the fixation and saccade conditions. Before considering those results, however, we first show that the present study replicated previous demonstrations that new objects are prioritized for viewing regardless of their transient status, but that new objects that appear as transient onsets during fixations draw attention faster and more often than objects that appear during a saccade. These results are illustrated in Figure 2.

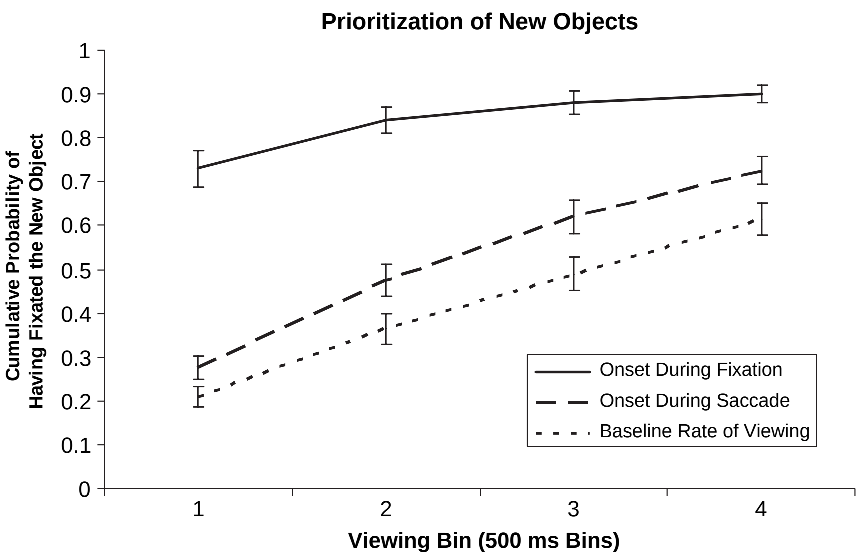

Figure 2. Mean cumulative probability (with standard error) of having fixated the critical object as a function of time and onset type.

Collapsing across the between-subject factor of consistency, a 2 (onset type) × 4 (viewing bin) repeated measures ANOVA revealed a main effect of viewing bin, $F(3, 117) = 225.5$, $p < .001$, as the cumulative probability of having fixating the added object increased over bins. Importantly, a main effect of onset type, $F(1, 39) = 39.2$, $p < .001$, was observed: The probability of first fixating the critical objects in the first 2000 ms of viewing was greater in the fixation condition than the saccade condition. In addition, a reliable interaction was observed, $F(3, 117) = 23.4$, $p < .001$, as the slope of the cumulative probability function was steeper in the saccade condition as the effect of the new object on gaze was extended in time relative to the effect of the added object in the fixation condition. In fact, the cumulative probability of fixating the critical object across all four viewing bins (2000 ms of postonset viewing) in the saccade condition was equal to that observed in the first viewing bin (up to 500 ms of postonset viewing) in the fixation condition. As we will demonstrate below, new objects were fixated at rates greater than expected by chance at all viewing bins in both the saccade and fixation conditions. Having conceptually replicated the findings reported by Brockmole and Henderson (2005a, 2005b), we now turn to the effect of object consistency on prioritization.

Semantic consistency and attention capture

A 2 (trial type) × 2 (consistency) × 4 (viewing bin) mixed model ANOVA was conducted on the fixation-onset condition to address the effect of semantic consistency on attention capture. Results are illustrated in the top panel of Figure 3. A main effect of trial type was observed, $F(1, 36) = 119$, $p < .001$. The probability of initially fixating the critical objects in the first 2000 ms of viewing was greater in the abrupt onset condition compared to the baseline condition. Planned comparisons demonstrated that this difference was observed from the very first viewing bin where, on average, 73% of critical objects were fixated if they were added, compared to 20% if they had been present from the beginning of the trial. The magnitude of this difference varied across viewing bins, however, as shown by a reliable interaction between trial type and viewing bin, $F(3, 108) = 20.3$, $p < .001$. The slope of the cumulative probability function was steeper in the baseline condition than in the onset condition. These results support the conclusion that new objects appearing with onset transients draw attention, as the probability of fixating the critical object was dramatically higher in the very first viewing bin than expected based on the baseline rate of viewing.

A main effect of consistency was also observed, $F(1, 36) = 7.71$, $p < .01$. The probability of first fixating the critical objects in the first 2000 ms of viewing was greater if the critical objects were inconsistent as compared to

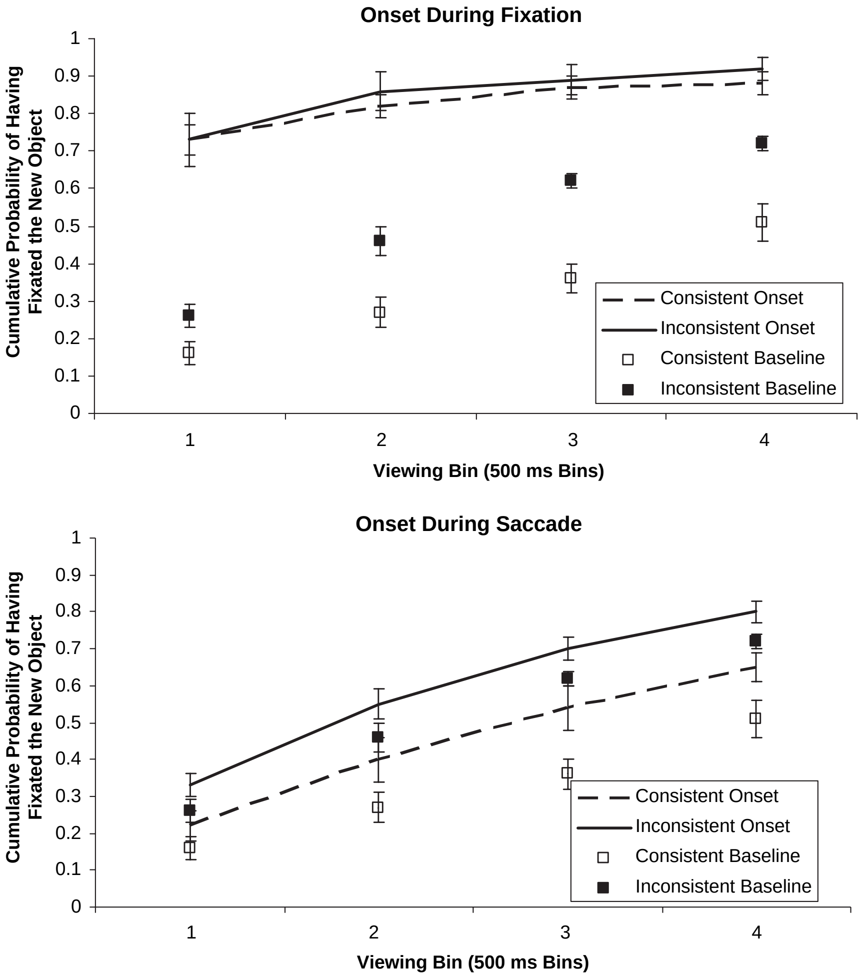

Figure 3. Mean cumulative probability (with standard error) of having fixated the critical object as a function of time, semantic consistency, and onset type. Top panel shows probability functions for new objects that appeared during a fixation, and bottom panel shows the functions for new objects that occurred during a saccade.

when they were consistent. Consistency also interacted with viewing bin, $F(3, 108) = 3.01$, $p < .05$, as the slope of the cumulative probability function was steeper in the inconsistent condition than in the consistent condition.

The preceding analyses indicate that, overall, abrupt-onset objects added during fixations capture attention and that inconsistent objects are viewed sooner than consistent objects. A reliable interaction between trial type and consistency indicated that the effect of consistency was not constant across situations where the inconsistent object was always present and when it abruptly appeared, $F(1, 36) = 4.63$, $p < .05$. The difference between the consistent and inconsistent conditions was larger in the baseline condition than in the onset condition. The three-way interaction including viewing bin was not reliable, $F(3, 108) = 1.70$, $p = .17$, indicating that this difference was constant across viewing bins. Thus, to characterize the interaction between trial type and consistency, we performed a simple means comparison between consistent and inconsistent objects within the baseline and new object conditions, collapsing across viewing bin. Two-group *t*-tests demonstrated that in the baseline condition, the probability of initially fixating the critical objects in the first 2000 ms of viewing was greater for inconsistent objects, $t(14) = 4.48$, $p < .001$. However, in the new object condition, no differences were observed in the probabilities of fixating consistent and inconsistent objects, $t(14) < 1$.

Although inconsistent critical objects were fixated faster in the baseline condition, the consistency of those same objects when they were abruptly appearing new objects had no bearing on their ability to capture attention. That is, both consistent and inconsistent objects captured attention with equal efficacy when the critical object suddenly onset during a fixation.[4]

Semantic consistency and memory-based prioritization

A 2 (trial type) × 2 (consistency) × 4 (viewing bin) mixed model ANOVA was conducted on the saccade condition to address the effect of semantic consistency on memory-guided prioritization. Results are illustrated in the bottom panel of Figure 3. A main effect of trial type was observed, $F(1, 36) = 7.59$, $p < .01$. The probability of initially fixating the critical objects in the first 2000 ms of viewing was greater in the new object compared to the baseline condition. This difference did not vary across bins, $F(3, 108) = 1.68$, $p = .18$. These results support the conclusion that the new object attracted attention, as the probability of fixating the critical object was higher than expected based on the baseline rate of viewing. The advantage of the new object was observed in the first viewing bin, suggesting that it is prioritized quickly after its appearance.

[4] By dividing trials into 500 ms viewing bins, our ability to detect an effect of semantic consistency in the new object condition on the order of hundreds of milliseconds may have been limited. To investigate this possibility, we calculated the elapsed time from the appearance of the new object to the start of the first fixation on that object when those first fixations began within the first 500 ms (viewing bin 1). In these situations, consistent objects were first fixated 286 ms after their appearance and inconsistent objects were first fixated 275 ms after their appearance, $t(22) < 1$. There is no evidence of a semantic consistency effect in the new object condition even in the very first viewing bin.

A main effect of consistency was also observed, $F(1, 36) = 19.0$, $p < .001$. The probability of initially fixating the critical objects in the first 2000 ms of viewing was greater when they were inconsistent compared to when they were consistent. Consistency also interacted with viewing bin, $F(3, 108) = 4.57$, $p < .001$, as the slope of the cumulative probability distribution was steeper in the inconsistent condition than in the consistent condition.

The preceding analyses indicate that, overall, new objects that appear during a saccade are prioritized for viewing and that inconsistent objects are viewed sooner than consistent objects. The interaction between trial type and consistency was not reliable, $F(1, 36) < 1$, nor was the three-way interaction including viewing bin, $F(3, 108) = 1.25$, $p = .30$, indicating that the advantage for inconsistent objects during normal scene viewing was maintained when those objects constituted new objects. Thus, newly appearing objects that are semantically inconsistent with the scene are prioritized more than newly appearing consistent objects when transient motion signals are eliminated. This suggests that the memory system that guides the prioritization of nontransient onsets is sensitive to the semantic nature of the new object.

In summary, new objects that appeared during a fixation and were thus accompanied by a transient motion signal captured attention quickly and reliably, and the consistency of that onset object was irrelevant. On the other hand, new objects that appeared during a saccade and relied on memory to guide their prioritization were viewed earlier if they were inconsistent than if they were consistent with the scene. As such, the memory system that is used to detect changes to a scene is sensitive to the semantic nature of those changes.

GENERAL DISCUSSION

The present study investigated the extent to which the semantic consistency of a suddenly appearing new object with the remainder of the scene affects its prioritization for attention. The baseline conditions established the rates at which the critical objects were viewed when they were not suddenly appearing objects and demonstrated that during scene viewing, inconsistent objects were viewed sooner than consistent objects. In the new object conditions, those same objects were added to the display after approximately 500 ms of viewing. Objects that appeared during a fixation and so were accompanied by transient motion signals captured attention immediately and with no effect of semantic consistency. Objects that appeared during a saccade and so without transient signals were also prioritized for viewing, but at a lesser rate. In addition, without a transient motion signal, the semantic consistency of the new object affected its prioritization: Inconsistent objects were fixated sooner following their appearance in the display than their matched consistent counterparts.

The fact that new objects accompanied by a transient motion signal were unaffected by the semantic identity of the object is consistent with the hypothesis that, when present, the transient motion signals that accompany the appearance of a new object, not the identity or meaning of object, capture attention in a bottom-up manner. But, what does the semantic consistency effect observed in the saccade-onset condition suggest about memory? Previously, we hypothesized that without the transient motion signal to capture attention, memory had to resolve the addition to the scene (Brockmole & Henderson, 2005a, 2005b). We suggested that this was accomplished by matching the current view of the scene to an existing actively maintained memory representation that is generated over the course of scene viewing (Henderson & Castelhano, 2005; Hollingworth & Henderson, 2002). Under this account, prioritization occurs when the perceptual input and the memory representation differ. Because memory is capacity limited and imperfect, discrepancies are often unnoticed. Here, we showed that the semantic consistency of the new object affects its prioritization: Inconsistent objects were fixated sooner following their appearance in the display than their matched consistent counterparts. This result suggests that the view-to-memory comparison process that guides gaze considers not only whether a change to the scene has occurred, but also the meaningfulness of that change.

The results obtained in the saccade condition reported here and by Brockmole and Henderson (2005a, 2005b) contrast with those reported by Franconeri et al. (2005), who found no prioritization of new objects when transient motion signals were eliminated by a moving occluder that hid the appearance of the new object (see also, for additional evidence that new objects can be prioritized when transient motion signals have been eliminated, Cole, Kentridge, & Heywood, 2004; Cole & Liversedge, 2006). However, the Franconeri et al. study used nonscene displays and measured capture via reaction time rather than eye movement measures. More research is required to resolve fully this discrepancy, but we think that it highlights the caution that needs to be taken when generalizing findings based on one type of stimulus or methodology to other situations. The conclusions reached regarding attention and memory may depend on the stimuli and dependent measures used. Thus, use of real-world scenes and gaze measures to investigate issues typically studied using simple arrays of objects, reaction time, and accuracy measures may constitute an important step in attaining a more complete understanding of the roles of onsets and objects in attentional prioritization in real-world scenes.

In addition to refining our understanding of the mechanisms that underlie the prioritization of new objects for viewing, the present report provides direct evidence that when making gaze control decisions based on scene memory, the meaningfulness of objects in the scene are taken into account. However, this conclusion contrasts with other work that has argued that the memory, representations that underlie gaze control decisions are based only on items' locations rather than their identities. For example, Beck, Peterson, and Vomela (2006) had observers search for a specific target items amid an array of coloured shapes. During viewing, either the colour–shape pairing of one distractor object was changed, or the location of one distractor object was changed. Changes to item features did not affect search behaviour but changing the location of an object disrupted search. However, there are at least two important differences between these studies. First, we used a memorization task under the guise that observers would have to detect changes to objects in a later test while Beck et al. used a search task. In our memorization task, therefore, the identity and features of all objects were critical, but in the search task, once an item was rejected as a distractor, its features were irrelevant. As such, our memorization task may have biased observers to include detailed object information in memory. Second, we used real-world scenes, whereas Beck et al. used very simple displays of coloured shapes. In our semantically rich scenes, object meaning is likely to be vital to understanding the stimulus, whereas in random arrays of coloured shapes, object identity is less important. At a minimum then, it appears that although visual memory may not always store or use object identity and meaning to guide gaze, circumstances certainly exist in which this information is stored and used to guide the eyes. Given the ubiquity of real-world scenes in our daily lives, it seems likely that the circumstances under which meaning is used to guide gaze are not "special cases" but may in fact represent the default state of gaze control decision making.

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