# Contextual Cueing in Naturalistic Scenes: Global and Local Contexts

James R. Brockmole
University of Edinburgh

Monica S. Castelhano
University of Massachusetts—Amherst

John M. Henderson
Michigan State University

In contextual cueing, the position of a target within a group of distractors is learned over repeated exposure to a display with reference to a few nearby items rather than to the global pattern created by the elements. The authors contrasted the role of global and local contexts for contextual cueing in naturalistic scenes. Experiment 1 showed that learned target positions transfer when local information is altered but not when global information is changed. Experiment 2 showed that scene–target covariation is learned more slowly when local, but not global, information is repeated across trials than when global but not local information is repeated. Thus, in naturalistic scenes, observers are biased to associate target locations with global contexts.

*Keywords:* contextual cueing, scenes, visual search, visual attention, visual memory

Repeated exposure to a specific arrangement of target and distractor items leads to a progressively more efficient search, an effect called *contextual cueing* (e.g., Chua & Chun, 2003; Chun & Jiang, 1998, 1999, 2003; Jiang & Chun, 2001; Olson & Chun, 2002). For example, in their seminal work on this effect, Chun and Jiang (1998) had observers search for a rotated *T* hidden among rotated *L*s. Over the course of trials, a subset of stimuli was consistently repeated with the arrangement of the target and distractor elements fixed. Across multiple repetitions, search times for repeated displays became faster than those for novel displays. This effect occurred without observers being aware that displays were repeated and without observers having explicit memory of target positions. Similar findings have been obtained with arrays of novel two- and three-dimensional (3D) shapes (Chua & Chun, 2003; Chun & Jiang, 1999).

Recently, Brockmole and Henderson (2006; see also Brockmole & Henderson, in press) completed the first investigation of contextual cueing in which real-world scenes constituted the learning context. Like artificial stimulus arrays, real-world scenes have stable structures (Henderson & Hollingworth, 1999). For example, each time we go to our neighborhood park, we recognize the athletic fields, playground equipment, and pavilions as the same objects and features arranged in the same spatial configuration. Even objects that can be moved appear in regular spatial arrangements; strollers are often lined up near the benches, and kites are in the air. In an examination of how regularities within real-world environments are used to guide visual attention to behaviorally relevant targets, observers were given the task of searching for and identifying a target letter arbitrarily embedded in scene photographs. Although search times across novel scenes remained constant throughout the experiment, search times for letters appearing in a consistent position within repeated scenes decreased across repetitions. With real-world scenes, however, memory for scene–target covariation was explicit; observers recognized repeated scenes more often than those that were presented once and displayed superior recall of target position within the repeated scenes. In addition, when scenes were inverted to increase recognition difficulty, the rate of learning was markedly reduced, suggesting information concerning object and scene identity is used to guide attention. These results indicate that paradigms using nonscene stimuli have led only to a partial characterization of contextual cueing within the real world.

A critical issue concerning contextual cueing in scenes is the nature of the information that is used to reference the target position. Previous studies using nonscene stimulus arrays have obtained evidence that the target is associated with a few nearby items, rather than with the global pattern or structure created by the elements in the display. For example, context–target associations have been shown to transfer to new contexts that have different global arrangements of elements as long as some local aspects of the previously learned context are preserved in the new global arrangement (Jiang & Wagner, 2004). This effect was so strong that even when the global context of the search arrays was highlighted by a line that connected all distractors to form a global

shape, observers continued to use local cues to locate the target, albeit at a lower rate. If a subset of local elements is preserved when the global structure of a display is changed, transfer is complete. Additional studies have shown that if the positions of some of the elements in a repeated array remain fixed while others vary, contextual cueing occurs only if the target appears within the invariant portion of the display (Olson & Chun, 2002). Variation in the local context immediately surrounding the target prevents cueing, and cueing is possible even if the global structure of all items is never repeated, as long as local context remains constant.

The purpose of the present study was to examine the degree to which search targets within naturalistic scenes are associated with the local context immediately surrounding the target versus the global context of the scene. Although global context is not the primary determinant of learning in nonscene displays, it may be a useful predictor of target locations in learned scenes. Scenes possess a degree of coherence absent from simple stimulus arrays. In fact, the identity of a scene at a basic categorical level can be extracted within the first 100 ms of viewing and affords expectations about spatial layout and component objects (see Henderson & Ferreira, 2004) and drives attention to task-relevant scene regions (Antes, 1974; Henderson, Weeks, & Hollingworth, 1999). This global level of scene representation may therefore also guide observers' attention to learned target positions before the observers identify specific local scene regions. In Experiment 1, we examined whether learned target positions transfer to situations in which local or global information is altered (cf. Jiang & Wagner, 2004). In Experiment 2, we examined whether target positions can be learned given local or global variation in the arrangement of items around the target (cf. Olson & Chun, 2002).

## Experiment 1

The purpose of Experiment 1 was to examine whether knowledge of a previously learned target position transfers to scenes that differ in either their local or global context. Observers were presented with a sequence of trials on which they searched for and identified an arbitrarily located target letter within computer-rendered illustrations of realistic scenes. Rendered illustrations were used instead of photographs because they enabled the independent manipulation of local and global contexts. Local context was defined as a group of objects in close proximity to the target. The remainder of the scene constituted the global context. The trial sequence was divided into two phases. In the learning phase, amid a sequence of filler trials, a library scene was consistently repeated. Within this scene, the target was always located on the coffee table, although the target's identity was randomly selected with each repetition. Repetition of the scene allowed observers to learn this association. In the transfer phase, the previously repeated stimulus was replaced with a transfer stimulus that altered local aspects of the scene surrounding the target while preserving the global content of the learned scene or that changed the global content of the learned scene while maintaining some local aspects (see Figure 1). Half of the observers saw a unique coffee table in the now-familiar room (local change), whereas the other half of the observers saw the familiar coffee table in a unique room (global change). The question of interest was whether and how the prior benefits of learning would transfer to these altered stimuli.

In both the local and global change conditions, search times would be expected to progressively decrease during the learning phase of the experiment. The critical analysis concerns search time on the transfer trial. If observers associated the target with local contextual information during learning, then search time for the
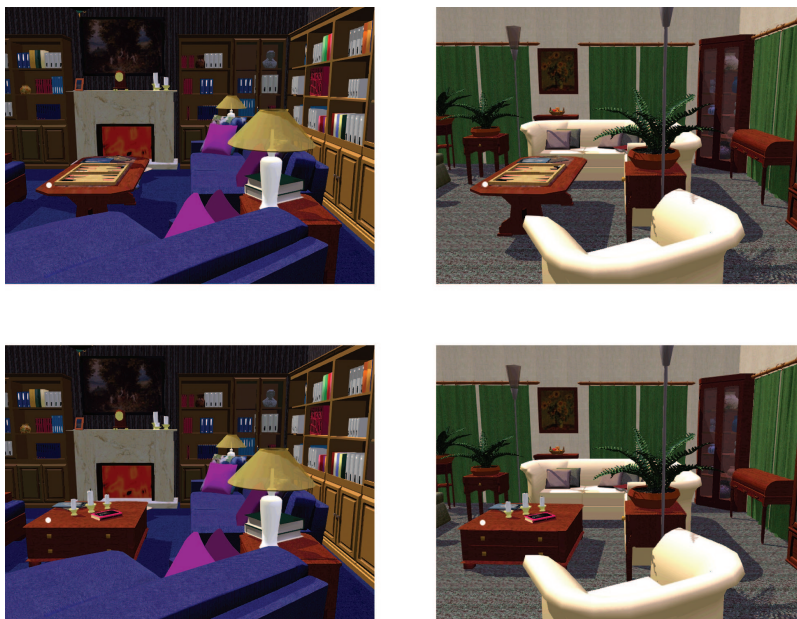


*Figure 1.* The four critical stimuli in Experiment 1 (stimuli were presented in full color). For illustrative purposes, white dots have been added that highlight the size and position of the letter targets. Horizontally adjacent stimuli constitute global changes while vertically adjacent stimuli constitute local changes.

transfer trial in the local change condition should increase relative to that observed at the end of the learning phase. On the other hand, if observers learned the association between the global context and the target, then search time for the transfer trial should increase in the global change condition.

### Method

*Subjects.* Thirty-two Michigan State University undergraduates, randomly divided into two equal groups, participated in this study after providing informed consent. All subjects were naïve with respect to the experimental hypotheses and were compensated with course credit.

*Stimuli and apparatus.* Stimuli consisted of 3D-rendered illustrations of naturalistic scenes created with Data Becker Home Design software, version 5.0 (Data Becker International, Düsseldorf, Germany). Scenes represented kitchens, living rooms, dining rooms, nurseries, offices, bedrooms, recreation rooms, bathrooms, foyers, cellars, porches, and garages. These scenes were displayed at a resolution of 800 × 600 pixels × 24-bit color on a 17-inch cathode ray tube (CRT), with a refresh rate of 100 Hz. Each scene included a single small gray *T* or *L* presented in 9-point Arial font, which constituted the target in a visual search task. The use of letters ensured that target position could not be predicted by local or global scene content before learning had taken place.

Four critical stimuli were created that orthogonally combined global and local scene components (see Figure 1). Two library scenes were created that contained different coffee tables but were otherwise identical. Similarly, two living room scenes were created that were identical except for the coffee tables. The same two tables were used in the library and living room scenes. An additional set of 50 filler scenes were created. Although some of these filler scenes shared the same semantic category (e.g., living room, kitchen, etc.), the arrangement of principal objects and the selection of specific object tokens for each scene were unique.

*Design and procedure.* Participants viewed 60 stimuli, divided into 10 blocks of six trials. Blocks 1–9 constituted the learning phase of the experiment. Each block contained five *novel* trials, each of which presented one of the filler scenes described above exactly once during the experiment. These trials measured baseline search speed. The remaining trial in each block was a *repeated* trial. Across blocks, the repeated trial presented exactly the same stimulus. Block 10 constituted the transfer phase of the experiment. This block contained five novel trials and one *transfer* trial. In a between-subjects manipulation, we incorporated into the transfer trial a change in either the local (table) or global (room) information that was repeated in Blocks 1–9. In the transfer block, observers in the local change condition saw a different coffee table in the repeated room. Observers in the global change condition saw the same repeated coffee table in a different room. The coffee table was presented in the same location and orientation on the transfer trial as it was during the learning trials so that the target was always located in the same (*x*, *y*) coordinates on the display. Counterbalanced across subjects, all eight combinations of repeated and transfer stimuli were used.

At the beginning of each trial, a blue dot was centered on a gray background. Observers were instructed to look at this dot and to press a key when ready to view the scene. Upon identifying the target, observers pressed one of two buttons corresponding to either *T* or *L*. The trial was terminated if a response was not made within 20 s of scene onset. This was the same method used by Brockmole and Henderson (2006). No information regarding the block structure or the repetition of scenes was given to observers; any learning of scene–target covariation was incidental.

### Results and Discussion

In our analyses, we first considered the learning phase of the experiment to show that repetition of scenes led to increasingly efficient searches. To increase statistical power, we collapsed the nine learning blocks into three epochs. Average search times for novel and repeated trials are illustrated in Figure 2, broken down by repetition condition and epoch. The difference between the novel and repeated trials, which we will refer to as the *cueing effect*, is plotted in Figure 3. The cueing effect served as the dependent variable for all analyses (Chun & Jiang, 1998).

Cueing effects for the learning epochs were entered into a 2 (Transfer Condition) × 3 (Epoch) mixed model analysis of variance (ANOVA). The effect of transfer condition was not reliable, $F(1, 30) < 1$. The effect of epoch, however, was reliable, $F(2, 60) = 54.0$, $p < .001$, characterized by a reliable linear trend, $F(1, 30) = 4.53$, $p < .05$. These factors did interact, $F(2, 60) = 3.36$, $p < .05$. This interaction was driven by baseline differences between the groups in the first epoch. Note that by the end of the learning phase, observers in each group displayed equivalent cueing effects.

The cueing effect observed in the transfer phase was compared with that observed at the conclusion of learning. Cueing effects in the final learning epoch and the transfer epoch were entered into a 2 (Transfer Condition) × 2 (Epoch) mixed-model ANOVA. The main effect of transfer condition was not reliable, $F(1, 30) = 2.61$, $p = .12$. The effect of epoch, however, was reliable, $F(2, 60) = 11.7$, $p < .01$. Critically, these factors interacted, $F(2, 60) = 10.1$, $p < .01$. Planned comparisons showed that in the local change condition, the cueing effect at transfer did not reliably differ from that observed in the last learning epoch, $t(15) < 1$. In the global change condition, however, the cueing effect was reliably smaller at transfer compared with such an effect at the conclusion of learning, $t(15) = 3.34$, $p < .01$; in fact, the cueing effect in the transfer epoch was statistically equivalent to that observed in the first learning epoch, $t(15) < 1$.

After observers learned the location of a target in a naturalistic scene, changes in the local information surrounding the target had no impact on contextual cueing when the global scene information remained constant. The search time advantage achieved at the end of learning was entirely preserved. Changes in the global scene information, however, completely eliminated the benefits of contextual cueing, even though the local information around the target was preserved. These results suggest that during the learning phase, the target was encoded relative to global scene information.

During the learning phase of the experiment, both local and global information were redundant because each perfectly predicted target position. Although the results of this experiment show that in such a situation, global context drives cueing, the results do not exclude the possibility that target position can be associated with local information in other circumstances. In Experiment 2, we tested this possibility by divorcing local and global scene information during learning. For example, the same local context could be presented within a variety of global contexts. In such a situation, in order for this repetition to affect search, the target would have to be associated with the local context.

### Experiment 2

In Experiment 2, we varied local and global contexts independently during learning. As in Experiment 1, we presented observers with a sequence of trials on which they searched for and identified an arbitrarily located target letter. The majority of trials presented a scene that had not been shown previously. A subset of
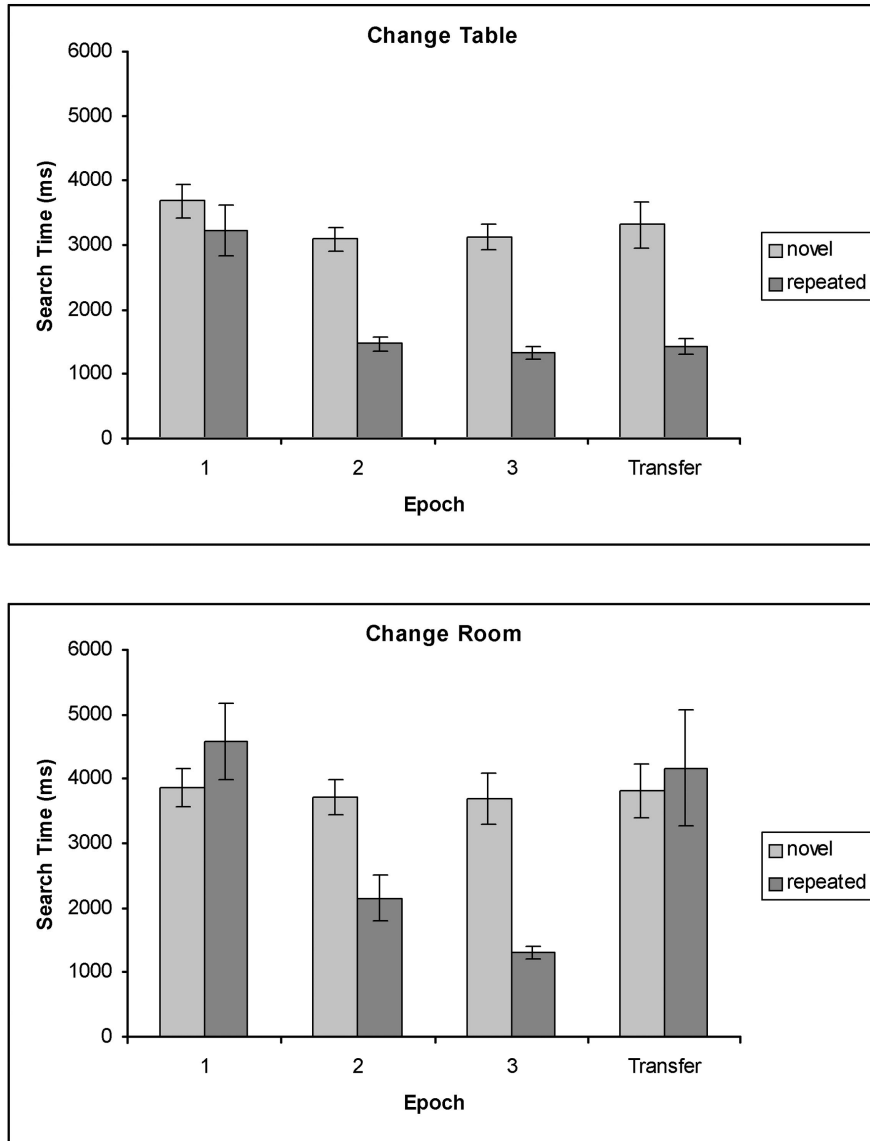
Figure 2.  Mean search time (and standard error) in the three learning epochs and the transfer block of Experiment 1.
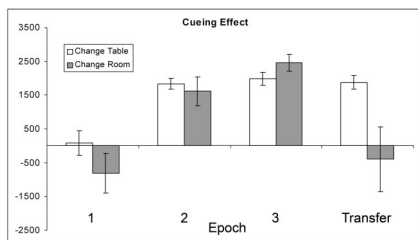


Figure 3.  Mean cueing effects (and standard errors) observed in Experiment 1.

critical trials, however, repeated global and/or local information contained on previous trials (see Figure 4). For one group of observers, critical trials repeated local scene information that predicted a target's position independently of the global scene information. Specifically, a subset of different rooms all contained the same coffee table on which the target was always located. Thus, this table was perfectly predictive of the target position in the scene. For a second group of observers, critical trials repeated global scene information that predicted a target's position independently of the local information near the target. Specifically, a subset of otherwise identical scenes each contained a different coffee table on which the target appeared; thus, the room was entirely predictive of target position. For a final group of observers, exactly the same table–room combination was presented mul-

**Local Repetition Condition**



Repeated          Novel          Novel          Novel          Repeated

**Global Repetition Condition**



Repeated          Novel          Novel          Novel          Repeated

**Total Repetition Condition**



Repeated          Novel          Novel          Novel          Repeated

*Figure 4.* Sample trial sequences used in Experiment 2. For illustrative purposes, white dots have been added that highlight the position and size of the letter targets. Stimuli were presented in full color.

tiple times, and the target was always presented in the same position. This final condition represented the typical contextual cueing situation, with no variability in the repeated scenes and served as a baseline measure of cueing.

If observers are able to learn the association between the local context and the target independently of variation in the global context, then search times would be expected to decrease over repetitions in the local repetition condition. Likewise, if observers are able to learn the association between the global context and the target independently of variation in the local context as suggested by the results of Experiment 1, search times would be expected to decrease over repetitions in the global repetition condition. If both local and global associations contribute to learning when both local and global information is repeated, search time on these critical trials should maximally decrease over repetitions.

### Method

*Subjects.* Sixty Michigan State University undergraduates, randomly divided into three equal groups, participated in this study after providing informed consent. Subjects had not participated in Experiment 1 and were compensated with course credit.

*Stimuli and apparatus.* As in Experiment 1, stimuli consisted of 3D-rendered illustrations of indoor scenes each containing a single *T* or *L* search target. Illustrations were displayed at a resolution of $800 \times 600$ pixels $\times$ 24-bit color on a 17-inch CRT. Ten *locally* consistent scenes were created that contained the same local context, a coffee table, within different global contexts, the room in which the table was present. Ten

*globally* consistent scenes were also created that portrayed the same global room context but contained different local table contexts. An additional set of 40 filler scenes was created in the same manner as in Experiment 1.

*Design and procedure.* Participants viewed 50 stimuli, divided into 10 blocks of five trials. Each block contained four novel trials, each of which presented one of the filler scenes described above. Each filler scene was presented exactly once during the experiment. These trials were used to measure baseline search speed. The remaining trial in each block was a *repeated* trial. Each repeated trial was created by orthogonally combining a unique coffee table and room.

For observers in the *local* repetition condition, each repeated trial presented the same coffee table in a different room. For observers in the *global* repetition condition, each repeated trial presented a different coffee table in the same room. Finally, for observers in the *total* repetition condition, each repeated trial presented the exact same coffee table–room combination. As in Experiment 1, across all repeated trials in all repetition conditions, the search target was located on the coffee table, although the target's identity was randomly selected with each repetition. The coffee table was also presented in the same location and orientation on all repeated trials so that the target was always located in the same $(x, y)$ coordinates of space regardless of repetition condition.

The procedure was the same as in Experiment 1. At the beginning of each trial, a blue dot was centered on a gray background. Observers were instructed to look at this dot and to press a key when ready to view the scene. Upon identifying the target, observers pressed one of two buttons corresponding to either *T* or *L*. The trial was terminated if a response was not made within 20 s of scene onset. No information regarding the block structure or the repetition of scenes was given to observers; any learning of scene–target covariation was incidental.

## Results and Discussion

To increase statistical power, we collapsed the 10 blocks into five epochs. Average search times for novel and repeated trials are illustrated in Figure 5, broken down by repetition condition and epoch. Corresponding cueing effects are illustrated in Figure 6. As in Experiment 1, the cueing effect served as the dependent variable entered into all analyses.

One-way repeated measures ANOVAs examined cueing effects across epochs for each repetition condition separately. For the local repetition condition, although the effect of epoch was not reliable, $F(4, 76) = 1.58$, $p = .19$, a reliable linear trend emerged, $F(1, 19) = 5.76$, $p < .05$. In contrast, for the global repetition condition, a main effect of epoch was observed, $F(4, 76) = 10.3$, $p < .001$, described by reliable linear, $F(1, 19) = 37.2$, $p < .001$, and quadratic, $F(1, 19) = 4.11$, $p < .05$, trends. Similarly, an effect of epoch was observed for the total repetition condition, $F(4, 76) = 18.6$, $p < .001$, also characterized by reliable linear, $F(1, 19) = 21.2$, $p < .001$, and quadratic trends, $F(1, 19) = 15.8$, $p < .001$. Thus, in all conditions, cueing effects increased over epochs.

To contrast the cueing effects within each condition, we initially entered data into a 3 (Repetition Condition) $\times$ 5 (Epoch) mixed-model ANOVA. The effects of condition, $F(2, 57) = 9.77$, $p < .001$, and epoch, $F(4, 228) = 24.0$, $p < .001$, were reliable. Critically, these factors interacted, $F(8, 228) = 2.53$, $p < .01$. The magnitude of the cueing effect across epochs was not equal in all repetition conditions. To investigate the nature of this interaction, we decomposed the omnibus ANOVA into three 2 (Repetition Condition) $\times$ 5 (Epoch) mixed-model ANOVAs to directly compare each repetition condition to the others.

Contrasting the local and global repetition conditions, main effects of condition, $F(1, 38) = 5.70$, $p < .05$, and epoch, $F(4, 152) = 10.5$, $p < .001$, were observed. These factors also interacted, $F(4, 152) = 3.21$, $p < .05$. Contrasting the local and total repetition conditions, main effects of condition, $F(1, 38) = 18.8$, $p < .001$, and epoch, $F(4, 152) = 13.9$, $p < .001$, were also observed in addition to the interaction, $F(4, 152) = 4.39$, $p < .01$. The repetition of local scene information around the target divorced from global information led to substantially smaller and slower developing cueing effects than were observed when the global scene information was repeated either in isolation from or in conjunction with local scene information. Contrasting the global and total repetition conditions, although main effects of condition, $F(1, 38) = 4.12$, $p < .05$, and epoch, $F(4, 152) = 26.2$, $p < .001$, were observed, the factors did not interact, $F(4, 152) < 1$. Although, on average, the cueing effect was smaller when only global scene information was repeated than when all information was repeated, the rate of learning was the same in both the global and total repetition conditions.

In summary, cueing effects were observed when only local information was repeated as well as when only global information was repeated across trials. However, although observers associated target positions with local information when global information was not predictive, cueing was substantially greater when global scene information was repeated, regardless of local constancy.

## General Discussion

In the present study, we examined whether contextual cueing within naturalistic scenes results from a learned association be-
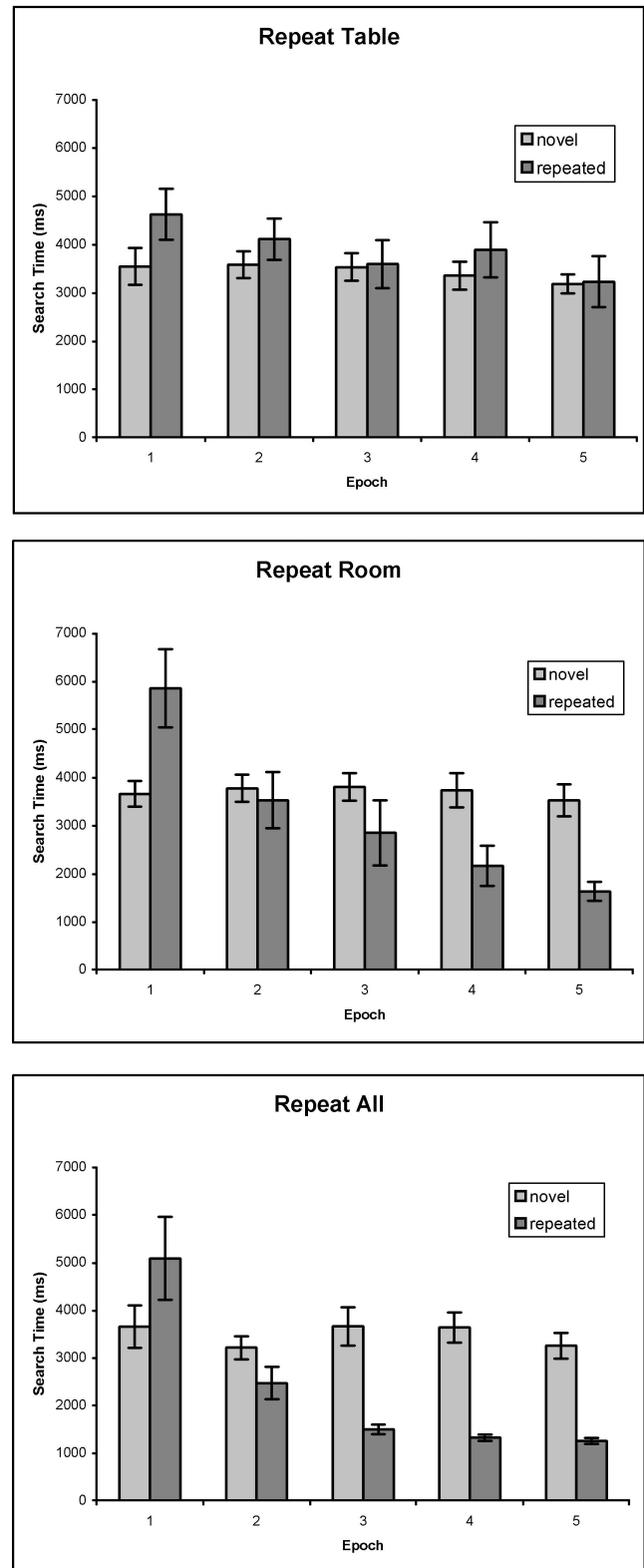


*Figure 5.* Mean search time (and standard error) in the five epochs of Experiment 2.
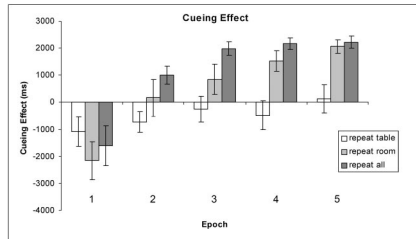
*Figure 6.* Mean cueing effects (and standard errors) observed in Experiment 2.

tween local information near the target or from global scene information. In Experiment 1, observers learned the position of targets in repeated scenes. The global and local information was redundant, and both allowed equally precise predictions of target location. In a transfer phase, however, the local scene information and global scene information were divorced. Some observers were presented with stimuli in which the local information around the target had been preserved but the global scene in which the information was presented had been changed. Other observers were shown new local contexts in the same global scene. Complete transfer of learning occurred for violations of local content, but learning benefits were completely eliminated when global content was altered. In Experiment 2, the local and global aspects of repeated stimuli were independently manipulated during learning. Observers saw either the same local context appear in different global contexts or different local contexts appear in the same global context, or a consistent repetition of both local and global information. In all cases, cueing effects were observed; however, cueing developed faster and yielded a substantially greater benefit when global context was repeated. Together, these results indicate that in naturalistic scenes, observers have a strong bias to associate targets with global scene contexts and only when such contexts are nonpredictive is local scene information used to encode a consistently located target. These results starkly contrast with previous studies showing that with nonscene stimuli, targets are associated with local elements rather than with global patterns (Jiang & Wagner, 2004; Olson & Chun, 2002).

Why does global information play a more prominent role in search through scenes compared with stimulus arrays? In both situations, the global aspects of the display contain a greater proportion of the presented elements, but they appear to be used to code target position only in the context of real-world scenes. Further experimentation is required to completely resolve this issue, but here we propose three explanations supported by the current results and other related literatures.

First, for scenes, in contrast to letter arrays, global contexts contain more useful information compared with that provided by local contexts. Arbitrarily arranged letter arrays do not give rise to inherent expectations concerning the arrangement of elements, but scenes are collections of objects arranged in a spatially licensed manner (Henderson & Hollingworth, 1999). This means that the arrangement of objects in a scene must, in part, adhere to the physical and semantic constraints established by the identity and context of the scene. Thus, even when local objects have yet to be identified, scene identity and category information can engender expectations about layout and component objects (Friedman, 1979;

Potter, 1976; see also Henderson & Ferreira, 2004). As a result, the principal association of target positions and global scene information may enable faster orienting of attention to the target than in a situation in which the target was associated only with local context. Support for this hypothesis was obtained in Experiment 2, in which target position was learned at a slower rate when local, but not global, information was repeated across trials.

Second, global context may provide a better retrieval cue for past searches and target locations. Unlike memory for random arrays of letters, observers are able to explicitly recognize hundreds if not thousands of previously novel scene images after a single exposure to them (Shepard, 1967; Standing, 1973). Changes in the arrangement or identities of a large, spatially distributed number of objects in a scene (i.e., global context), as opposed to the identity of a small subset of spatially clustered objects (i.e., local context), can alter the identity of a scene, thereby removing salient retrieval cues. Support for this view is derived from Experiment 1, in which changes to global context (scene identity) led to incomplete transfer of learning despite the preservation of the local information surrounding the target.

Third, specialized brain areas are dedicated to the processing of global scene information. Specifically, a region of inferior temporal cortex called the parahippocampal place area (PPA) becomes activated when viewing scene background information that establishes structure and geometry but is not activated when viewing objects divorced of this global structure (Epstein & Kanwisher, 1998). However, the PPA does not appear to be associated with memory and is preferentially activated when viewing novel as opposed to repeated scenes (Epstein, Harris, Stanley, & Kanwisher, 1999). Thus, the PPA is not likely to be involved in learning target position relative to global or local contexts but may be part of a neural architecture that preferentially processes global scene information.

In addition to the above considerations based on experimental data, we speculate that two additional factors that fall outside the scope of the present experiments might also contribute to the priority of global scene information as a basis for learning. First, despite the finding of a previous study that target positions within real-world scenes are explicitly encoded in memory (Brockmole & Henderson, 2006), it is possible that the nature of the memory representations involved in learning local and global context differ. That is, the repetition of local contexts might be encoded implicitly, whereas global contexts might be encoded explicitly, resulting in awareness of the repetition and thus more robust learning when global, but not local, information is repeated. Second, aside from cognitive or "top-down" factors being involved in target learning, a host of low-level differences may exist between the global and local aspects of the visual world such as statistical regularities in luminance, contrast, and spatial frequency components, as well as in color. Similar differences also certainly exist between artificial stimulus arrays and naturalistic stimuli. In addition, the visual homogeneity of elements found in these different stimulus types likely differs; for example, the visual similarity between items in a letter array is greater than the visual similarity between objects in a scene. This array of differences might lead to differences in how targets are associated with visual information available in a display and could potentially lead to different learning strategies in each situation. Further research is required to determine whether and to what extent any of these factors influence the differences observed

in the rates of learning between global and local levels of scenes or between artificial and naturalistic displays.

Regardless of the root cause, whether the precedence of global scene information in the guidance of attention to targets is a general property of learning or if any circumstances arise in which local context may dominate remains an open question. For example, it could be that if the local context were preferentially attended, it would become dominant over global context. In the present report, we operationalized *local* as a set of objects within close proximity of the target and *global* as the remainder of the scene. However, the relationship between global and local aspects of a scene depends on the spatial extent of that scene. In the present study, the scenes presented to observers were rather expansive rooms. However, a scene could also be a relatively small aspect of such an environment. For example, the coffee tables that served as local context in this report could be construed as global contexts in another experimental design. The extent to which the view of the world afforded to observers is "zoomed in" could have an important impact on the usefulness of global or local scene information during learning because the spatial extent of the scene may be correlated with the relative informativeness of local and global scene information.

In summary, the present study provides additional evidence that contextual cueing in naturalistic scenes and simple stimulus arrays operate differently. Previous research using nonscene stimuli has suggested that contextual cueing is an implicit memory effect driven by developing memory for a target's position that is based on consistently located local elements, even when global configurations are highlighted. In contrast, contextual cueing in real-world scenes is an explicit memory phenomenon driven in part by global scene information. Global scene information is the primary context with respect to which the target is learned in scenes; local contexts near the target are only used to guide attention when global information is nonpredictive. Thus, it seems that the independence of contextual cueing from global information is not a general property of the phenomenon but is specific to situations in which global identity is difficult to derive, is not useful, or is absent. These differences in the manner in which consistently arranged information guides attention to known search targets reflects different memory mechanisms involved in the encoding and retention of complex meaningful scenes and simple arrangements of letters or shapes.

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