Novelty is not always the best policy: Inhibition of return and facilitation of return as a function of visual task

Michael D. Dodd

University of Nebraska – Lincoln

Stefan Van der Stigchel

Utrecht University

Andrew Hollingworth

University of Iowa

In press at Psychological Science

Address correspondence to:

Michael D. Dodd
238 Burnett Hall
Department of Psychology, University of Nebraska-Lincoln
Lincoln, NE, 68588
Tel. (402) 472-00547
mdodd2@psych.unl.edu

Abstract

We report a study that examined whether inhibition of return (IOR) is specific to visual search or a general characteristic of visual behavior. Participants were shown a series of scenes and were asked to either a) search each scene for a target, b) memorize each scene, c) rate how pleasant each scene was, or d) free-view each scene. An examination of saccadic reaction times to probes appearing at previously fixated or novel location provided evidence of IOR influencing search: participants were slower to look at probes at previously fixated locations relative to novel locations. For the other three conditions, however, the opposite pattern of results was observed: participants were faster to detect targets at previously fixated locations relative to novel locations, a *facilitation of return* effect that has not been reported previously. These results demonstrate that IOR is a search-specific strategy and not a general characteristic of visual attention.

Novelty is not always the best policy: Inhibition of return and facilitation of return as a function of visual task

To successfully navigate our visual world, we must efficiently direct attention to important features in the environment while simultaneously ignoring unimportant or distracting stimuli. One process that is thought to facilitate the selection of visual information is inhibition of return (IOR), in which attention is slower or less likely to be returned to recently inspected locations than to be directed to novel locations. Since the initial discovery of IOR by Posner and Cohen (1984), researchers have posited that the purpose of IOR is to maximize the efficiency of visual search for an object by ensuring that attention is not returned to previously examined locations. Initial evidence that IOR influences search behavior was provided by Klein (1988; see also Müller & von Mühlenen, 2000; Takeda & Yagi, 2000), who found that the detection of a probe stimulus was impaired at locations that had been attended in a serial search task.

Klein and MacInnes (1999) provided further evidence of a role for IOR in search using Where's Waldo displays. During search, participants had to make a saccade to a target probe appearing at a previously fixated or novel location. Saccadic reaction times (SRTs) to probes at one-back and two-back locations were slowed relative to probes at novel locations, indicative of IOR. These results are consistent with memory-based models of IOR, in which previously attended locations are tagged and held in memory so that attention does not return to these locations.

Further evidence that IOR both a) influences search, and b) involves a memory component, has been provided by studies investigating whether IOR occurs at several sequentially cued locations (Danziger, Kingstone, & Snyder, 1998; Dodd, Castel, & Pratt, 2003; Dodd & Pratt, 2007; Snyder & Kingstone, 2000; Tipper, Weaver, & Watson). For example, Snyder and Kingstone (2000) used a display of eight peripheral placeholders and six sequential cues on each trial, observing IOR for the five most recently cued locations. This finding is consistent with the idea that IOR can influence search by biasing attention away from several sequentially attended locations, while at the same time suggesting that the system has a limited capacity, with only a subset of locations held in memory at any given time.

While there is ample evidence to suggest that IOR influences search behavior, IOR is often discussed as though it is a general characteristic of attention (such that attention is always thought to be slower to return to recently inspected locations independent of task set), despite little systematic investigation of this issue. That Posner and Cohen observe an effect of IOR on target detection in a non-search task would seem consistent with this idea, but it is important to note that target detection tasks are search-like in that the overall goal is to shift attention to find a target in a display. It is not surprising, therefore, that IOR influences target detection.

In the present study, we examined whether IOR is specific to visual search tasks or is a general property of visual behavior[1]. Although a mechanism that biases attention to novel locations would clearly be advantageous to search, it is less clear that such a mechanism would be useful for other common visual tasks. IOR might be useful if an individual is trying to memorize a scene, as increasing the number of areas sampled may help to create a more complete representation of that scene. However, if one is trying to remember the details of a few prominent objects in a scene, the creation of a memory representation may be facilitated by returning to the locations of prominent objects (e.g., Henderson, Weeks, & Hollingworth, 1999). Similarly, if one is comparing two objects in a scene, a series of fixations between the two objects might be necessary. Such rapid alternations between objects would be impaired by an IOR mechanism. A similar argument can be made for pleasantness judgments. Given that many common visual tasks may be impaired by an IOR mechanism, it is important to determine whether IOR is limited to visual search (and potentially other tasks that would benefit from a novelty bias) or whether IOR extends to all types of visual tasks, consistent with the assumption that IOR is a general property of visual attention. To this end, in the present study we had participants view a set of scenes under four tasks condition (search, memorize, pleasantness rating, or free-view) while monitoring their eye movements. If IOR is a general property of attention, then we should observe IOR in all four conditions even though task performance in the memory, pleasantness rating, and free-view conditions would not necessarily benefit from a novelty bias. If, however, IOR is a process specialized for visual search, then we would only expect to find evidence of the effect in the search condition.

Though numerous researchers have suggested that memory and as such, IOR, influences search, it is worth noting that this view is not without its critics. While the aforementioned research is indicative of a role of IOR/memory in search, other researchers have suggested that the role of IOR/memory in search is limited (e.g., Gilchrist & Harvey, 2000) or nonexistent (Horowitz & Wolfe, 1998, 2001, 2003). Part of the difficulty in measuring IOR in search, however, is that there is no agreed upon method of doing so. Consequently, in the present research, we use multiple measures to investigate the influence of IOR on performance. Our critical measure was SRTs to probes appearing at previously fixated locations relative to novel locations. Our expectation was that participants would be slower to look at probes appearing at previously fixated locations. We also examine the number of refixations individuals make during each trial, as well as the amount of time between refixations to obtain converging evidence of the presence/absence of IOR.

Method

Participants: Forty-eight undergraduate students from the University of British Columbia and the University of Nebraska-Lincoln underwent individual 30-minute sessions, receiving course credit as remuneration for participating in the study. Twelve of the students participated in the each. All had normal or corrected-to-normal vision and were naïve about the purpose of the experiment.

Apparatus: The eye tracker utilized in the present study was the SR Research Ltd. EyeLink II system. This system has high spatial resolution and a sampling rate of 500 Hz. For all participants, the dominant eye was monitored for use in subsequent analyses. Saccade movement onset was detected when acceleration ($8000°/s^2$) and velocity (30°/s) thresholds were reached with saccades of 0.5° of visual angle or greater, and movement offset was detected when velocity fell below 30°/s and remained so for 10 consecutive samples.

Stimulus displays were presented on two monitors, one for the participant and the other for the experimenter (allowing for real-time feedback and recalibration when necessary). The average error in the computation of gaze position was less than 0.5°.

A 9-point calibration procedure was performed at the beginning of the experiment, followed by a 9-point calibration accuracy test. Calibration was repeated if any point was in error by more than 1° or if the average error for all points was greater than 0.5°.

The experiment, programmed in Visual C++, was individually conducted on a Pentium IV PC with a Dell monitor in a testing room equipped with soft lighting and sound-attenuation. Participants were seated approximately 44 cm from the computer screen, and made responses using both eye movements and the keyboard in front of them.

For all subjects, the experiment consisted of the presentation of 68 computer generated natural scenes depicting common environments (e.g., rooms and locales). The scenes were adapted from a set used by Hollingworth (2007). A few examples of the scenes we used can be found on Figure 1. Each scene had a small letter N or Z imbedded in the picture for the purpose of the search task (described below). At the beginning of each trial, a fixation point appeared in the middle of the screen and participants were instructed to look directly at the fixation point and press the spacebar to initiate each trial. Each scene was displayed for eight seconds during which participants engaged in a primary task, described below. On 36 of the 68 trials, a probe (a green circle, 71.9 cd/m2, 1.0°) appeared at approximately the six-second point. The probe occupied either a novel location that had not been previously fixated (18 trials), or the location of a previous fixation (18 trials). When the probe occupied a previously fixated location, it appeared at either a 2-back location (two fixations previously), 4-back location (four fixations previously), or 6-back location (six fixations previously)[2]. Fixations were monitored in real-time by the computer program to determine where the probe would appear. Participants were instructed that in addition to their primary task, they should look at the probe the moment they detected it.

There were four task-set conditions that were manipulated between-subject. Participants in the search condition were told that the letter N or Z was present in each picture and that they were to search for the letter. At the end of each trial, participants were asked to make a choice response as to whether an N or Z had been presented via keypress response. The letter was very small and well camouflaged and could not be detected unless fixated (this ensured that participants in the other conditions were unlikely to detect the letter while viewing the scene). The purpose of this manipulation was to keep participants searching for the entire 8 seconds as if the target was easy to detect it may alter their eye movement behavior post-detection. The majority of participants indicated that they rarely, if ever, found the target meaning that they continually searched for the entire eight seconds during which the scene was visible.

The remaining participants took part in either the memory, pleasantness-rating, or free-view conditions. In the memory condition, participants were asked to memorize each scene for a subsequent memory test (memory was not actually tested). In the pleasantness rating condition, participants were asked to decide how much they liked each picture on a scale from 1 to 7 (1 = do not like the picture at all, 7 = like the picture very much) and responded via a key-press at the end of each trial. Finally, in the free-view condition, participants were given no specific instruction and simply told to view each picture as they chose.

Results and Discussion

Saccadic reaction times to probes as a function of probe location and task set, and IOR values can be found on Table 1. The average number of fixations and refixations per trial, and the average amount of time that elapses between refixations as a function of task set can be found on Table 2. If IOR is a general characteristic of visual behavior, we would expect SRTs to always be slower to probes appearing at previously fixated locations relative to previously unfixated locations. Moreover, we would expect little difference in the number of refixations and time between refixations as a function of task set.

Saccadic Reaction Times: The most direct test of whether IOR influenced visual behavior in our various tasks comes from our probe detection task. On more than 50% of probe trials, the first eye movement made after the appearance of the probe was made to the probe. On a smaller proportion of trials participants made one additional eye movement before looking at the probe and on a few trials participants made more than one additional eye movement before looking at the probe or failed to look at the probe at all. In the analyses reported below we included only those trials on which participants immediately look at the probe when it appeared. We also performed analyses including trials on which one additional eye movement was made before probe fixation (accounting for more than 90% of all probe trials), and the results were unchanged. Critically, there was no difference in the number of trials on which the probe was immediately fixated, fixated after one additional eye movement, or not fixated at all as a function of task set and/or probe location.

To determine whether SRTs were influenced by probe location and task set we performed a mixed analysis of variance (ANOVA) with probe location as a within subjects factor and task set as a between subjects factor. There was a marginal effect of task-set, $F(3, 44)=2.37$, $p_{rep}=.83$, $\eta_p^2=.14$ but critically, there was a strong interaction between probe location and task-set, $F(9, 132) = 4.17$, $p_{rep} = .99$, $\eta_p^2=.22$. As can be seen in Table 1, and as confirmed by planned comparisons, there was strong evidence of IOR in the search task. Participants were significantly faster to saccade to a probe at a previously unfixated location than to a probe at a 2-back, t(11) = -2.38, p_{rep}=.95 or 4-back location, t(11) = -3.67, p_{rep}=.95. This trend did not continue to the 6-back location, but this is not surprising given evidence that IOR influences only the last five attended/fixated locations in search and search-like tasks (e.g., Snyder & Kingstone, 2000). The magnitude of IOR was larger for the 4-back location relative to the 2-back, but not significantly so.

Although there was strong evidence of IOR in the search task, the reverse pattern of results was observed for the other tasks. Participants were significantly faster to look at a probe at a previously fixated location relative to a previously unfixated location. Planned comparisons revealed that participants were always faster to look at 2-back probes relative to novel probes for all other task sets (all p_{reps}>.90), and faster to look at 4-back probes than novel probes for the pleasantness and free view tasks (all p_{reps}>.90). Only the pleasantness task set elicited faster SRTs to 6-back probes relative to novel probes (p_{rep}=.95).

One concern when interpreting the SRT data for the different task sets is that participants in the search task tended to look over a greater spatial area of the scene than participants in the other three task conditions. Perhaps participants were slower to detect probes in the 2-back and 4-back conditions relative to unfixated condition because the probe appeared further from the present position of their eye when compared with the other task sets. To address this issue, we calculated the average distance between the probe location and the position of the eye when the probe appeared. These data, presented as a function of the average number of visual degrees between eye and probe, can be found in Table 3. A mixed ANOVA on the mean distance values with probe location as a within subjects factor and task set as a between subjects factor elicited an unsurprising main effect of probe location, $F(3, 132)=21.90$, $p_{reps}=.97$, $\eta_p^2=.33$. There were no other significant main effects or interactions ($F(9,132) < 1$ for the critical interaction between probe location and task set). Thus, the distance between probe position and eye location did not vary as a function of task and could not have caused the differences in IOR among task conditions.

Though the SRT data suggest that IOR is search specific, one alternate explanation needs to be ruled out. It has been demonstrated that bottom-up saliency of objects in a scene can influence saccades (Parkhurst, Law, & Niebur, 2002; Peters, Iyer, Itti, & Koch, 2005). It may be that participants were more likely to fixate salient areas during memory/pleasantness-rating/free-view relative to search, which would mean that probes at previously fixated locations would be more likely to appear at salient locations in these tasks. To examine this possibility, we used Saliency Toolbox 2.0 (Walther & Koch, 2006) to determine the most salient regions in each of our scenes. Then, for all probes in all conditions, we calculated the saliency of probe location as well as the proportion of trials on which the probe appeared in a salient region. A mixed ANOVA was conducted on the average probe saliency values with probe location as a between-subjects factor and task set as a within-subjects factor. There was a main effect of probe location, $F(3,132)=2.85$, all $p_{rep}=.93$, $\eta_p^2=.06$, as average probe saliency was greater at the 6-back location relative to all other locations (consistent with salient locations being fixated earlier than non-salient locations, Parkhurst et al., 2002; all $p_{reps}>.95$) but average saliency did not differ between the other three locations. Critically, the interaction between probe location and task set was not significant, $F(9,132)=1.23$, $p_{rep}=.65$. An analogous ANOVA was also performed on the proportion data to determine whether probes were more likely to occur in salient regions as a function of probe location and task set but no significant main effects or interactions were observed (all $Fs<1$), ruling out saliency as an influence on our SRTs. Consequently, the SRT results are clear: IOR was observed for the search task but was not observed for any of the non-search tasks. Moreover, for the non-search tasks, there was actually an advantage for probes at previously fixated locations compared with unfixated locations, a *facilitation of return* effect that is the reverse of what would be expected if IOR was a general characteristic of visual behavior.

Fixation and Refixation data: A careful examination of Table 2 reveals differences in both the number of fixations, the number of refixations, and the amount of time between refixations, as a function of task set. One-way ANOVAs on the number of fixations, refixations, and time between refixations as a function of task set confirmed an influence of task-set ($F(3,44)=9.6$, $p_{rep}=.98$, $F(3,44)=7.44$, $p_{rep}=.96$, and $F(3,44)=5.767$, $p_{rep}=.95$ for fixations, refixations, and time between refixations, respectively), with planned comparisons demonstrating that participants made more fixations during search than any of the other conditions (all $p_{reps}>.95$), fewer refixations during search than any of the other conditions (all $p_{reps}>.95$), and took more time between refixations during search than any of the other conditions (all $p_{reps}>.95$). Interestingly, participants took, on average, three seconds between refixations in the search condition, which is also the typically observed temporal limit of IOR (though see Dodd & Pratt, 2007; Tipper, Grison, & Kessler, 2003, and Wilson, Castel, & Pratt, 2007 for evidence of a longer lasting inhibitory effect). Consistent with the probe SRT data, participants were less likely to refixate objects in the search task than in the non-search tasks, suggesting that inhibition of return observed during search does not necessarily extend to non-search tasks.

General Discussion

The purpose of this study was to determine whether IOR is observed across a range of visual tasks or is limited to visual search, in which a bias toward new objects is beneficial. Inhibition of return is often thought of as a general characteristic of visual behavior despite little to no systematic investigation of this issue. In the present experiment we examined whether there would be evidence that IOR influenced not just search, but also memorization, pleasantness rating, and free-view tasks. Surprisingly, while there was ample evidence that IOR influenced search, we observed the opposite pattern of results for all other task sets: individuals were much faster to look at previously fixated locations when doing anything other than search. Previously, researchers have used the term "facilitation of return" to describe a speeded response to make a color or orientation discrimination at a previously attended location and while that finding is different from the one described here, the spirit is quite similar (e.g. Okubo, Mugishima, & Misawa, 2005; Pratt & Castel, 2001; Tanaka & Shimojo, 1996). Moreover, Smith and Henderson (2007, in press) have recently revived the term "facilitation of return" in a series of studies investigating IOR and scene perception, reaching similar conclusions to those outlined in the present study. The influence of IOR seems task dependent which may suggest that IOR is simply a search-dependent strategy and nothing more. When task performance benefits from a bias toward new objects, as in visual search, IOR is observed. Presumably, IOR would be observed in non-search tasks as well if task performance depended on avoiding previously examined objects and locations (e.g., counting the number of objects present). In contrast, in tasks that do not depend on a novelty bias, IOR is reversed. These data suggest that the prioritization of previously attended objects is much more flexible than has typically been assumed. Moreover, this would lead to the suggestion that facilitation of return, and not inhibition of return, is actually the default setting of the visual system, with IOR representing an exception implemented during search. Further research across a more broad array of tasks will be required if we are to draw firm conclusions on this issue.

The immediate question then is why individuals are faster to return to previously fixated locations when they are doing non-search activities. As previously mentioned, IOR could positively influence memorization and/or pleasantness rating if an increase in the number of areas fixated/sampled leads to a more complete memory representation or better sense of whether a scene is "pleasant." Instead, the bias to return to previously attended objects could reflect a number of operations. When trying to create a memory representation or determining whether a scene is pleasurable, it could be helpful to return to already viewed locations to 1) determine the spatial relation between items, 2) establish how each item fits into the larger context, or 3) ensure that initial perceptions and reactions are consistent with overall scene content. It is less clear, however, why participants were also faster to return to previously fixated locations during the free-view task. Previously, Hooge, Over, van Wezel, and Frens (2005) provided evidence that IOR occurs during search and free viewing, however, they used a different measure of IOR and only analyzed each eye movement as it related to the movement that preceded it. We feel that our multiple dependent measures provide the most complete possible picture of how IOR does or does not influence scene viewing as a function of task set.

Another possible reason as to why we do not observe IOR in free-view tasks is that individual participants differ in their approach to free viewing. When given no specific instruction, participants may decide to impose their own task set on the task and it is plausible that some participants simply decided, coincidentally, to take the approach of memorizing or rating each picture. We did ask participants during debriefing how they approached the free-view task but most participants found this difficult to characterize.

That people are generally faster to return to previously fixated locations in non-search tasks would seem to be strong evidence that IOR represents a search specific strategy. Clearly there is an advantage when searching to continually visit novel locations but in other tasks where the usefulness of this strategy is less transparent, IOR is not observed. Collectively, these findings shed considerable light on IOR and visual behavior in general, as IOR is clearly not a general characteristic of visual behavior and that generally, we are faster to return to previously attended/fixated locations in most other situations.

References

Danziger, S., Kingstone, A., & Snyder, J. J. (1998). Inhibition of return to successively stimulated locations in a sequential visual search paradigm. *Journal of Experimental Psychology: Human Perception & Performance*, *24*, 1467-1475.

Dodd, M. D., Castel, A. D., & Pratt, J. (2003). Inhibition of return with rapid serial shifts of attention: Implications for memory and visual search. *Perception & Psychophysics, 65,* 1126-1135.

Dodd, M. D., & Pratt, J. (2007). Rapid onset and long-term Inhibition of return in the multiple cue paradigm. *Psychological Research*, *71*, 576-582.

Gilchrist, I. D., & Harvey, M. (2000). Refixation frequency and memory mechanisms in visual search. *Current Biology*, *10*, 1209-1212.

Henderson, J. M., Weeks, P. A. Jr., & Hollingworth, A. (1999). The effects of semantic consistency on eye movements during complex scene viewing. *Journal of Experimental Psychology: Human Perception and Performance, 25*, 210-228.

Hollingworth, A. (2007). Object-position binding in visual memory for natural scenes and object arrays. *Journal of Experimental Psychology: Human Perception and Performance, 33*, 31-47.

Hooge, I. Th.C., Over, E. A. B., van Wezel, R. J. A., & Frens, M. A. (2005). Inhibition of return is not a foraging facilitator in saccadic search and free viewing. *Vision Research*, *45,* 1901-1908.

Horowitz, T. S., & Wolfe, J. M. (1998). Visual search has no memory. *Nature*, *394,* 575-577.

Horowitz, T. S., & Wolfe, J. M. (2001). Search for multiple targets: Remember the targets, forget the search. *Perception & Psychophysics*, *63*, 272-285.

Horowitz, T. S., & Wolfe, J. M. (2003). Memory for rejected distractors in visual search? *Visual Cognition*, *10*, 257-298.

Klein, R. (1988). Inhibitory tagging system facilitates visual search. *Nature, 334*, 430-431.

Klein, R. M., & MacInnes, W. J. (1999). Inhibition of return is a foraging facilitator in visual search. *Psychological Science*, *10*, 346-352.

Müller, H. J., & von Mühlenen, A. (2000). Probing distractor inhibition in visual search: Inhibition of return. *Journal of Experimental Psychology: Human Perception & Performance*, 26, 1591-1605.

Okubo, M., Mugishsima, Y., & Misawa, G. (2005). Facilitation of return in voluntary orienting to visual attributes. *Japanese Psychological Research*, *47*, 271-279.

Posner, M. I., & Cohen, Y. (1984). Components of visual orienting. In H. Bouma & D. G. Bouwhuis (Eds.), *Attention and performance X: Control of language processes* (pp. 531-556). Hillsdale, NJ: Erlbaum.

Parkhurst, D., Law, K., & Niebur, E. (2002). Modeling the role of salience in the allocation of overt visual attention. *Vision Research*, *42*, 107–123.

Peters, R. J., Iyer, A., Itti, L., & Koch, C. (2005). Components of bottom-up gaze allocation in natural images. *Vision Research*, *45*, 2397-2416.

Pratt, J., & Castel, A. D. (2001). Responding to feature or location: A re-examination of inhibition of return and facilitation of return. *Vision Research, 41,* 3903-3908.

Smith, T. J. & Henderson, J. M. (2007) Facilitation of Return. *Rank Prize Funds Mini-Symposium on Representations of the Visual World in the Brain*, Grasmere, UK. 3-6th December, 2007.

Smith, T. J., & Henderson, J. M. (in press). Facilitation of return during scene viewing. *Visual Cognition*.

Snyder, J. J., & Kingstone, A. (2000). Inhibition of return and visual search: How many separate loci are inhibited? *Perception & Psychophysics, 62*, 452-458.

Takeda, Y., & Yagi, A. (2000). Inhibitory tagging in visual search can be found if search stimuli remain visible. *Perception & Psychophysics*, *62*, 927-934.

Tanaka, Y., & Shimojo, S. (1996). Location vs. feature: Reaction time reveals dissociation between two visual functions. *Vision Research, 36*, 2125-2140.

Tipper, S. P., Weaver, B., & Watson, F. L. (1996). Inhibition of return to successively cued spatial locations: Commentary on Pratt and Abrams (1995). *Journal of Experimental Psychology: Human Perception & Performance, 22*, 1289-1293.

Walther, D., & Koch, C. (1996). Modeling attention to salient proto-objects. *Neural Networks 19*, 1395-1407.

Wilson, D., Castel, A.D., & Pratt, J. (2006). Long-term inhibition of return for spatial locations: Evidence for a memory retrieval account. *Quarterly Journal of Experimental Psychology, 59,* 2136-2148.

Wolfe, J. M., & Pokorny, C. W. (1990). Inhibitory tagging in visual search: A failure to replicate. *Perception & Psychophysics*, *48*, 357-362.

Yarbus, A. (1967). Eye movements during perception of complex objects. In L. Riggs (Ed.), *Eye Movements and Vision*. New York, NY: Plenum Press.

Footnotes

[1] Yarbus (1967) has demonstrated that scanpaths are affected by task set but the influence of task set on IOR has yet to be determined.

[2] We did not use a 1-back probe given the mixed findings regarding 1-back probes in Klein & MacInnes (1999). Moreover, 1-back probes always appear in a location that is 180° in the opposite direction of which the eye just moved, making it unclear whether a slowing is indicative of the IOR mechanism or a slowing in motor activity due to making a return saccade.

Author Notes

This research was partially supported by Killam and Natural Sciences and Engineering Research Council (NSERC) post-doctoral fellowships to M. Dodd. We would like to thank Kristin Divis and Jim Do for assistance in collecting the data and two anonymous reviews for useful comments on an earlier version of the manuscript. Correspondence regarding this manuscript may be sent to Mike Dodd, The University of Nebraska – Lincoln, Department of Psychology, 238 Burnett Hall, Lincoln, NE, USA, 68588. (mdodd2@psych.unl.edu).

Figure Captions

Figure 1: An example of the computer-generated natural scenes that were used as stimuli in the present study.

Figure 1

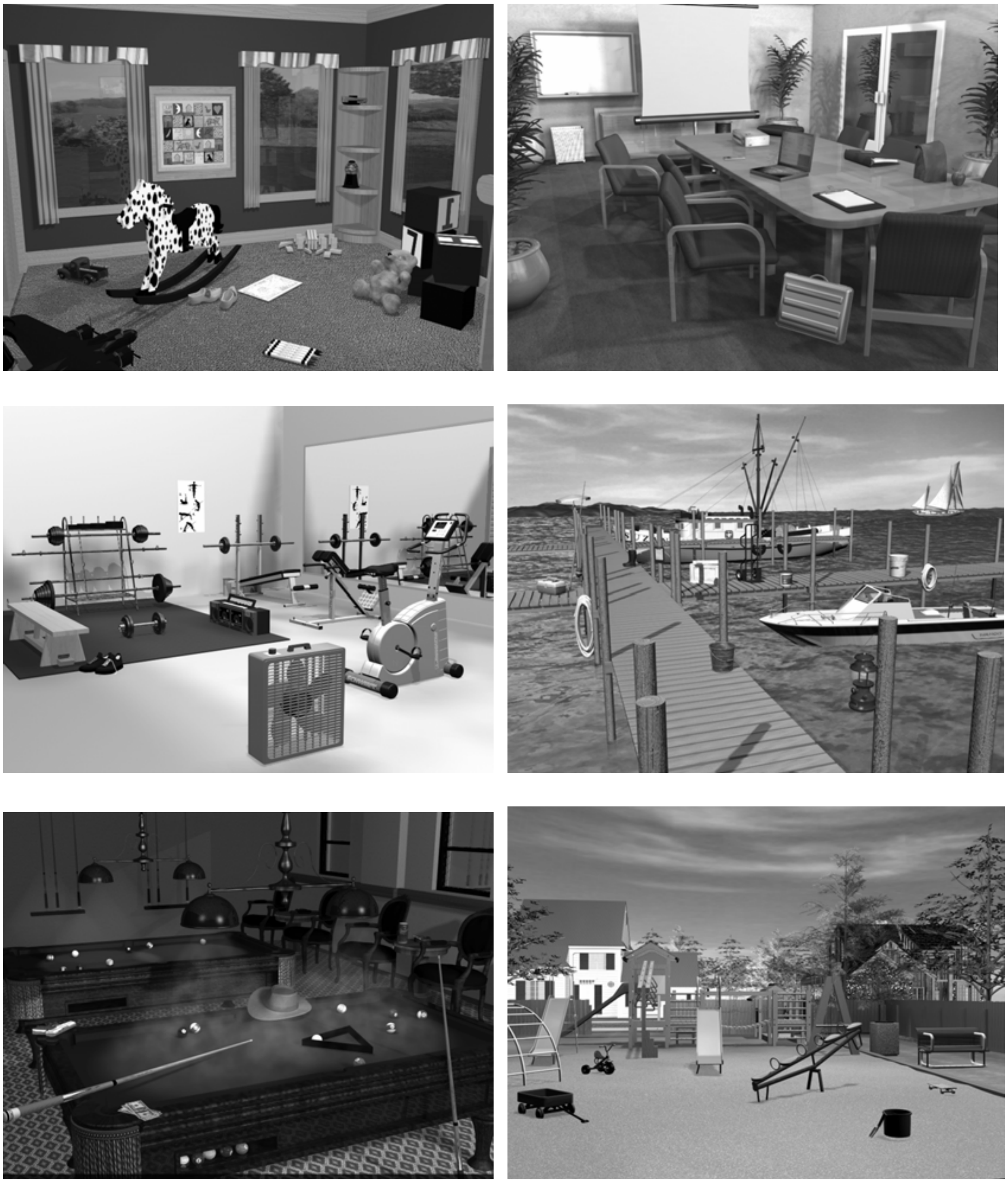

Table 1:

Saccadic RTs (in ms) and standard deviations (in brackets next to each RT) to probes as a function of probe location (novel, 2-back, 4-back, 6-back) and task set (search, memorization, pleasantness rating, free view) as well as the magnitude of inhibition of return (determined by subtracting SRT to detect targets at previously fixated locations from SRT to detect probes at novel locations)—negative values are indicative of IOR whereas positive values are indicative of facilitation in returning to previously fixated locations.

	Probe Location			
	Novel	**2-back**	**4-back**	**6-back**
Task				
Search	254 (45)	324 (64)	336 (60)	256 (60)
IOR		-70	-82	0
Memory	293 (50)	261 (78)	280 (84)	289 (56)
IOR		32	13	4
Pleasantness	291 (34)	231 (32)	231 (44)	223 (49)
IOR		60	60	68
Free View	292 (64)	249 (38)	260 (44)	296 (69)
IOR		43	32	-4

Table 2:

Mean number of fixations per scene, mean number of refixations per scene, and mean amount of time between refixations (in ms) as a function of task set (search, memorization, pleasantness rating, free view). Standard deviations for each value are presented in brackets

Task	Fixations	Refixations	Time between refixations
Search *IOR*	26.82 (2.5)	3.37 (.6)	2973 (403)
Memory *IOR*	23.53 (3.23)	4.57 (1.2)	2552 (156)
Pleasantness *IOR*	23.66 (2.3)	5.57 (1.6)	2766 (282)
Free View *IOR*	20.92 (2.7)	4.22 (.98)	2584 (219)

Table 3:

Mean distance (in visual degrees) of the eye from the probe at the exact moment that the probe appears as a function of probe location (novel, 2-back, 4-back, 6-back) and task set (search, memorization, pleasantness rating, free view). Standard deviations appear in brackets next to each mean value.

	Probe Location			
	Novel	**2-back**	**4-back**	**6-back**
Task				
Search	8.50 (1.2)	6.42 (1.9)	7.73 (2.7)	8.61 (2.0)
IOR				
Memory	8.64 (.75)	5.93 (1.7)	7.85 (1.0)	8.53 (1.9)
IOR				
Pleasantness	8.21 (1.0)	4.80 (2.0)	7.17 (2.5)	7.56 (3.4)
IOR				
Free View	8.95 (1.1)	6.74 (2.4)	8.31 (1.9)	8.98 (2.5)
IOR				