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Competing Action Memories Can Produce the Appearance of Memory-Free Visual Search

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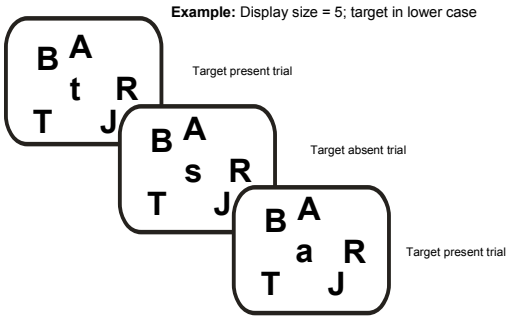
Abstract

The role of memory in visual search is under debate. Wolfe et al. reported that RTs to confirm the presence of a target increased with the number of display items even when search displays were repeated multiple times. They took these results to indicate that subjects continued to search through repeated displays as if they had no memory for the display items. In contrast, Chun et al. showed that with repeated presentation, subjects moved their attention to the target location more quickly. These "contextual cueing" effects suggested that memory plays a role in visual search. We hypothesized that competing action memories might produce the appearance of memory-free search in the Wolfe et al. paradigm, as follows. Suppose subjects move their attention to the target location before they affirm its presence; a display with multiple repeated targets will have multiple associated action memories. To move attention to the location of one target, competition among these memories must be resolved. Competing action memories might increase resolution time, thereby producing Wolfe et al.'s pattern of results. By this account search time should vary with the number of probed targets in repeated displays rather than with the number of display items, factors that were confounded in the original design. Like Wolfe et al. we repeated search displays containing 2, 3, 5, or 8 items multiple times by block. In each block, every display item was probed an equal number of times (display size condition). We also included a condition in which 8 items were always displayed, but only 2, 3, or 5 items were probed by block (relevant size condition). (There was also a set of target absent trials in each condition). When the number of probed targets varied from 2 to 5, search slopes were equivalent (34 ms) in the display size and the relevant size conditions consistent with the competing action memories account.

Wolfe and Colleagues



When the same visual displays remain in view and all items in the display are probed equally often (for target present), target present RTs increase as display size increases (2, 3, 5, or 8; e.g. Wolfe, Klempen, & Dahlen, 2000).

After repeated exposure, no visual display is present at test, RTs are independent of display size, showing that Ss remember which items were present in the display (Oliva, Wolfe, & Arsenio, 2004).

Wolfe et al.'s Interpretation:

Ss search among all display items to find the targ memory-free search.

Question: Why does search appear to be memory-free when the display is present?

Alternative Perception-Action Interpretation:

1. With display present, Ss move their attention to the target to verify its presence.
2. Memory for the display includes memory for the actions taken with respect to it.
3. RTs in the search task are determined by **both** memory for:
   * display items
   * actions taken
4. On a present trial one action must be chosen from among competing action memories. The time to choose increases with the number of competing memories.

Wolfe et al paradigm:

Each item in each set size display was probed equally often

Equally strong action memories for each location.

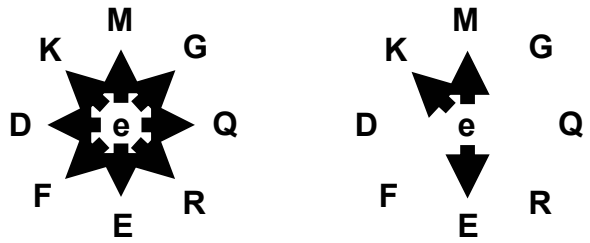
No single action was privileged. RTs cannot reveal evidence of action memories independent of set size.

Chun and Colleagues

When a target is found in the same location repeatedly in a given display context, RTs to find that target decrease (e.g. Chun & Jiang, 1998). This is consistent with the idea that action memories affect performance (although these results could be location memory only).

Experiment

Are RTs determined by the number of items in the display or by the number of action memories?



Manipulate the number of action memories independently of display size:
keep set size constant
manipulate the number of repeatedly probed items.

Conditions

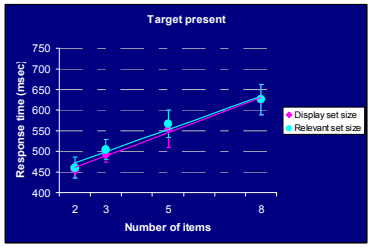
Display Size Condition (Replication of Wolfe et al; set size = number of repeated targets):

* 2, 3, 5, and 8 items – different displays; blocked (160 trials).
* Same display containing the same targets always present during a block.

Relevant Set Condition (set size & number of repeated targets independent):

* All displays 8 items.
* In different blocks 2, 3, or 5 items were probed.
* Different displays for different blocks.

Results



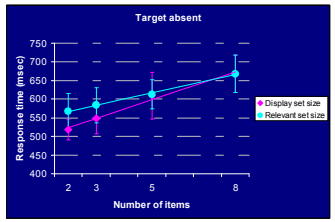
Even though 8 items were always present, RTs the relevant set conditions of 2, 3, and 5 were equal to those in the matched display size condition. Subjects were not searching through the entire display for the target.

Discussio

Results are consistent with the perception-action hypothesis.
A linear relationship between RT and the number of display items need not suggest search through all display items. Competing action memories can produce the same pattern of results.

Remaining Questions

1. Can these results be interpreted as memory free search through the relevant set rather than through the entire set (see Palmer, 1995)?
Identifying the Relevant Set requires a substantial number of trials and therefore, requires memory. Regardless, an experiment is underway to investigate this alternative to the action memories account.



Inconsistent with the Search view are the target absent results, shown to the left. In the Display Size condition RT increased with set size on absent trials. (not in the Relevant Set condition).

The slope was smaller for absent trials (30 ms) than for present trials (34ms), p<.05). A shallower slope is not expected on a search account, where target absent slopes are larger than target present slopes.

2. **Why does RT increase with set size on absent trials?** Perhaps in each set size block subjects waited longer than the longest "present" RTs before responding "absent." (Can test by intermixing trials.)

Reference

Chun, M. M. & Jiang, Y. (1998). Contextual cueing: Implicit learning and memory of visual context. *Cognitive Psychology, 36*, 28- 71.

Oliva, A., Wolfe, J. M. & Arsenio, H. C. (2004). Panoramic Search: The interaction of memory and vision in search through a familiar scene. *Journal of Experimental Psychology: Human Perception and Performance, 30*, 1132-1146.

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Wolfe, J. M., Klempen, N. & Dahlen, K. (2000). Postattentive vision. *Journal of Experimental Psychology: Human Perception and Performance, 26*, 693-716.

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