Desperately seeking memory in visual search

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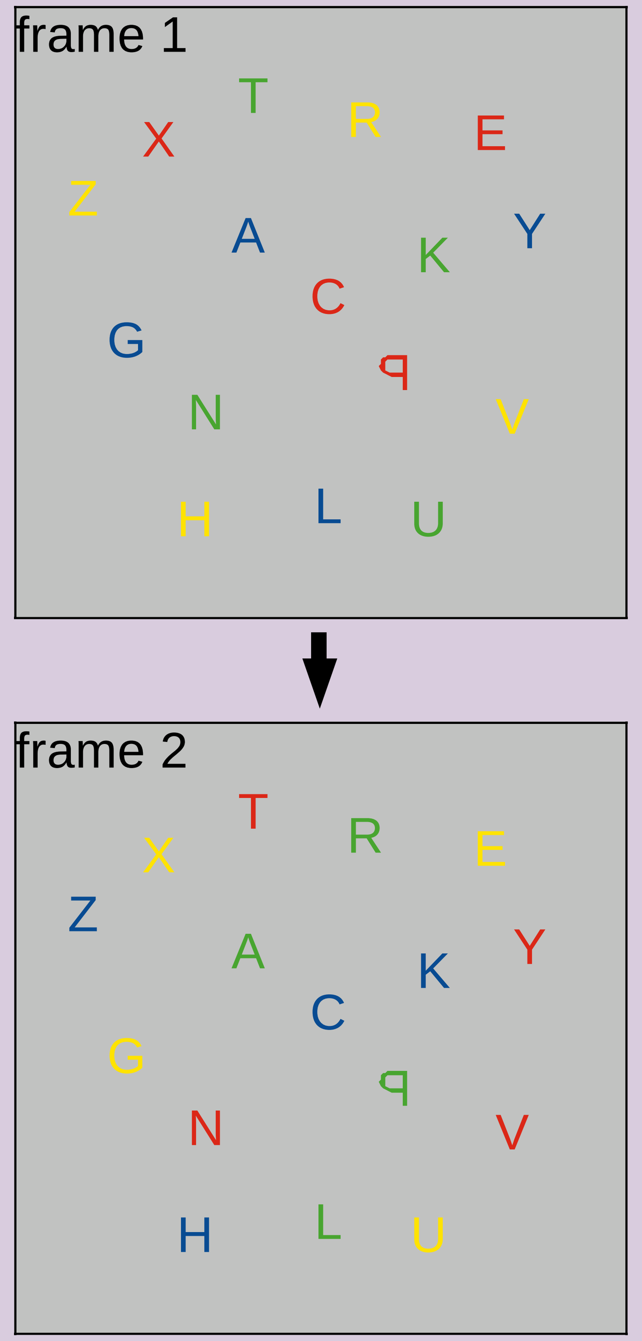
Introduction

A standard assumption of visual search models has been that the visual system avoids devoting resources to non-targets by marking rejected distractors. In several experiments (Horowitz & Wolfe, 1998; in press), we have found no evidence for this sort of memory in visual search. Our conclusions are supported by some (Gibson, et al., 2000; Gilchrist, et al., 2000) and criticized by others (Kristjansson, 2000). Here we used a new paradigm measuring detection time rather than reaction time. Subjects searched for a mirror-reversed S or P, with other letters as distractors. Each letter was randomly red, green, blue, or yellow. At some transition time, all letters changed color. Subjects reported the color of the target when they found it. We measured the probability of finding the target as a function of transition times. The shape of this function tells us whether search is memory-driven, amnesic, or something in between.

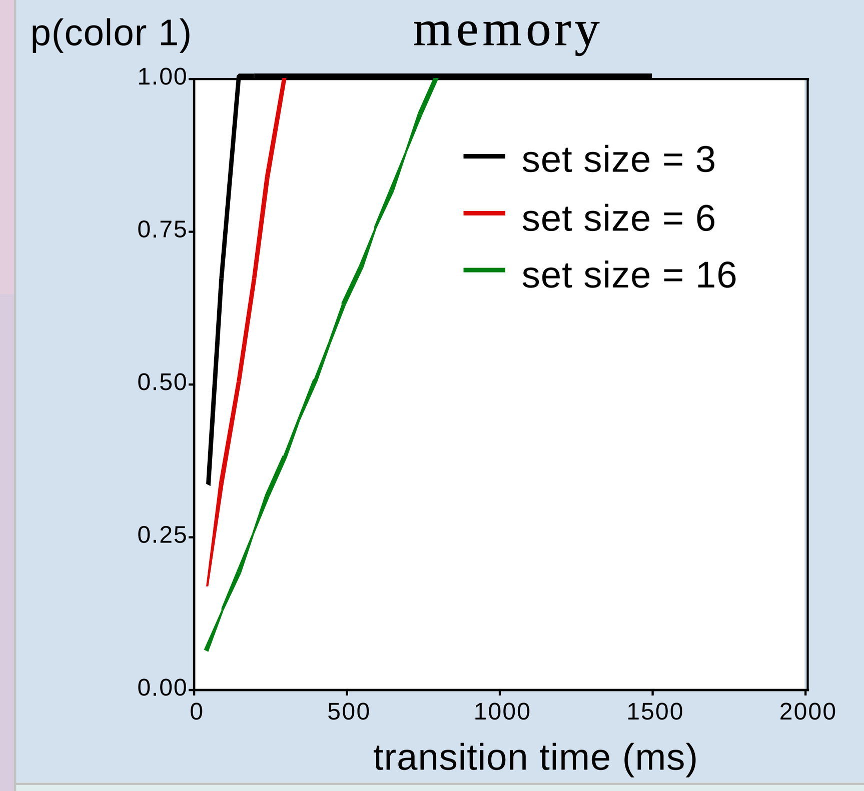
General Method

Stimuli: The target was either a mirror-reversed "P" or a mirror-reversed "S." Distractors were drawn from the rest of the alphabet.
Task: Report the color of the target *when you found it.* Unspeeded 4-choice response.
Procedure: Each trial consisted of two frames, identical except for the color of the letters. Frame 1 was presented until the transition time, at which point it was replaced with frame 2. The range of transition times used was different in each experiment.

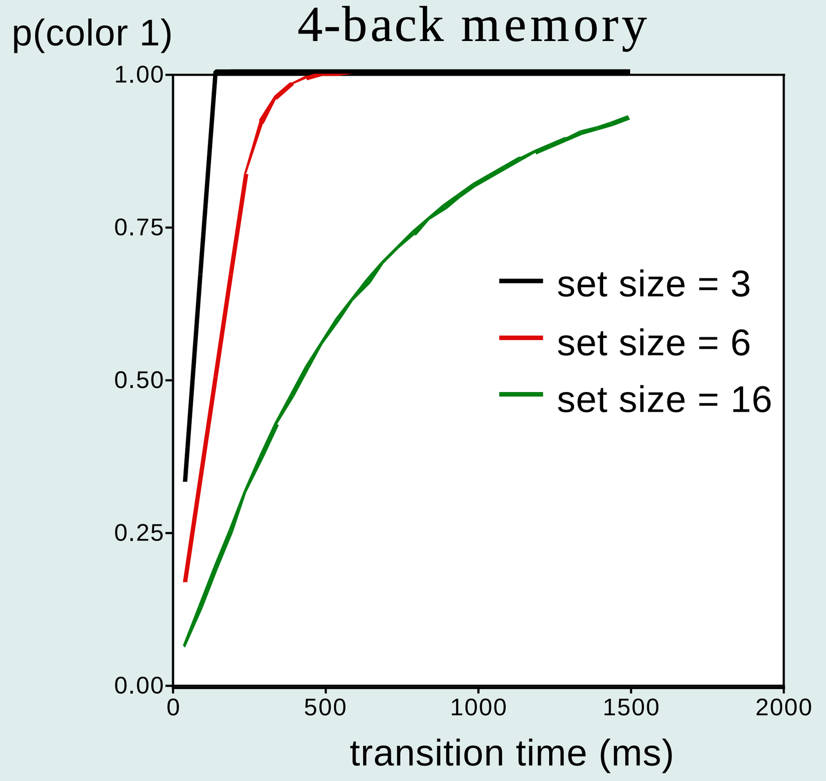


The probability of detecting the target before the transition is computed from the proportion of correct trials (where one of the two target colors was reported correctly) on which subjects reported the color of the target in frame 1 (e.g. red in the example). This probability, *p(color 1)*, is plotted against the transition time.

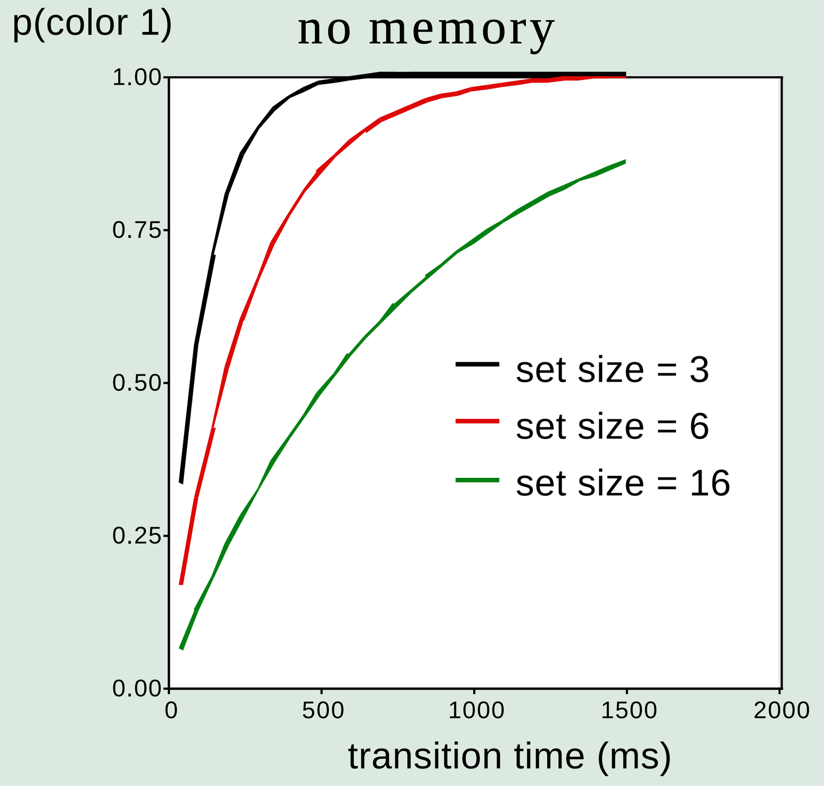
Different models make *qualitatively* different predictions



With full memory (e.g. inhibitory tagging), *p(color 1)* rises linearly to 1.



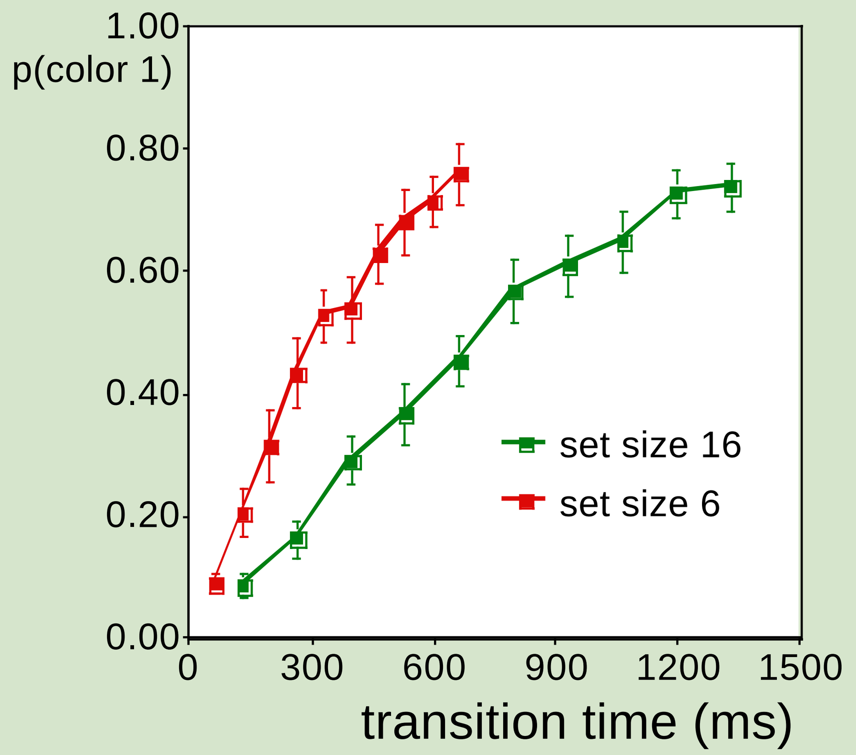
With a limited memory, the function is linear at the beginning, and curvilinear later on. The smaller the set size, the more *linear* the function, because more of the search can be completed before memory runs out.



With no memory, the function is curvilinear. The smaller the set size, the more *curvilinear* the function purely because of the scale

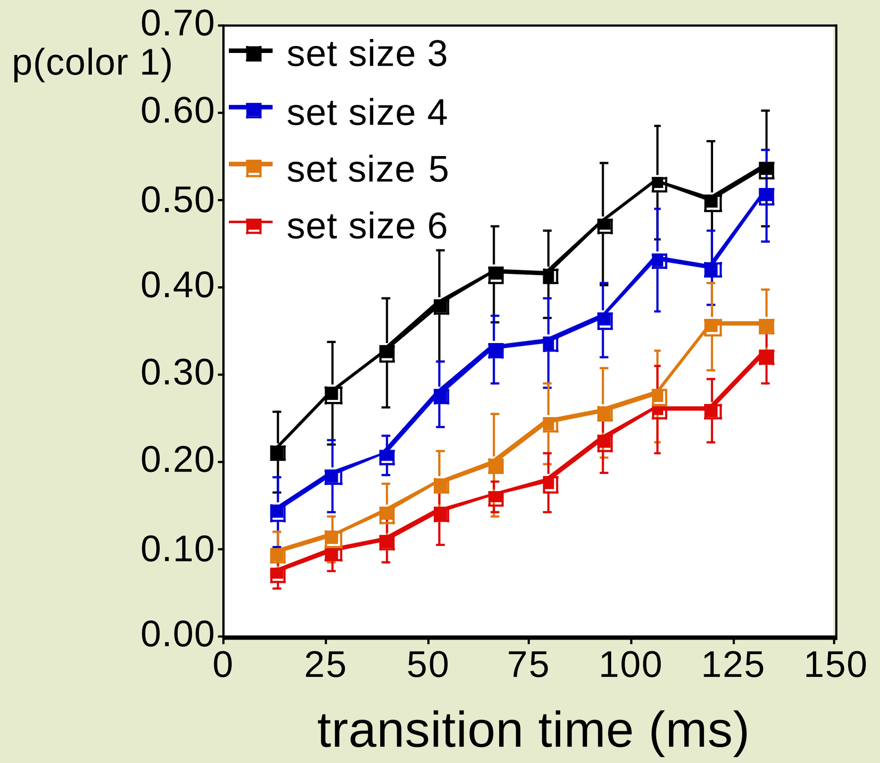
These functions are more curvilinear than linear, rejecting the full memory model.

low resolution data

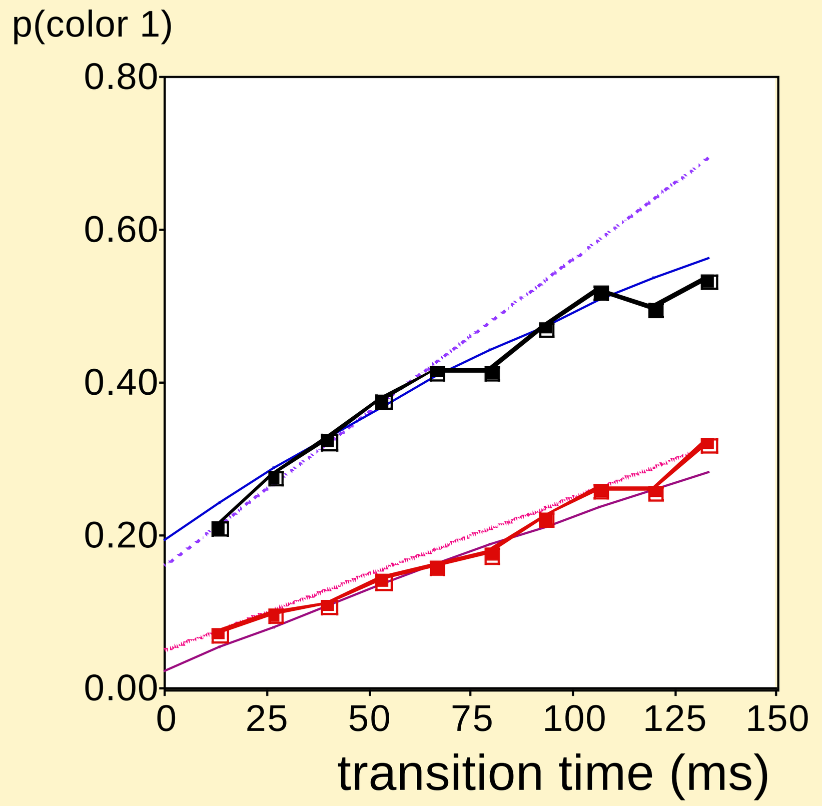


To contrast the limited memory and no memory models, we need to look at the first 150 ms.

high resolution data



The small set sizes are more curvilinear than the large set sizes, rejecting the limited memory model.



The solid lines are fits of a simple exponential fit to the data. The dotted lines are a linear fit to the first 60 ms of data

Note: The line fits on the figure are for didactic purposes only. Fits of an explicit no memory (exponential) model are better than an explicit full memory (linear) model for all functions except for the high-resolution set size 5 and 6 data.

Conclusions

We have developed a new method to measure search times without reaction times.

The qualitative results favor the no memory model.

Quantitative model fits also favor the no memory model.

If there is any memory in visual search, it is well-hidden.

References

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