Pitting Target-Distractor Similarity Against Stimulus-Response Mapping in Visual-Memory Search

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ABSTRACT

The reported experiments pit target-distractor similarity against stimulus-response mapping in an attempt to determine which principle is more critical to the automatization of visual-memory search. In the consistent mapping (CM) condition of the experiments, different sets of stimuli served as targets and as distractors but no single feature allowed to discriminate the two sets. By contrast, a single feature allowed to discriminate the two sets of stimuli used in the other condition of the experiments, (called categorical varied mapping or CVM), but the two sets of stimuli switched roles as targets and distractors. Response times provided evidence of automatization in the CVM condition, but not in the CM condition, even after twice as much practice. Performance on single feature search trials in the CVM condition remained very efficient when such trials were mixed with conjunction search trials. Overall, results show a greater influence of similarity than mapping on visual-memory search.

INTRODUCTION

Shiffrin and Schneider's **Automatic Attention Attraction theory** predicts that practice in a consistent mapping condition will lead to automatized processing of memory and display items, resulting in shallow or null visual and memory search slopes. By contrast, the theory predicts that a varied mapping or a categorical varied mapping condition will result in steep search slopes, irrespective of the amount of practice.

*Consistent mapping (**CM**): The stimuli are divided in two sets. The targets are always taken from one set and the distractors from the other.

*Categorical varied mapping (**CVM**): The stimuli are divided in two sets that switch role. The targets are taken from one set on some trials and from the other set on other trials so that, over trials, the two sets of stimuli serve as targets and distractors.

*Variable mapping (**VM**): The stimuli are not divided into subsets. Targets and distractors are randomly picked among the entire set of stimuli so that each individual stimulus may serve as a target and be associated with a positive response on some trials, while serving as a distractor to be ignored on other trials.

Treisman's **Feature Integration theory** makes predictions about target-distractor similarity. According to this theory, shallow visual search slopes will obtain when search is disjunctive, irrespective of the amount of practice. By contrast, conjunctive search will always produce steep search slopes.

*Disjunctive search: A single feature allows to distinguish the target from the distractors.

*Conjunctive search: A conjunction of two or more features is necessary to distinguish the target from the distractors.

Both theories make predictions about search slopes, but they are based on very different principles: mapping versus similarity. Each of these principles also underlie other theories of automatization. Which of these two principles is the most critical?

METHOD

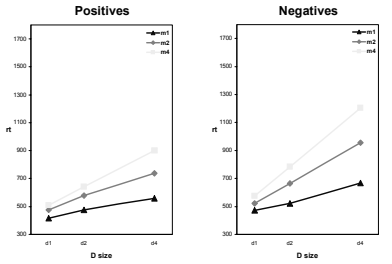
In our experiments, a standard visual-memory search paradigm was used. On each trial, either 1, 2 or 4 potential targets were specified in the memory set. The memory set was followed by a display set containing 1, 2 or 4 stimuli. A single target was present on half the trials, the remaining items on the display serving as distractors

Consistent Mapping condition (*CM*)

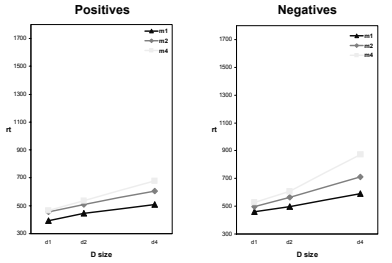
The stimuli were eight lowercase letters, separated into two sets of four. In the CM condition, the sets were assembled so that no simple line segment allowed to distinguish a target from all the possible distractors, making search conjunctive. This required using a special font, especially for the letter y. The two sets of stimuli used in the CM condition are illustrated below.

One group (A) of four participants did five training sessions in the **CM** condition, while another group (B) completed 10 training sessions, each comprising over 500 trials.

Group A
5th training session



Group B
10th training session



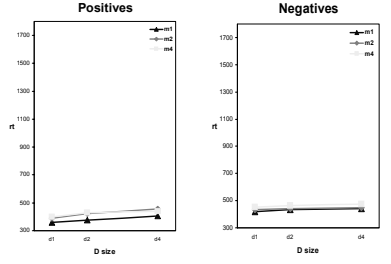
After about 5000 trials of practice under CM conditions, both visual and memory search remain difficult, as shown by the relatively steep memory (M1 to M4) and display (D1 to D4) search slopes. There was also an interaction between memory and display set size.

Categorical Varied Mapping condition (*CVM*)

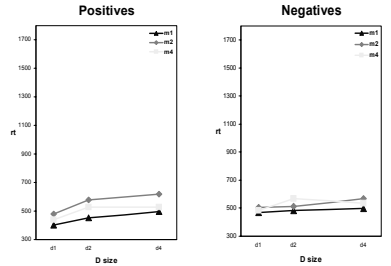
The same letters used in the **CM** condition were assembled into two new sets, so that a single feature (open or closed circle) would allow to distinguish all items of one set from all items of the other set.

One group (C) of four participants did five training sessions, the stimuli from sets 3 and 4 serving equally often as targets and distractors within each session. Another group (D) completed 10 training sessions, the stimuli from sets 1 to 4 serving as targets and distractors. The purpose of mixing sets 1 and 2 (which require conjunctive search) with sets 3 and 4 (which allow disjunctive search) was to make it more difficult for participants to anticipate the type of search involved. The results below are those obtained with the sets that allow disjunctive search.

Group C
5th training session



Group D
10th training session



Visual and memory search slopes are smaller in the CVM condition than the CM condition. Moreover, the effects of memory and display set size are additive. The advantage of the CVM over the CM condition holds even after a smaller amount of practice and when the search task is made more complicated.

Conclusion: Similarity is the critical feature for the automatization of search.