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Visual Search for Features and Conjunctions

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Visual Search for Features and Conjunctions

Overview: How do people find objects in cluttered visual scenes? Think, for example, of looking for keys on a messy desk, finding the ripest looking fruit at the grocery store, locating your car when you can't quite remember where you parked it, or finding an old friend at an airport exit gate. Clearly, an understanding of visual perception is going to play a role in any answers, and more specifically, an understanding of *visual attention* will be crucial. Visual attention refers to the ability to focus in on just part of an image, mustering one's processing resources selectively to determine whether the thing being looked for —the target, in the standard experimental jargon— is present. To study search and attention, experimental psychologists have developed a widely used paradigm known (unsurprisingly) as visual search.

They have also motivated a great deal of research by the intuition that any good theory of search is going to have to explain why some things are easy to find and others are hard to find. So in the context of the visual search paradigm, perceptual psychologists have often focused on contrasting easy searches with more difficult ones. The most influential contrast is between what researchers call a 'Feature Search' and a 'Conjunction Search'.

Procedure

1. Stimulus design

1.1. The experiment is going to include two types of trials. In half of the trials —the Feature Search trials —participants will be asked to find a red bar among blue ones. So render a set of 40 displays, placing the red bar randomly in each, and randomly placing either 3, 6, 9, or 12 blue bars as well. The number of blue bars is the 'distractor load.' There will be equal numbers of trials (10 in this case) for each load.

1.2. The experiment also requires 'target absent' trials, trials that do not include the search target, in this case, the red bar. Make 40 of these as well, again, including 10 for each distractor load. The target present and absent trials, by load, will look something like the examples shown below.

Figure 1

1.3. The other half of the trials will involve Conjunction Search. In this case, observers will search for a **red** bar that is oriented at **-45** degrees (in other words, that is tilted to the left, instead of to the right). Again, distractor load will vary, including 3,6,9, or 12. But in this case, the distractors will come in two types: **blue bars at a -45** degree angle, and **red bars at a +45** degree angle (i.e. tilted to the right). Each trial will include both kinds of distractors, and again, there will be target absent trials as well. The trials will look something like this:

Figure 2

2. Procedure

2.1 Run the Feature Search and Conjunction Search trials in separate blocks. Some participants will do Feature first, and the others will do Conjunction first. But the basic procedure is the same for both types of trials.

2.2 To sequence the experiment, randomly interleave present/absent trials and distractor loads, so that the experiment will comprise a sequence of unpredictable trials.

2.3 On each trial, one of the trial displays appears and remains present until the participant indicates whether a target is present or absent in that trial. Assign one key, the ‘M’ key to present responses, and the ‘Z’ key to absent responses.

2.4 The participant’s task is to respond as quickly as possible, but without making mistakes.

2.5 Using an experimental software package, such as ePrime, or a programming environment such as MATLAB, record the participant’s response on each trial, along with their response time. This way, you can check that the participant answered correctly, and also see how long they took.

3. Analysis

3.1 At the end of the experiment, the data should be output as a spreadsheet describing whether the participant answered correctly, their response time, and the parameters of each trial —was it a present or an absent trial, in the Feature or Conjunction search block, and with how many distractors.

3.2 Average together the participant’s response times in all the target *present* trials, as a function of condition (Feature vs. Conjunction), and distractor load.

3.3 Note that the results of the target absent trials don’t get analyzed. Those are there because, otherwise, the participant could simply hit ‘present’ on each trial without ever finding the target. Look at overall performance though, to make sure the participant was paying attention and trying their best. Generally, if a participant is less than 75% correct on absent trials, their response time data is not analyzed.

3.3 The main analytical questions concern differences in response time between conjunction and feature search trials. Response times should become considerably longer for conjunction search trials as distractor load increases. But they should be relatively unaffected in feature search trials.

Representative Result

When the results are graphed, they will look something like this:

Figure 3

Note that response times in Feature Search trials are relatively unaffected by distractor load. In contrast, Conjunction Search response times increase linearly. In fact, the slope of that function describes the amount of extra search time it takes, on average, for each additional distractor in the scene. In this case, it looks like about 50ms per item. Similarly, both searches take about 200 ms with only 3 distractors present. This suggests that a uniform amount of time is necessary to get a search going and make a response.

Applications

The difference between Feature and Conjunction search shows how one of the challenges faced by the human visual system involves putting different kinds of information together. Finding a red bar among all blue ones is easy —it pops out— because only one kind of information is relevant: color. But finding something that is defined by multiple different kinds of features —in this case, orientation and color— needs focused attention to help bind those features together.

In the real world, understanding how search works has many important applications. For example, major research programs are currently applying an understanding of visual search in the laboratory to understand and improve how doctors search for certain telltale signatures when they look at an x-ray or MRI scan. Similar research programs look at how TSA personnel search through scans of passenger baggage at the airport (**Figure 4)**, and even how athletes locate their teammates on a field.

Legend:

Figure 1 — Sample displays for pop-out visual search. Top row shows trials with a target present, a single red bar. The bottom row shows trials without a target, 'target absent.' The number of non-targets (distractors) increases from left to right.

Figure 2 — Sample displays for conjunction visual search. Top row shows trials with a target present, a red bar oriented to the left. The bottom row shows trials without a target, 'target absent.' The number of non-targets (distractors) increases from left to right.

Figure 3 – Response times as a function of distractor load in target present trials, both feature search (green) and conjunction search (yellow) shown.

Figure 4- Woman's handbag under X-ray

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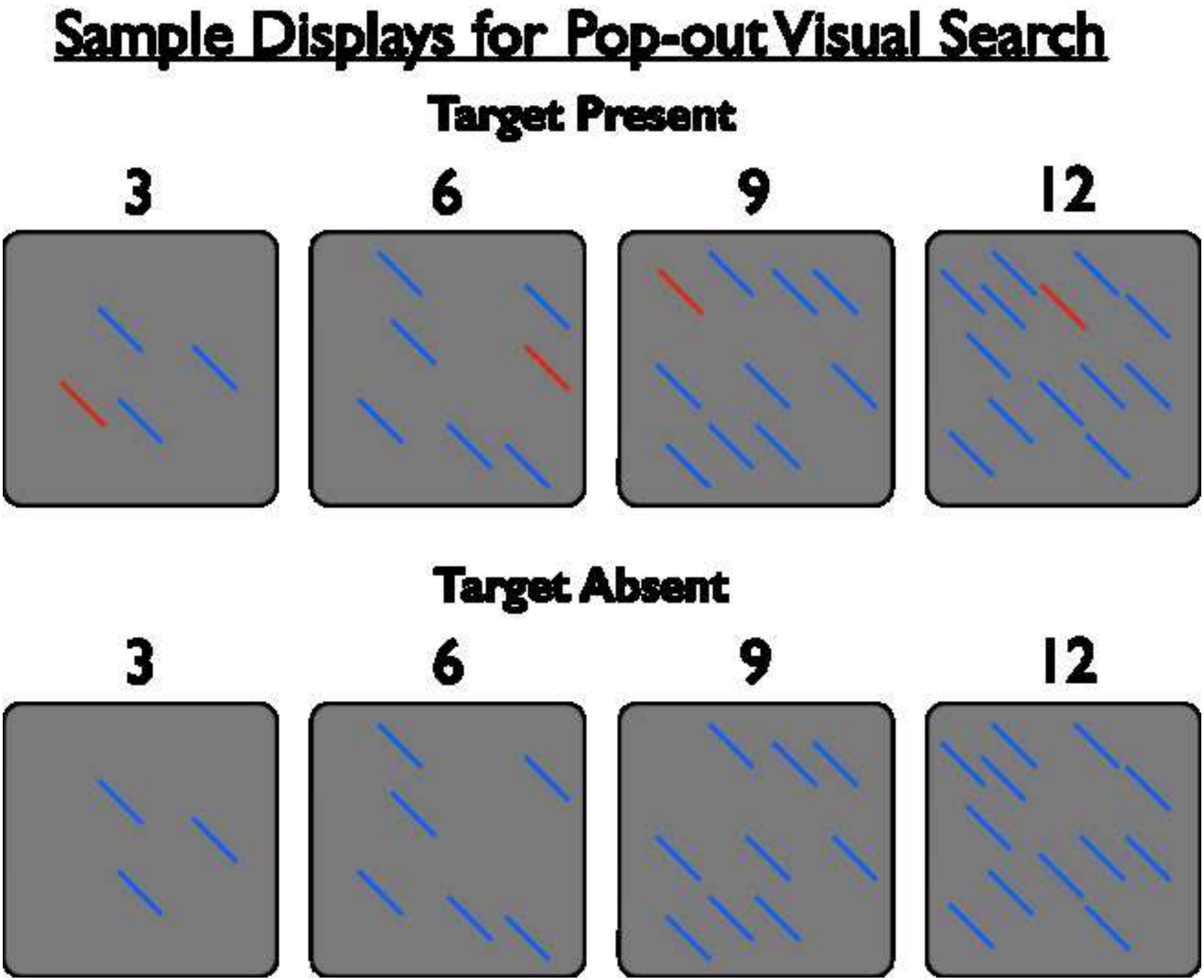
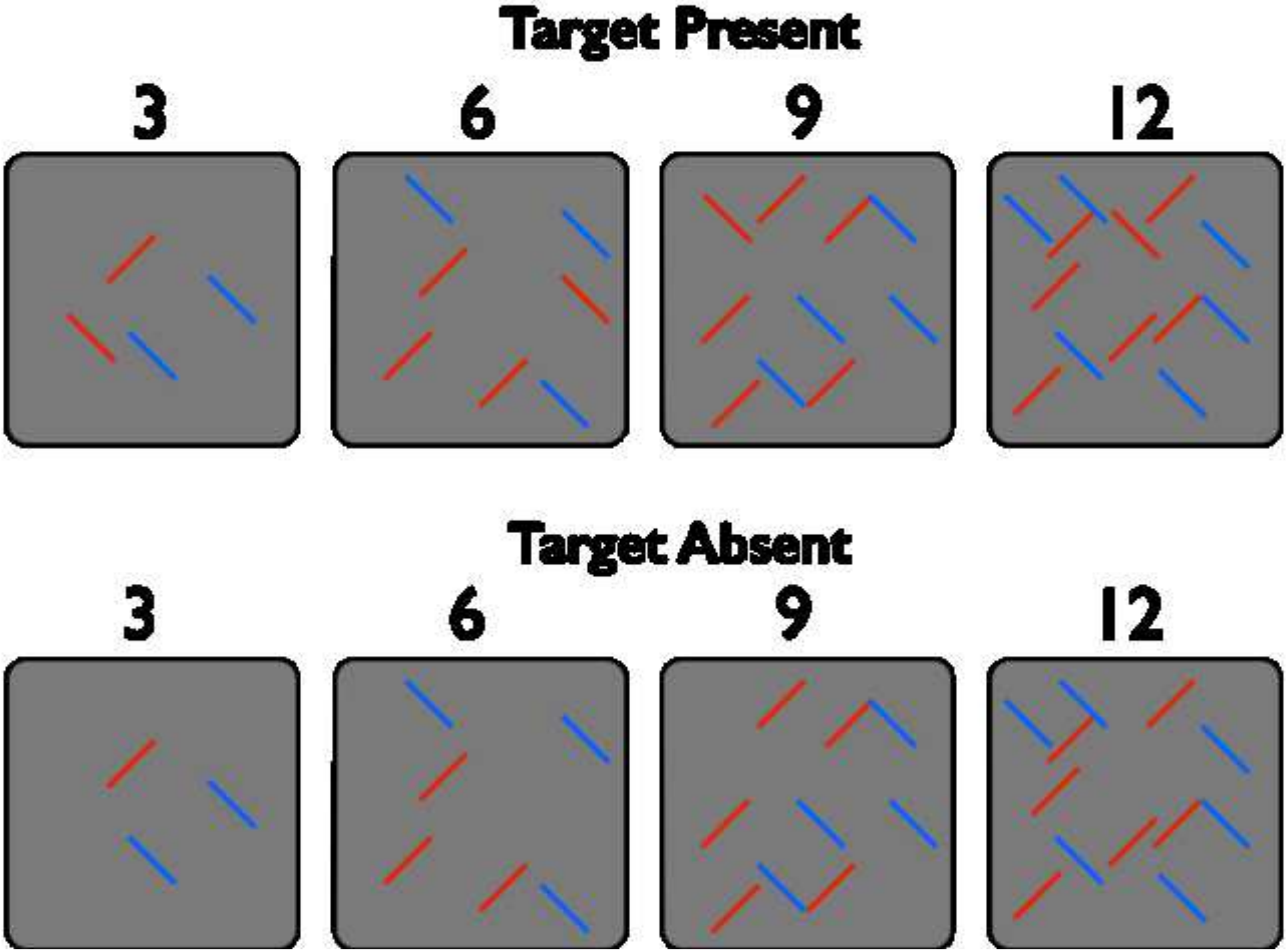


Sample Displays for Conjunction Visual Search



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