

Found Targets are Powerful Distractors in Multiple-Target Search

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Question

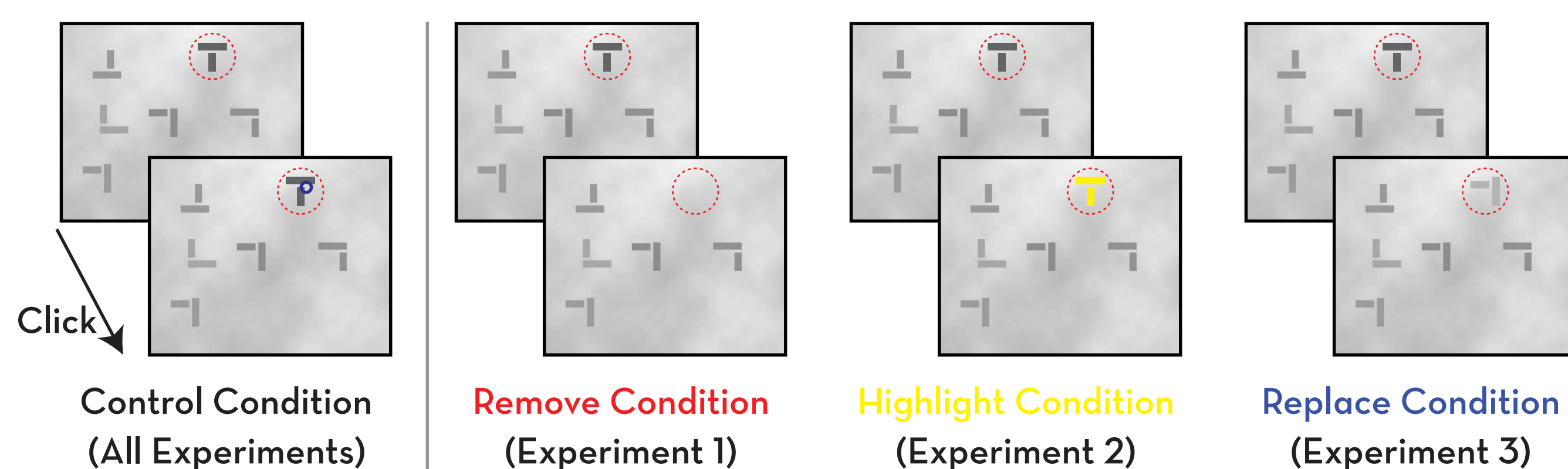
How does finding one target in a multiple-target visual search affect subsequent search?

Multiple-Target Visual Search

- A target in a visual search is less likely to be found when presented with another target than when presented alone (e.g., Berbaum, et al., 2010)
 - These misses are a frequent source of errors in multiple-target search (e.g., Tuddenheim, 1962; Smith, 1967; Fleck, Samei, & Mitroff, 2010)
- A key difference between multiple-target and single-target search is the existence of a found target
- Current goal: Contrast two competing theories of the role of the found target
 - **Perceptual Salience:** The found target has all the perceptual features of a target and leads to bottom-up attention capture
 - **Resource Depletion:** The found target (and/or its location) is stored in working memory, reducing the cognitive resources available for subsequent search

General Methods

- Participants searched for target 'T's among distractor 'L's
- Items were high-salience (dark) or low-salience (light)
- 0, 1, or 2 targets per trial
- Critical Comparison: Low-salience target accuracy on dual-target trials in which the high-salience target was correctly found first
- 15-second time limit
- Searchers clicked on targets then clicked a button labeled 'Done'
- Searchers completed the Control Condition & an experimental condition:
 - **Control for all Expt's:** Clicks are marked with a small blue circle
 - **Remove:** Clicked items disappeared
 - **Highlight:** Clicked items turned yellow
 - **Replace:** Clicked items replaced with a random, low-salience distractor

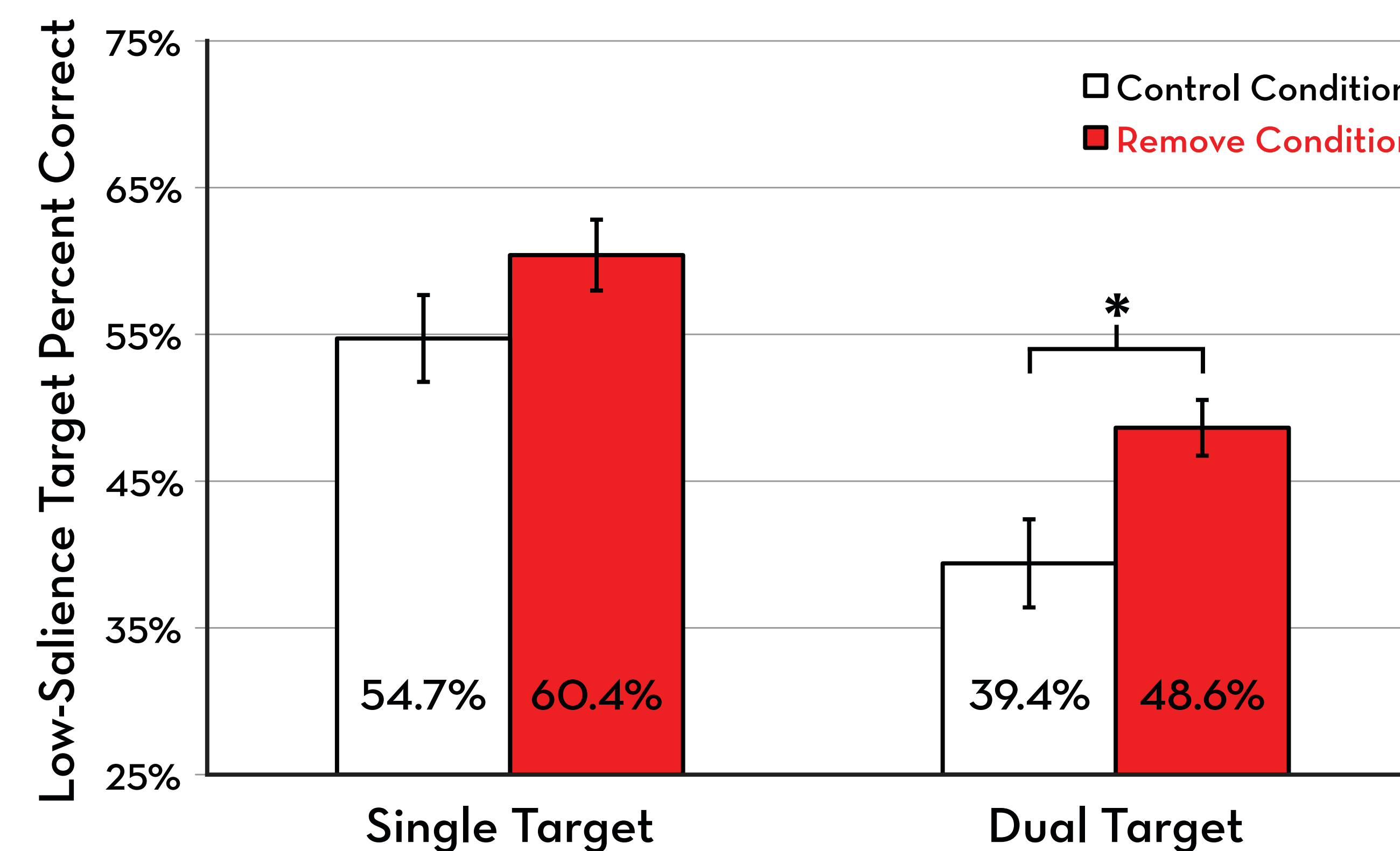


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- This study is approved for public release

Expt. 1—Target Removal

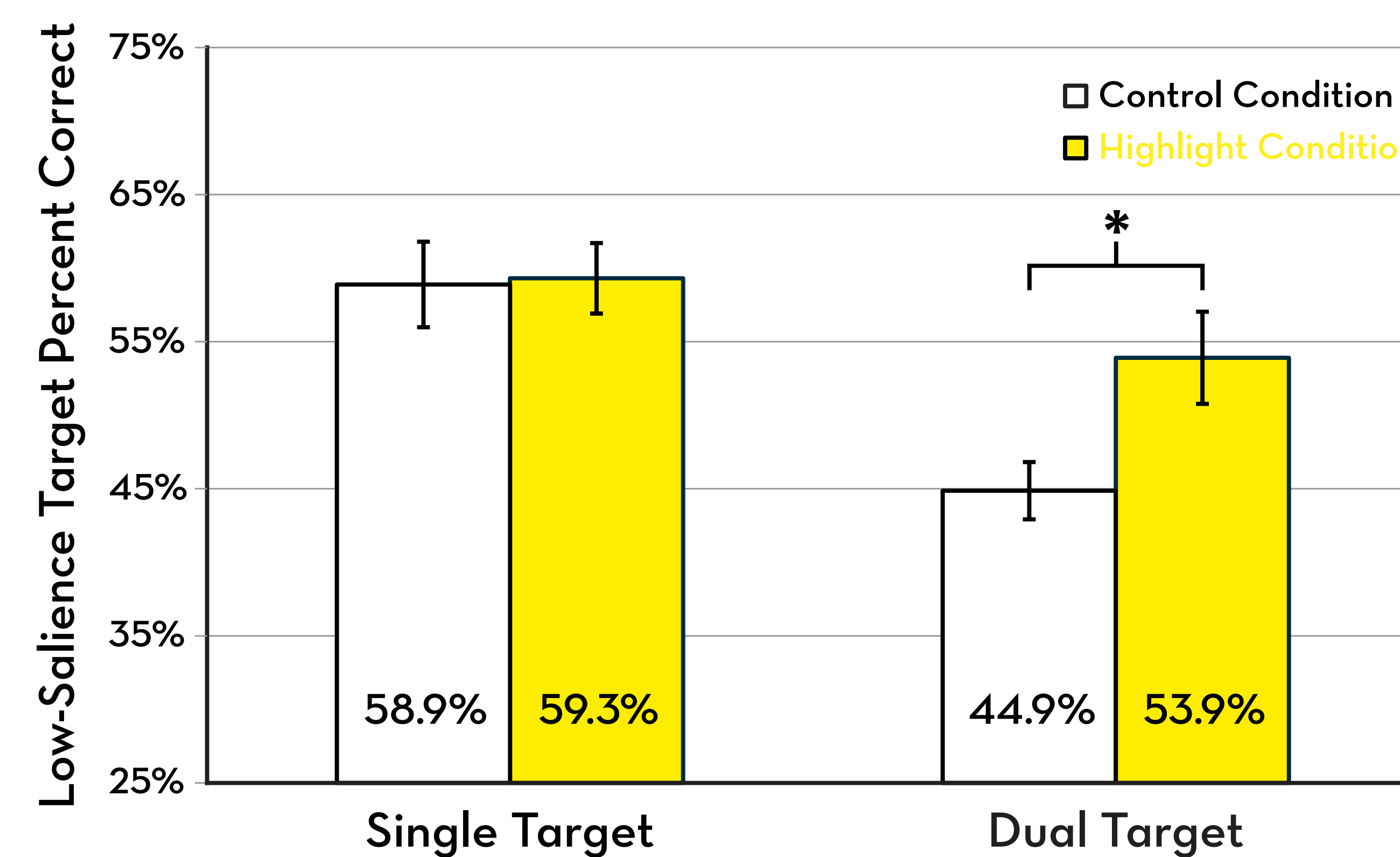
- Items disappeared when clicked
- Removing the first found target led to *improved accuracy* for finding second targets



- Results are consistent with both hypotheses:
 - **Perceptual Salience:** The found target is no longer available to perceptually capture attention
 - **Resource Depletion:** The location & identity of the found target does not have to be remembered to prevent re-searching it

Expt. 2—Target Highlighting

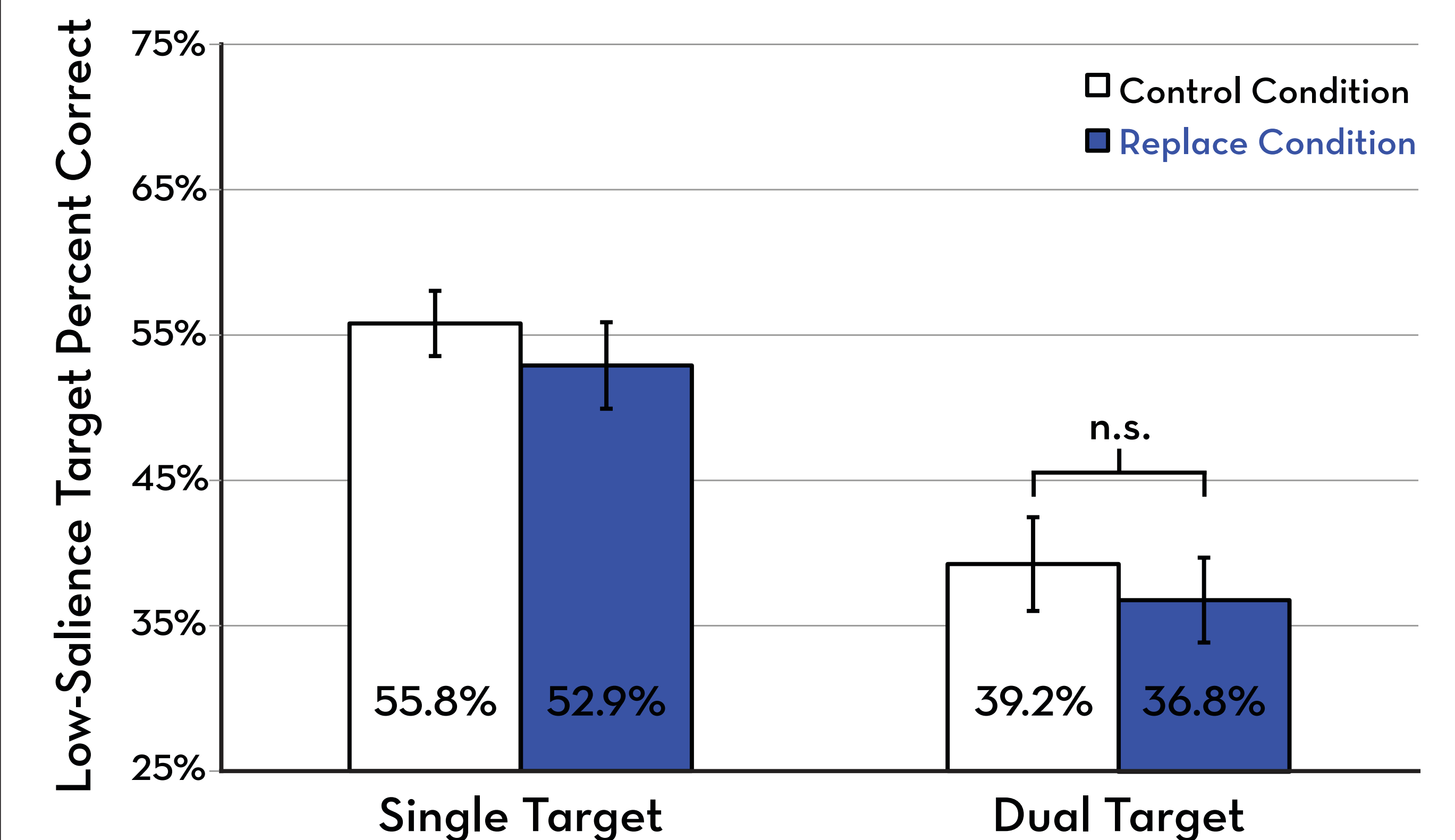
- Items turned yellow when clicked
- Highlighting the first found target led to *improved accuracy* for finding second targets



- Results are consistent with both hypotheses:
 - **Perceptual Salience:** The found target can be perceptually filtered before it is fully processed and captures attention
 - **Resource Depletion:** The found target can be perceptually filtered and, thus, does not need to be remembered

Expt. 3—Target Replacement

- Items replaced with a random distractor when clicked
- Replacing the first found target *did not affect accuracy* for finding second targets



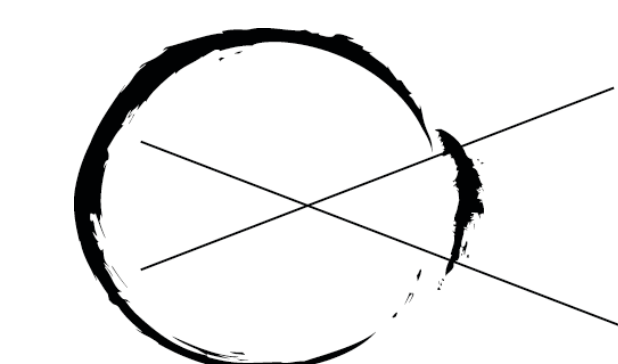
- Results are inconsistent with Perceptual Salience:
 - **Perceptual Salience:** The found target's features are not available to capture attention, but performance is unchanged
 - **Resource Depletion:** The found target's 'object file' likely updates to the new features, preserving the memory load

Conclusions

Found targets are stored in working memory, thus impeding subsequent search by reducing available cognitive resources

- Results are more consistent with the **Resource Depletion** account than with **Perceptual Salience**
- Removing or Highlighting a found target improves subsequent search, but Replacing it has no effect
- Eye tracking data (Cain, Adamo, & Mitroff, VSS 2012) show increases in distractor refixations after a target is found, consistent with impaired memory for previously searched locations
- Resource Depletion may explain findings that time pressure and anxiety impair second target accuracy (Cain, Dunsmoor, LaBar, & Mitroff, 2011; Fleck et al., 2010)
- Removing or Highlighting targets did not completely return performance to baseline, suggesting other factors may also impact second target accuracy

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