**What Eye-Tracking Can Tell Us About Multiple-Target Visual Search**

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**Background**

- **Satisfaction of Search (SOS)**
  - A target in a visual search is less likely to be found when presented with another target than when presented alone (see Berbaum et al., 2003, for a review)
  - A frequent source of error in multiple-target search (e.g., Deck, Samec, & Mitroff, 2003)
- **Recognition Errors**
  - The target was never fixated long enough
  - **Decision Errors**
    - The target was fixated long enough to be recognized, but was incorrectly declared not a target
- **Other possible systematic causes of SOS search errors**
  - **Refixation Errors**
    - Looking back at already found targets may interfere with subsequent searching (not a factor in single-target search)
  - **Strategic Errors**
    - Terminating a search early in order to maximize rate of target finding (e.g., Cain, Vul, Clark, & Mitroff, in press)

- **How do each of these types of errors contribute to SOS?**

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**Methods**

- **Participants:** N=218, 61 males, 157 females, mean age 49.5
- **Eye-tracking:** Tobii 1750, 50 Hz IR-illuminated video
- **Tasks:** Fix-target: "T" shapes among distractor 'L' shapes
  - Targets and detection salience:
    - high-salient (57.65% black)
    - low-salient (22.45% black)
  - 1 or 2 targets per trial
  - 20% single-target
  - 80% dual-target
    - one high-salient target
    - one low-salient target
  - 15 second time limit per trial
  - Searchers fixated on targets and pressed the spacebar to quit
  - The focus here is specifically on dual-target trials in which the high-salient target was found, but the low-salient target was missed

- **Scanning Errors**
  - Searchers did not fixate the second target on half of miss trials, making Scanning Errors the most prevalent error type

- **Radiological studies found 10–30% of misses were Scanning Errors (Kundel et al., 1978; Nodine & Kundel, 1987)**

- **First-Target Refixations**
  - High-salient targets were refixated after being found on 23.7% of all trials
  - There were more high-salient target refixations on trials where the low-salient target was missed than on which it was found

- **Strategic Errors**
  - Despite 80% dual-target trials, on 13.1% of misses no further items were fixated after the first-target click
  - Searchers may have been trying to maximize their overall target finding rate rather than their hit rate (e.g., Cain et al. in press)

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**Summary**

- **Half of Satisfaction of Search errors were due to faulty scanning:** searchers never fixated the second target, likely due to both scanning problems (i.e., an ineffective search pattern) and strategic problems (i.e., not searching long enough)
- **Recognition and Decision Errors account for the other half:** with Recognition Errors more prevalent
- **This pattern is reversed from that found in radiology,** where Decision Errors were most common, suggesting that the relative contributions of error types are influenced by the nature of the search and searchers
- **Refixating previously found targets contributed to Satisfaction of Search errors, impairing search efficiency**
- **Strategic Errors contributed overtly to some trials, but likely contributed subtly to many Scanning Errors**

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**References**


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**Goal**

Catalogue the types of multiple-target search errors

**Breakdown of Second-Target Miss Errors**

Low-salient targets were missed on 30% of dual-target trials in which the high-salient target was found (vs. 15% misses on single-target trials, a significant SOS effect, t(27)=8.00, p<.0001). Here we categorize the causes of those miss errors.

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**Recognition & Decision Errors**

- Searchers did fixate the second target on half of miss trials, but did not click on it
  - Recognition Errors: 469 trials (32.4%) had low-salient target fixations shorter than 260 ms (corresponding to the 75th percentile of low-salient detector fixation durations)
  - Decision Errors: 179 trials (12.4%) had low-salient target fixations longer than 260 ms