Top-down and bottom-up influences on saccades in a visual search task

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INTRODUCTION

NASA interest in cockpit displays and controls

• The ability of pilots and astronauts to quickly and reliably acquire information from complex cockpit displays is crucial for safe flight.

• Computational models of human visual search will enable the design of more efficient and effective human-centered interfaces that take into account perceptual/cognitive capabilities and limitations.

METHODS

Stimuli

6-AFC Paradigm

Oculometric Analysis

• Eye-tracker temporal resolution was 4 ms and spatial resolution was 0.1deg

• 6-AFC oculometric decision (Ekstein et al., 2001): -- Defined as element location nearest to the 1st saccade’s end point -- Saccades detected using low-pass differentiator -- Saccades within central 1.1 deg ignored -- Trials with saccadic latencies < 50 ms discarded

MODEL PREDICTIONS

• Target and decoy were odd-symmetric spatial Gabors (spatial frequency: 3.3 cdeg, c. 0.3 deg)

• All combinations of target and decoy contrasts (at 0, 6, 12, 18, and 24%) were tested

• Target and decoy orientation were perpendicular

• White noise background (mean luminance 18 cd/m2, rms contrast 26%) were used

• Six element evenly spaced locations (size: 1.1 x 1.1 deg; eccentricity: 6 deg) were used

• Target contrast and orientation were fixed and decoy contrast was randomized in each run

• Prior to a run, a noiseless target was shown to indicate the fixed target orientation and contrast for that run

• Two observers with normal or corrected-to-normal vision participated in the experiment

RESULTS

• No data from both observers must consist with a mixed model

• Saccades to decays (Oculomotor Capture) increased with decoy contrast even at high decoy contrast, despite the increased ideal observer target-decoy discriminability, indicating that bottom-up mechanisms play a dominant role.

• Top-down effects were also manifested. Observers tended to saccade to the target more than the decoy, for displays with equally salient target and decays.

• Results are consistent with a bottom-up model in which top-down information (attention) selectively enhances the gain of mechanisms with orientations similar to the target.

• Modifying a display by adding highly salient items will promote oculomotor capture and may lead to unintended performance degradation.

CONCLUSIONS

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Thanks to Chad Netzer for software support and to Anton Krukowski for help with stimulus generation.

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