Rare Targets Induce Less “Perceptual Readiness:” Evidence from Pupillometry

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In visual search, rare targets are missed disproportionately; this potentially has dire consequences for important searches (1).

Sometimes, low-prevalence (LP) targets are missed simply because searchers quit before attending to them.

Importantly, our prior work (2) showed (using RSVP search) that when searchers cannot quit early and must attend to each item, the LPE still persists. And (using eye-tracking and oculomotor search) that observers often look right at LP targets and still miss them (more often than high-prevalence [HP] targets).

These findings suggest that LP misses represent failures of perception.

HP targets seem to enjoy privileged status in the mind of the searcher, leading to stronger top-down matching between target templates and potential target items.

The Low-prevalence Effect (LPE)

Pupil Dilation Results

Pupillometry

Reflexive (tonic) pupillary changes occur independently of task-related (phasic) changes. Phasic changes reflect increases in mental effort (see 3 for review).

Pupil responses also track the strength and specificity of memory traces (4).

If target templates for HP targets receive more internal attention/preparation, then the pupillary response should reveal stronger resonance (2, 5).

Prediction: pupillary responses will be stronger when HP targets are located, relative to LP targets.

Method & Accuracy

Participants searched for two target categories (teddy bears and butterflies) simultaneously; only one could appear per trial.

Overall prevalence was 50%, but one category appeared more frequently than its counterpart. Relative prevalence rates manipulated between-subjects.

RSVP search used to ensure targets were examined. 32 objects shown (for 200ms each) in alternation with short (50ms) blank screens.

One-second delay followed the stream, after which participants indicated their absent vs. present decision.

Pupil dilation tracked (at 500 Hz) using an Eyelink 1000 tracker. Three blocks of 100 trials.

Conclusions

Before prevalence rates were appreciated, LP and HP trials elicited comparable dilation. Pupils dilated more when targets were present indicating detection.

As prevalence effects took hold, HP trials resulted in more dilation than LP trials, as indexed by peak dilation.

This suggests that the resonance between target templates and incoming visual information was stronger for HP targets.

Together, our findings suggest that HP targets enjoy privileged attentional status in the mind of the observer, promoting greater resonance when they are examined (see 2).