New Mexico State University
Vison Sciences and Memory Lab

Cutting Through the MADness:
Investigating visual search efficiency in dynamic displays

Collin Scarince & Michael C. Hout

Introduction

Visual attention is guided by basic visual features (Treisman & Gelade, 1980; Wolf, Cave, & Franzel, 1989), such as color, shape and orientation. Dynamic features, like motion (McLeod et al., 1988) and luminance changes (Yantis & Jonides, 1984), can also direct attention if those features are unique to a visual target. As more target features overlap with distractor features, reaction times (RT) and miss rates increase. Miss rates and RTs also increase as target prevalence decreases (Wolfe, Horowitz, & Kenner, 2005).

MAD Search

Some environments contain stimuli that are not stationary. Sometimes key elements of a display move over time or become obstructed from view due to shadows or the presence of other objects. Kunar and Watson (2011; 2014) developed a Multi-element Asynchronous Dynamic (MAD) search display to test visual search performance in dynamic and complex visual tasks (such as monitoring closed circuit security feeds for "suspicious activity"). These displays consisted of stimuli with a combination of moving, blinking, and stationary dynamic features, in high visual set sizes (16, 24, and 32 items). Participants searched for one of five vowel letters amongst consonant distractors. Moving targets resulted in higher miss rates and higher search slopes than non-moving items. MAD search also resulted in higher miss rates (~30%) than is usually expected in laboratory visual search experiments.

Current Study

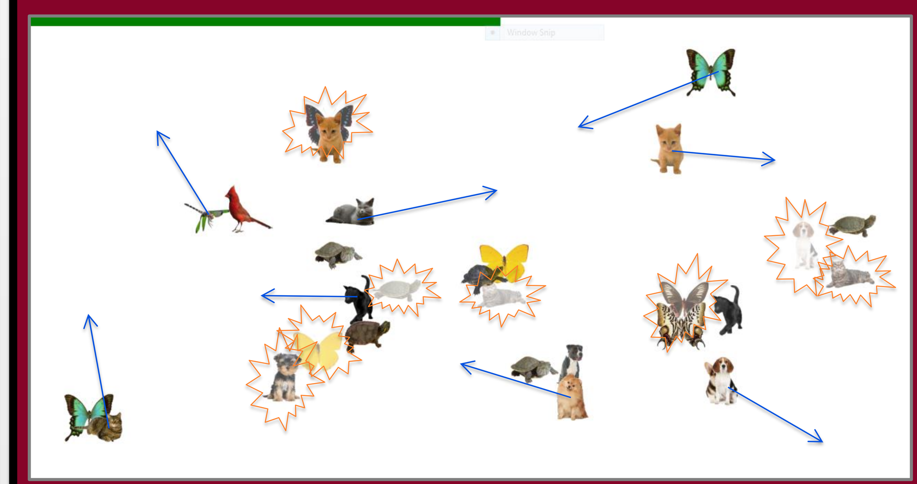
Although there are clear subjective differences between MAD and static visual search, the exact mechanism of the increased error rate is not clear. One possible source of error is a categorical prevalence effect created by the dynamic features and multiple targets (e.g., Kunar & Watson, 2011; Hout et al., 2015). Another possibility is that MAD search is regularly terminated too quickly compared to static search. We tested for these two potential causes of errors in dynamic search over two experiments, using real-world objects in a MAD search paradigm.

Methods

Experiment 1: Testing prevalence effects.
Participants (N=28; 50% female) completed 500 trials of MAD search with real-world stimuli. The overall target prevalence was 60%, but each dynamic feature appeared at a different rate (5%, 20%, 35% of trials) between participants.

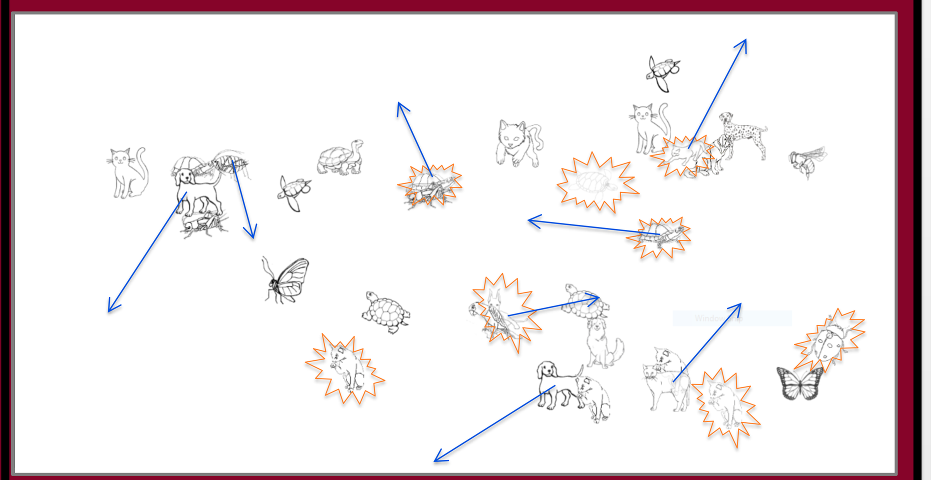
Experiment 2: Testing quitting threshold differences.
Participants (N=19; 57% female) completed 250 trials each of MAD and static search. Stimuli were similar to Experiment 1, but were simpler line drawings of the same categories. Target prevalence was 50%, and dynamic features occurred at equal rates across targets. Participants were also given accuracy feedback after each trial.

Experiment 1



- Colored, real-world stimuli
- Set sizes: 16, 24, 32
- 5 second time limit (with indicator)
- No trial-by-trial feedback

Experiment 2



- Line drawings
- Set sizes: 32
- 10 second time limit
- Received accuracy feedback after each trial

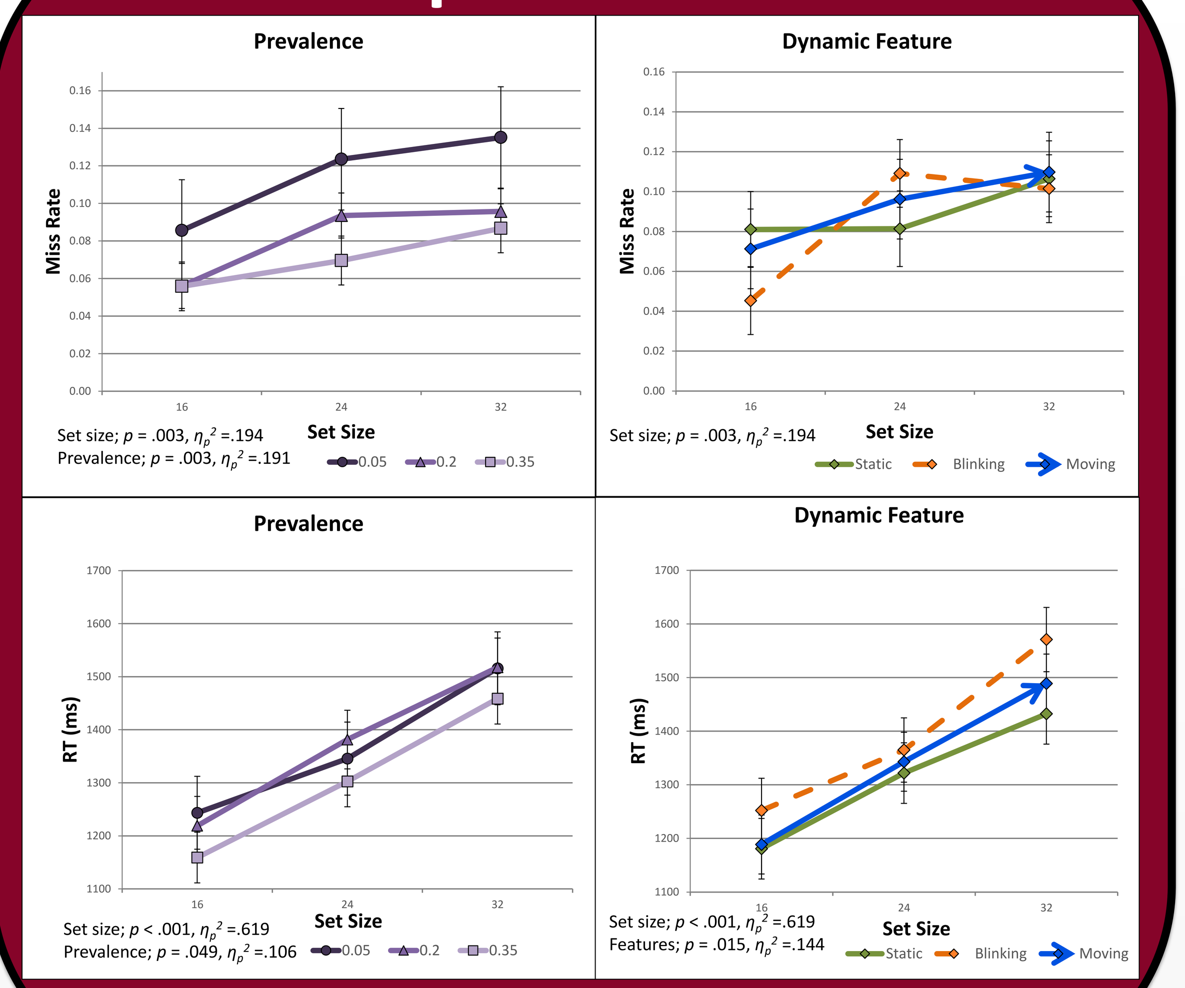
Experiment 1

- Do dynamic features create a categorical-prevalence effect?
- If the rate at which targets possess a dynamic feature plays a role in the high error rates in MAD search, then the prevalence of dynamic features (within targets) should directly affect search performance (e.g., when targets rarely blink, blinking targets should be missed most often).

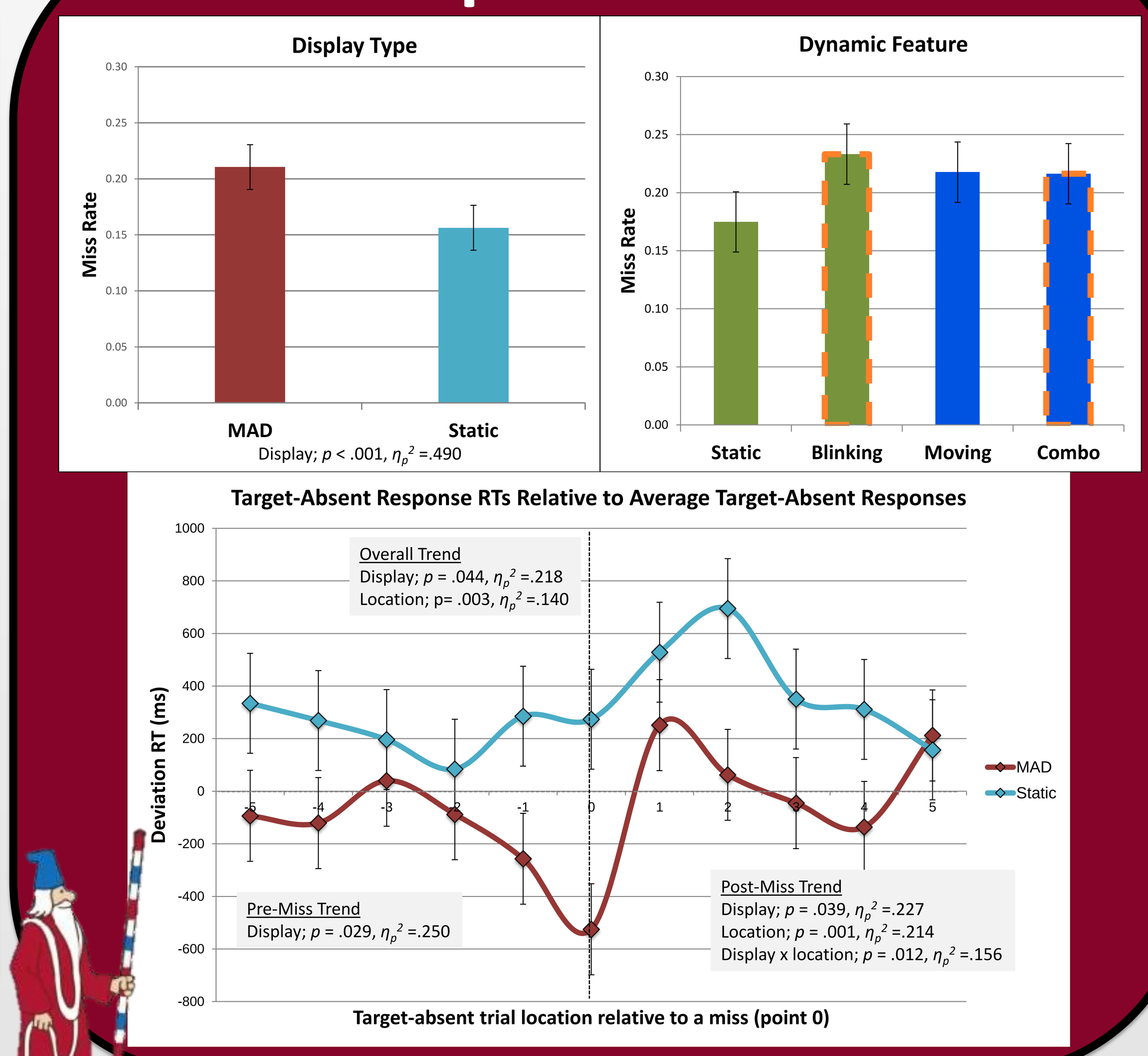
Experiment 2

- Is there a key difference in quitting behavior between MAD and static searches?
- If misses occur in MAD search because search is terminated too quickly, then RTs should trend downward (prior to a miss). This would suggest that overconfidence results in termination that occurs before the display has been exhaustively searched.

Experiment 1



Experiment 2



Discussion

- Targets that possessed a rarely occurring dynamic feature tended to be missed more than regularly occurring features.
- Regularly occurring dynamic features facilitated target detection time.
- Blinking targets were found slower than stationary or moving targets (Exp 1).
- MAD search resulted in higher miss rates than static search.
- Misses in MAD search appeared to be the result of the quitting threshold becoming too low after successive target-absent responses. Interestingly, misses in static search did not show a decrease in the quitting threshold leading up to a miss, as has been found in previous research (Chun & Wolfe, 1996).