Coping with a MAD World: Visual Search Strategies in Dynamic Environments

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New Mexico State University
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Search guidance by feature

• Target:
Search guidance by feature

- Target:
Search guidance by feature

- Target:
Search guidance by feature

- Target:
Search guidance by feature

- Target:  □  = □ + Blue
Importance of features in visual search
Importance of features in visual search

- Target:
Current Study

• Experiments 1a & 1b
  • Compare the effects of dynamic feature prevalence within targets against the effects of dynamic features.

• Experiment 2
  • Compare quitting behavior that leads to misses between dynamic and static search
Do (non-defining) Dynamic Features create a low-prevalence-like effect when distributed disproportionately across targets?

<table>
<thead>
<tr>
<th>Target prevalence</th>
<th>Feature prevalence</th>
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</thead>
<tbody>
<tr>
<td>60%</td>
<td>Low (5%)</td>
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<tr>
<td></td>
<td>Medium (20%)</td>
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<td>High (35%)</td>
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</table>

- Miss Rate vs. Feature Prevalence graph
**Experiment 1a & 1b**

- **Method**
  - **Participants**
    - 28 participants (50% female)
      - $M_{\text{age}} = 22.4(3.24)$ years
    - 68 participants (70% female)
      - $M_{\text{age}} = 19.3(3.05)$ years
  - **Multielement Asynchronous Dynamic (MAD) Search** (Kunar & Watson, 2011; 2014)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence</th>
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<tr>
<td></td>
<td>Low (5%)</td>
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<td>Medium (20%)</td>
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<td>High (35%)</td>
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<tr>
<td>1</td>
<td>Static, Blinking, Motion</td>
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<td>2</td>
<td>Static, Motion, Blinking</td>
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<td>3</td>
<td>Blinking, Static, Motion</td>
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<td>4</td>
<td>Blinking, Motion, Static</td>
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<td>5</td>
<td>Motion, Static, Blinking</td>
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<tr>
<td>6</td>
<td>Motion, Blinking, Static</td>
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</tbody>
</table>
Experiment 1a & 1b

- Method
Experiment 1a & 1b

- Results (Dynamic Features Miss Rates)

### Experiment 1a

<table>
<thead>
<tr>
<th>Set Size</th>
<th>Static</th>
<th>Blinking</th>
<th>Moving</th>
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<td>16</td>
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<td>24</td>
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<td>32</td>
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**Set size;** $p = .003, \eta^2_p = .194$

### Experiment 1b

**d = 0.43**

**Dynamic Features;** $p < .001, \eta^2_p = .110$
Experiment 1a & 1b

- Results (Prevalence Miss Rates)

Experiment 1a

\[ d = -0.43 \]

Experiment 1b

\[ d = -0.37 \]

Set size; \( p = .003, \eta_p^2 = .194 \)
Prevalence; \( p = .003, \eta_p^2 = .191 \)

Prevalence; \( p = .004, \eta_p^2 = .078 \)
Experiment 2

• Purpose
  • Do quitting thresholds vary between dynamic and static searches?

Deviation RTs relative to a miss
Experiment 2

• Method
  • 36 participants (62% female)
    • $M_{\text{age}} = 20.6(2.21)$ years
Experiment 2

• Results

Deviation RTs relative to missed targets

Trial; $p = .001$, $\eta_p^2 = .091$

Miss RT; $p = .044$

$d = -0.32$

Miss RT; $p = .423$

$d = -0.05$
General Discussion

• Non-defining features affected search guidance and target detection.
• Dynamic displays might prevent observers from establishing a consistent quitting threshold.
Thanks to...

- Dr. Hout
- Dr. Simon, Dr. MacDonald & Dr. Post
General Discussion

- Non-defining features affected search guidance and target detection.
Experiment 1a & 1b

• Discussion

• Dynamic feature prevalence (collapsed across features) affected miss rates.

• These findings suggest non-defining, dynamic features can affect search performance.
Experiment 2

- Discussion
  - MAD and static searches resulted in expected search termination behavior after a miss.
  
  - Miss reaction times in MAD search tended to be lower than average target-absent responses.
Search guidance by feature

- Target:
Dynamic features in complex displays?

- Target:
Guidance from dynamic features

- **Target**: Moving
Guidance from dynamic features

- **Target:** Moving

[Diagram showing a pattern of blue circles and squares with red and orange circles indicating Perceptual Activation levels, ranging from Low to High.]
# Feature prevalence

- Effects of multiple targets and dynamic features

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Quitting threshold

- Target: 🔴
Quitting threshold

• Target: ☐
 Quitting threshold

- Target: [Blue square]

- Quitting Threshold: [Graph showing a linear increase]
General Discussion

• Feature prevalence and learning

Target: —
General Discussion

• Quitting behavior
  • Evidence of two sources of miss errors