Is this object “gray” or is this object “not blue”? Confirmatory and disconfirmatory strategies influence object identification during visual search

Stephen C. Walenchok¹, Joseph W. Houpt², Hayward J. Godwin³, Michael C. Hout⁴, and Stephen D. Goldinger¹

¹Arizona State University
²Wright State University
³University of Southampton
⁴New Mexico State University
Distractor Rejection

• Find your blue car in a parking lot:
  1. Guide attention\(^1\)
  2. Decide “Is this my car?”
     • A “black box” in visual search research!

• People could identify whole objects, or they could reject objects on the basis of individual features

\(^1\)Wolfe, Cave, & Franzel (1989)
The Capacity Coefficient: $C(t)$

- Ratio of distractor rejection efficiency in single- and dual-target search:
  
  Find this: vs. Find either of these: Is this (one of) the target(s)?

- Are people equally efficient, more efficient, or less efficient at rejecting distractors when looking for two targets versus either target in isolation?
The Capacity Coefficient: Potential Outcomes

\[ C(t) = 1 \]

UCIP Baseline
Equally efficient for single- and dual-target search.

\[ C(t) < 1 \]

Limited Capacity
Less efficient for dual-than single-target search.

\[ C(t) > 1 \]

Super Capacity
More efficient in dual-target search. Any mismatching feature can disqualify a non-target

1. Cumulative distribution function for UCIP baseline:

\[ P[T_{12} \leq t] = P[T_1 \leq t] \times P[T_2 \leq t] \]

2. Cumulative reverse hazard function; logarithm of eq. 1:

\[ K_{12}(t) = K_1(t) \times K_2(t) \]

3. Capacity Coefficient:

\[ C_{AND}(t) = \frac{K_1(t) + K_2(t)}{K_{12}(t)} \]
Search for this target:
RED button = target

YELLOW button = distractor
RED button = target

YELLOW button = distractor
RED button = target

YELLOW button = distractor
RED button = target

YELLOW button = distractor
Search for either of these targets:
RED button = target

YELLOW button = distractor
RED button = target

YELLOW button = distractor
RED button = target

YELLOW button = distractor
RED button = target

YELLOW button = distractor
Experiment 1

- Single, relevant features, all tested separately
- All distractors differed from targets by one feature

Circle Color or Line Color | Orientation | Dash Type
--- | --- | ---
T1 | T1: | T1: 
T2 | T2: | T2: 
(distractors): | |
Interpreting $C(t)$

Simulated Capacity Functions

- Super Capacity
- Limited Capacity

More efficient
Less efficient
Experiment 1 Results

Object-level
“Not my blue sedan”

Feature-level
“Not blue”

Circle Color

Super Capacity

Limited Capacity
Experiment 1 Results

Object-level
“Not my blue sedan”

Feature-level
“Not blue”

Time (ms)

C(t)

Line Color

Super Capacity
Limited Capacity
Experiment 1 Results

Object-level
“Not my blue sedan”

Feature-level
“Not blue”

Super Capacity

Limited Capacity
Experiment 1 Results

Object-level
“Not my blue sedan”

Feature-level
“Not blue”

Super Capacity

Limited Capacity
Experiment 2

- Two relevant feature conjunctions selected for each target:

  **Example:** Circle Color and Line Color

  ![Example Diagram]

- Distractors now differ by 2 features rather than 1
- All possible feature combinations
Experiment 2 Results

Object-level

Circle Color and Line Color

Feature-level

Circle Color and Orientation
Experiment 2 Results

Object-level  

Feature-level

**Circle Color and Dash Type**

**Line Color and Orientation**

\[ C(t) \]

Time (ms)
Experiment 2 Results

Object-level

Feature-level

Line Color and Dash Type

Orientation and Dash Type

C(t)

Time (ms)
Conclusions

- People can reject distractors on the basis of whole objects or individual features.

- Assuming whole objects, people appear to be better-than-expected.

- Assuming individual features, people are more reasonable.

- Overall, these findings help us to peer into the “black box” of object identification in visual search.
Thank you for your attention.

• This work was supported by NIH Grant R01HD075800-02 to Stephen Goldinger and U.S. Air Force Office of Scientific Research Grant FA9550-13-1-0087 to Joseph Houpt.

• Thank you to our research assistants:
  • Jeffrey Beirow
  • Kayla Block
  • Feng Min Chen
  • James Harkins
  • Ga Young Kim
  • Jenalee Remy
  • Gia Veloria
The Feature Model

- A race to reject the current distractor:

  Time to affirm a feature’s presence: \( T^+_{\text{feature}} \)

  Time to reject a feature’s presence: \( T^-_{\text{feature}} \)

1. Time to reject a distractor based on unique features not shared with either target = minimum time required to affirm any of those features:

   \[ T^-_{P,1} = \min_{f,l \in P \setminus P_{AB}} \{ T^+_{f,l} \} \]

2. Time to reject a distractor that shares features with only Target A or Target B (at least one overlapping feature from each must be processed):

   \[ T^-_{P,2} = \max \left[ \min_{f,l \in P_A} \{ T^+_{f,l} \}, \min_{f,l \in P_B} \{ T^+_{f,l} \} \right] \]

3. One can also reject a distractor based on the absence of features shared between targets:

   \[ T^-_{P,3} = \min_{f,l \in (A \cap B) \setminus (P_A \cup P_B)} \{ T^-_{f,l} \} \]

4. ...or based on absent features unique to either target:

   \[ T^-_{P,4} = \max \left[ \min_{f,l \in A \setminus P_A} \{ T^-_{f,l} \}, \min_{f,l \in B \setminus P_B} \{ T^-_{f,l} \} \right] \]