Task-Relevance of Features Modulates Object Substitution Masking

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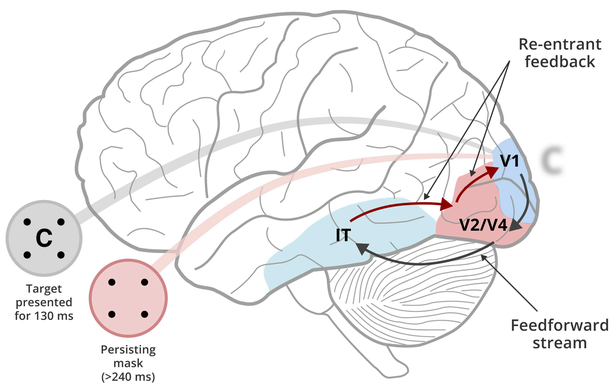
Introduction

Object Substitution Masking (OSM) & Recovery

- OSM refers to a phenomenon in which the identification of a target object is impaired when surrounded by sparse dots that remain visible after the target disappears (Enns & Di Lollo, 1997).
- It has been observed using simple, feature-based targets and masks (i.e., Cs surrounded by dots) (Enns & Di Lollo, 1997; Goodhew, 2017), as well as more meaningful ones (Savino & Kahan, 2023).

Figure 1
Reentrant processing account for OSM



Visual perception relies on iterative processing in which representations in higher-level regions are "checked" against current sensory input in lower-level regions. When a target disappears, this reentrant process updates the initial target-mask representation to reflect only the mask (Enns & Di Lollo, 2000). Recovery of the target perception occurs via a second round of reentrant processing (Goodhew et al., 2012).

Present Study

- *Research Question:* Savino & Kahan (2023) found that task-relevant dimensions affected masking and recovery when participants were asked to identify the target's object identity. Do these effects persist when the task-relevant dimension is basic features (i.e. the target's orientation)?
- *Hypotheses:* In a target-orientation identification task, overlap in the orientation of target and mask features will (1) increase masking and (2) affect patterns of recovery.

Method

Participants

- 20 undergraduate students from Bard College
- Convenience and snowball sampling

Design: Within-Subjects

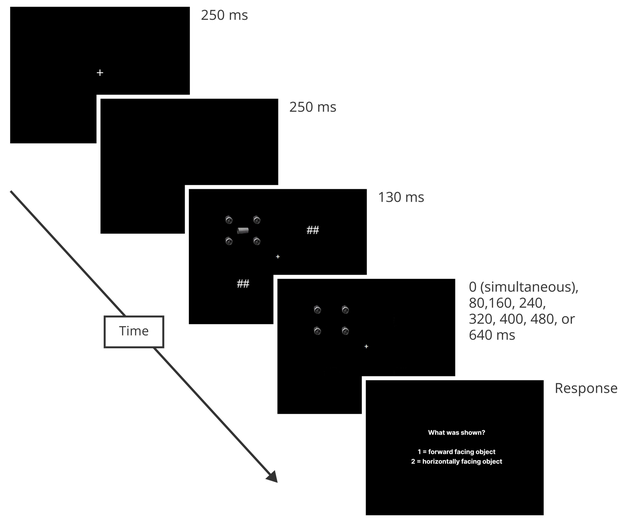
- 2 (orientation: congruent vs incongruent) x 2 (object: congruent vs incongruent) x 8 (mask offset: 0, 80, 160, 240, 320, 400, 480, 640 ms)

Procedure

- A graphic depiction of the trial sequence is presented in Figure 2
- Participants completed 8 practice trials and 504 experimental trials (four blocks of 126), for a total of 512 randomized trials
- Participants took three self-paced rest breaks between blocks

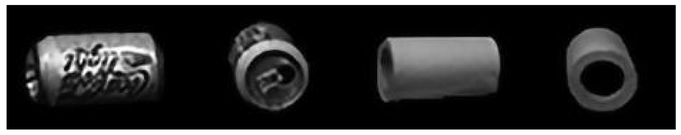
Method (continued)

Figure 2
Graphic Depiction of the Sequence of Events



Note. Adapted from Savino and Kahan (2023). Copyright 2022 by American Psychological Association.

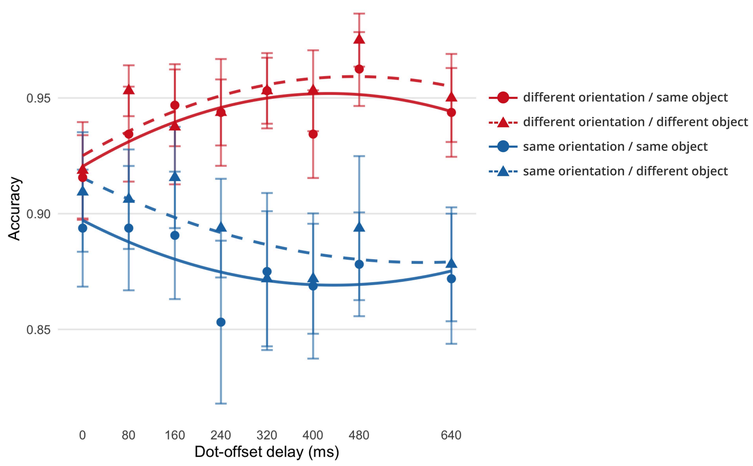
Figure 3
Experimental Stimuli



Note. Images adapted from "The Amsterdam Library of Object Images" by J. M. Geusebroek, G. J. Burghouts, and A. W. Smeulders, 2005, International Journal of Computer Vision 61(1), pp. 103–112 (https://doi.org/10.1023/B:VISI.0000042993.50813.60). Copyright 2005 by Springer.

Results

Figure 4
Mean Accuracy Rates and Best Fitting Quadratic Curves as a Function of Target-Mask Orientation Congruency and Object Congruency Across Dot-Offset Delay



Note. Target and mask were displayed together for 130 ms. Error bars represent ± 1 standard error of the mean.

Results (continued)

Accuracy

- Main effect of orientation: $F(1, 19) = 8.91$, $p = .008$, $\eta^2 G = .080$. Participants were more accurate when target-mask pairings had incongruent orientations.
- There were no other significant main effects or interactions.

Slope Analysis (0 ms & 640 ms)

- Main effect of orientation (0 ms): $F(1, 19) = 9.47$, $p = .006$, $\eta p^2 = .111$. When there was no delay between the target and mask (0 ms), participants performed significantly better when the orientations did not match than when they did.
- No significant effects at 640 ms.

Slope Analysis T-Tests (0 ms & 640 ms)

- Positive slope for different-orientation same-object (0 ms): $t(19) = 2.43$, $p = .025$, $d = 0.543$. When the target and mask depicted the same object in different orientations at a 0-ms delay, participants' accuracy showed a trend toward improvement.
- No other slopes significantly different from zero at 0 ms.
- No slopes significantly different from zero at 640 ms.

Discussion

Hypothesis 1

- Participants experienced more masking in the same-orientation conditions than in the different-orientation conditions.

Hypothesis 2

- We found little evidence of recovery in either condition: accuracy did not consistently improve at longer mask offsets for incongruent-orientation pairings, nor did it show the expected *decline-then-improvement* pattern for congruent-orientation pairings.

Conclusions

- These results suggest that task-relevancy impacts reentrant processes in OSM, highlighting the importance of cognitive control to visual perception.
- The overlap of task-relevant features seemed to inhibit participants' ability to distinguish between a target and mask, resulting in greater masking. This necessitated a second wave of reentrant processing to identify the target.

Future Research

- Same-orientation recovery under different contexts.
  - High identification accuracy for orientation compared to object meaning.
  - Interference due to salience of object-level information.
- Ongoing BAP Lab Research: Attentional Cueing; Pre-Crastination; Alerting-Congruency Interaction; Context-Driven Attention

References

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