Object substitution masking reveals a competitive dynamic between levels of categorization

Jason K. Chow & Michael L. Mack

Motivation
Categorization of visual objects requires significant time with different types of categorizations at different speeds.

Basic level categorizations were accepted as faster (Rosch et al., 1976). However, research has shown that superordinate categorizations can be faster in ultra-rapid exposure times (Thorpe, Fize, & Marlot, 1996).

Hypothesis
Early superordinate category advantages can be attributed to rapidly available global information (Mack & Palmeri, 2015). Later basic category advantages can be attributed to the similarity structure of representations (Rogers & Patterson, 2007).

How do these levels of categorization interact in real time? We use object substitution masking (OSM) to selectively measure levels of categorization. Behavioural and modelling data suggests a competitive dynamic in the time course of categorization.

Results
Interaction effect between mask offset and level of categorization found in d’.

Both levels of categorization are affected differentially by masking over time. A tradeoff between basic and superordinate categorization suggests a competitive dynamic.

Superordinate- and basic-level information directly compete in categorization. If performance in one level of categorization is reduced, an increase in performance should be found in the other level.

Main effect of level of categorization on response bias.

Superordinate level categorization is largely unaffected by masking and is biased towards confirming the category.

Longer mask offsets cause basic level categorization to show similar biases to superordinate categorization.

Experiment
OSM uses a trailing sparse mask to disrupt visual processing.

The trailing mask is known to selectively impair visual processing while still allowing some semantic processing to occur (Goodhew, 2017).

We used OSM to target the temporal dynamics of how perceptual encoding interfaces with category knowledge.

Category levels were presented in 5 blocks of 100 trials each. Mask offsets (0, 17, 33, 50, 68 ms) were randomized between trials.

Results

Superordinate or Basic?

No

Yes

Target Offset

0-68ms

~500ms

33ms

1500ms response

Accuracy x Mask Offset

Interaction effect between mask offset and level of categorization found in d’.

Modelling
Implementing a perceptual encoding framework with the addition of mask encoding allows for a proof of concept model that reflects a competitive dynamic between levels of categorization.

Conclusions

- OSM can selectively impair perception of category diagnostic information.
- Basic and superordinate categorization show a competitive dynamic which may account for previously found temporal dynamics between levels.
- Next steps include extending the model to drift diffusion framework to formalize mechanisms underlying the interactions between category levels.

References


This project is supported by NSERC grant RGPIN-2017-06753 to M. Mack and an OPAM Travel Award to J. Chow.