Feature diagnosticity affects semantic representations of novel and common object categories

Nina S. Hsu, Margaret L. Schlichting, and Sharon L. Thompson-Schill
Center for Cognitive Neuroscience, University of Pennsylvania

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INTRODUCTION

A central principle in feature-based theories of semantic memory is the differential weighting of some features over others [1-5].

Some of these features are **diagnostic** – they serve to distinguish or otherwise conspicuously differentiate one item from others [6,7].

In determining feature diagnosticity, we argue for a distinction between when a feature is available and needed, and when it is actually used.

Color is **necessary** in order to distinguish lemons and limes.

Color is **available** but not needed in order to distinguish stop signs and yield signs.

Using color as the diagnostic feature, we used a training paradigm to investigate how diagnostic features interact with semantic representations.

METHODS

Subjects learned one of two novel object sets over the course of four sessions:

COLOR + SHAPE:

SHAPE:

Color is necessary, shape is not sufficient:
P (object | shape) = 0.33
P (object | color) = 0.50
P (object | shape AND color) = 1.00

Color is available, shape is sufficient:
P (object | shape) = 1.00
P (object | color) = 0.50
P (object | shape AND color) = 1.00

Following training, subjects performed a number of behavioral tasks, including adjective generation and pairwise general similarity ratings:

klarve
1. purple
2. blobby
3. round
4.

klarve

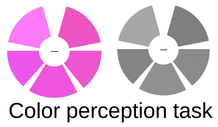
chulge

1 2 3 4 5 6 7 8 9
Very dissimilar Very similar

Thirty-two of these subjects (n = 16 for each group) performed a shape retrieval task while undergoing fMRI, answering yes/no shape questions about the objects. This task was followed by a functional color localizer.

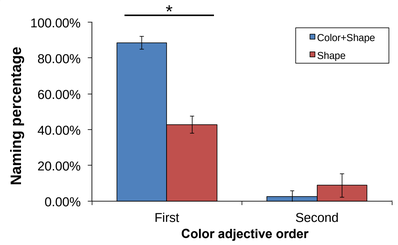
If you flipped a KLARVE over, would it stand up straight?

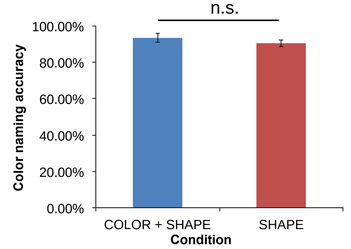
Shape retrieval task



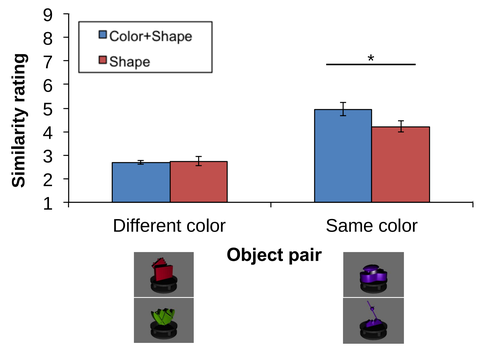
Color perception task

BEHAVIORAL RESULTS





When listing object adjectives, "color+shape" subjects (n = 29) listed color first 88% of the time, whereas "shape" subjects (n = 34) listed color first only 45% of the time (p < 0.001). Notably, the groups demonstrated comparable explicit object color knowledge.



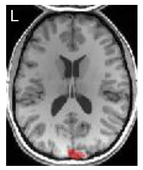
"Color+shape" subjects assigned higher *general* similarity ratings to same-colored object pairs than did "shape" subjects (p < 0.03). We replicated this result when comparing stimuli shared across both groups.

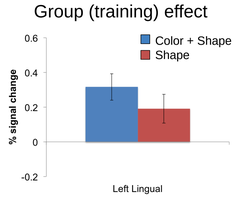
FMRI RESULTS

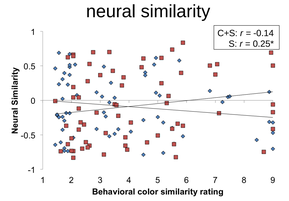
If you flipped a CARROT over, would it stand up straight?

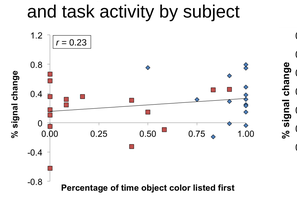
Identified via functional localizer

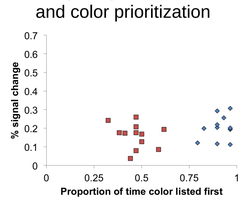
Lingual

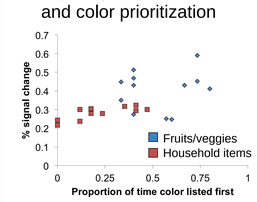




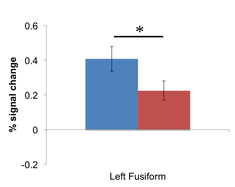


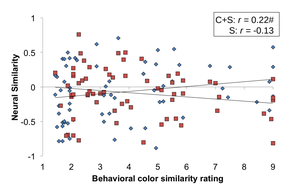


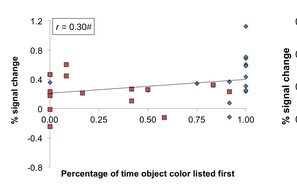


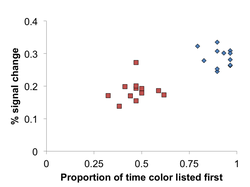


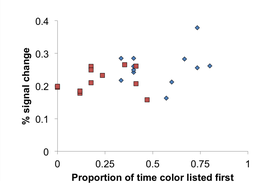
Fusiform



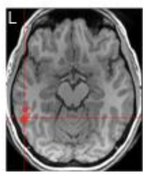


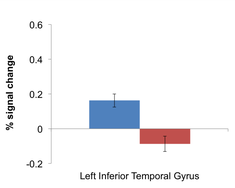


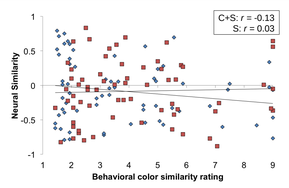


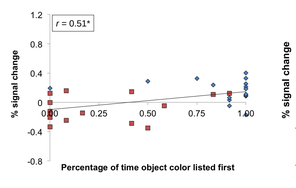


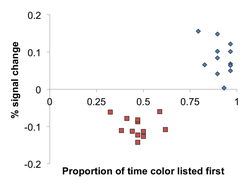
Identified via WB analysis
Inferior temporal gyrus

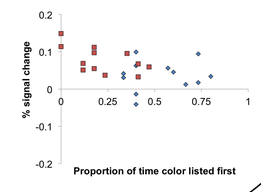












DISCUSSION

- Features can vary both in how well we *know* and *use* them, and this distinction taps into semantic representations.
- These results parallel previous work demonstrating differences in conceptual knowledge for blind versus sighted subjects [8].
- The neural instantiation of diagnostic features may vary along a posterior-anterior gradient in ventral temporal cortex.
- In conjunction with a parallel investigation of common object categories, these results suggest some similarities and differences in how feature diagnosticity interacts with both object category types.

ACKNOWLEDGEMENTS: The authors thank Lauren Hendrix for help with data collection. This work was funded by the NIH (R01 MH070850 awarded to S. L. T.-S.) and by a Ruth L. Kirchstein NRSA Predoctoral Fellowship awarded to N. S. H.

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CONTACT

Nina Hsu: ninash@mail.med.upenn.edu
http://www.psych.upenn.edu/stslab/