

# INTERACTIONS BETWEEN CONCEPTS AND PROPERTIES IN ADJECTIVE-NOUN COMBINATIONS



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## BACKGROUND

- ① Concepts are rarely used in isolation: research examining the neural processes underlying conceptual combination will help reveal how concepts interact with one another, thus enabling us to reference a theoretically infinite number of objects<sup>1,2,3,4</sup>.
- (2) In adjective-noun combinations (e.g. GREEN PUMPKIN), properties are directly ascribed to objects: here we explore if and how conceptual information is dynamically activated and transformed online as new properties are integrated into concepts during comprehension.

## HYPOTHESIS

If a concept (PUMPKIN) is in part composed of its ensemble of properties (ORANGE, SWEET), and if these properties are represented in distributed regions or networks corresponding to feature dimensions (COLOR, TASTE), then we should be able to witness activation of new properties (GREEN) during comprehension of adjective-noun combinations ("GREEN PUMPKIN") in these same networks, and the amount of additional information should be modulated by the strength of the property in the unmodified concept.

## DESIGN

Subjects (N=15) completed 5 different runs while fMRI data were collected: NOUN<sub>words</sub>, NOUN<sub>PICTURES</sub>, ADJ<sub>PICTURES</sub>, ADJ<sub>WORDS</sub>, and ADJ-NOUN<sub>words</sub>



OBJECTS	PROPERTIES
KEY	METAL
TABLE	WOODEN
PUMPKIN	ORANGE
GRASS	GREEN
COOKIE	SWEET
PICKLE	SALTY
PILLOW	SOFT
KNIFE	SHARP

- Each object was originally paired with a property with which it is strongly associated
- ii. Property Strength: We also collected ratings (N=50) on how strongly associated each property was with each object
- iii. Each of the 8 nouns were crossed with each of the 8 adjectives, resulting in 64 combinations

## PROPERTY VOXELS

We tested the models below in whole-brain searchlights. These models are based on the ADJ<sub>WORD</sub> and ADJ<sub>PICTURE</sub> beta patterns, and find voxels whose patterns discriminate between the two properties (e.g., orange and green) within the relevant property dimension (e.g., color). The <u>top 100 voxels</u> were extracted for <u>each feature dimension</u> for the following analyses.



(LDJ)

![](_page_0_Figure_21.jpeg)

GREEN

Was this word

on the last list?

SHARP

COLOR

ORANGE

![](_page_0_Figure_22.jpeg)

# DYNAMIC PROPERTY ACTIVATION

If a property is activated during adjective-noun comprehension, then the pattern evoked by the ADJ-NOUN pattern should be more similar to the ADJ pattern than is the unmodified NOUN pattern.

PROPERTY ACTIVATION = sim(ADJ-NOUN<sub>words</sub>, ADJ<sub>PICTURES</sub>) - sim(NOUN<sub>words</sub>, ADJ<sub>PICTURES</sub>)  
FOR EXAMPLE: sim 
$$\begin{pmatrix} "GREEN \\ PUMPKIN", ~ & & & \end{pmatrix}$$
 - sim  $\begin{pmatrix} "PUMPKIN", ~ & & & & \\ & & & & & & \\ \end{pmatrix}$ 

**Prediction:** If the transformation of a concept's informational structure reflects the activation of a new property, then there should be less additional property activation for strongly-associated properties because they were already present in the unmodified concept.

During adjective-noun processing, property-sensitive voxels show evidence of property activation (i.e., ADJ-NOUN<sub>words</sub> patterns become more similar to the ADJ<sub>PICTURE</sub> pattern) for the properties relevant to the voxels' dimension (blue bars) than for other properties (t(3)=14.99, p < 0.001)

![](_page_0_Figure_28.jpeg)

![](_page_0_Figure_29.jpeg)

- In color-encoding voxels, the amount of additional color (i.e., orange, green) activation during ADJ-NOUN comprehension depends on the extent to which that color is present in the unmodified object concept.
- The stronger the color in the object concept, the less additional color information is added during ADJ-NOUN comprehension (r(15)=-0.46,p=0.049).
- > This effect is not found for the other feature dimensions.
- This suggests that the influence of an adjective depends on the content of the object it modifies, and that conceptual information is dynamically transformed during language comprehension.

## ADDITIONAL ANALYSES

- Cluster the Property-Maps and run analyses in individual ROIs to link degree of property activation and integration with specific anatomical regions.
- ② Instead of a property-focused approach, isolate voxels underlying representation of object concepts and explore property activation and integration across the feature dimensions and properties of interest.

#### REFERENCES

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![](_page_0_Picture_41.jpeg)

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