Typicality Sharpens Category Representations in Object-Selective Cortex

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Typicality Sharpens Category Representations
Typical Categories
are recognized and categorized faster than less typical categories

Rosch 1973
Rosch & Mervis 1975

Neural Correlates of Real-World Object Typicality

more typical

less typical
How does the neural representation of real-world objects vary across the typicality continuum?

#1: Relationship to category central tendency
- Posner & Keele (1968), Rosch & Mervis (1975), Davis and Poldrack (2014), and many others

#2: Differentiating between basic level categories
- Rosch & Mervis (1975), Sigala & Logothetis (2002), Freedman et al. (2003), and many others

Family Resemblance Hypothesis
- Rosch & Mervis (1975)
64 categories x 16 images per category
Behavioral Experiment to Assess Category Typicality

8 subordinates

typicality ranking

more typical  less typical

Typicality Sharpens Category Representations
## Typicality Ranking

<table>
<thead>
<tr>
<th>Typicality Sharpens Category Representations</th>
</tr>
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<table>
<thead>
<tr>
<th>Birds</th>
<th>Cats</th>
<th>Dogs</th>
<th>Fish</th>
<th>Cars</th>
<th>Boats</th>
<th>Planes</th>
<th>Trains</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Images of birds]</td>
<td>[Images of cats]</td>
<td>[Images of dogs]</td>
<td>[Images of fish]</td>
<td>[Images of cars]</td>
<td>[Images of boats]</td>
<td>[Images of planes]</td>
<td>[Images of trains]</td>
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**Typicality:**
- More typical
- Less typical

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Iordan, Greene, Beck, Fei-Fei
fMRI Experiment

Block

1-back
image-level task

8 images

12 s 160 ms 590 ms 160 ms 160 ms 590 ms 12 s

Fixation

Fixation

16 blocks

2 blocks = 16 images per subordinate category

Canoe

Biplane

Hen

Sedan

Malamute

Run 1 2 3 4 5 6 7 8

300 s

n=11

Typicality Sharpens Category Representations

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Cortical Regions of Interest: ROI

early visual cortex: 
V1, V2, V3v, hV4

object-selective: 
LOC

Typicality Sharpens Category Representations
How does the neural representation of objects vary across the typicality continuum?

1. Relationship to central category tendency
Activity Pattern Similarity

Typicality Sharpens Category Representations

more typical

less typical
Activity Pattern Similarity

Typicality Effect

Correlation with most typical

No Typicality Effect

Category Central Tendency

Correlation with least typical

Typicality Sharpens Category Representations

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Typical subordinates are more similar to category central tendency in LOC

Correlation (R)

- Most typical subordinates
- Least typical subordinates

* p < 0.05
** p < 0.01
*** p < 0.001

n = 11

Typicality Sharpens Category Representations

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How does the neural representation of objects vary across the typicality continuum?

1. Relationship to central category tendency

2. Strength of category boundaries
Category Boundary Effect

Within-Category Similarity

Category Boundary Effect = \( \text{mean}(A) - \text{mean}(B) \)

Between-Category Similarity

Kriegeskorte et al. (2008), Iordan et al. (2015)
Typicality Sharpens Category Representations

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More Typical Subordinates
Category Boundary

Less Typical Subordinates
Category Boundary

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Typicality Sharpens Category Representations

More Typical Objects
More Distinguishable

Less Typical Subordinates
Category Boundary

More Typical Subordinates
Category Boundary

No Difference

Typicality Sharpens Category Representations
Typical exemplars are more similar to each other and more distinguishable from other categories in LOC.
How does the neural representation of objects vary across the typicality continuum?

1. Relationship to central category tendency

2. Strength of category boundaries

3. Full-brain searchlight analysis
Typicality Sharpens Category Representations

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More Typical Objects
More Distinguishable

Correlation (R)

*  

Voxel cube

Category Boundary Effect

Typicality Sharpens Category Representations

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**Typicality Effect: LOC**

- More Typical Objects
- More Distinguishable

Typicality Sharpens Category Representations

- Strength of Category Boundaries

- n = 11
- FDR < 0.05

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Typicality Effect: LOC

Less Typical Objects More Distinguishable

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<td><img src="chart1.png" alt="Bar Chart" /></td>
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More Typical Objects More Distinguishable

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<td><img src="chart2.png" alt="Bar Chart" /></td>
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Atypicality Effect: cIPL

Typicality Effect: LOC

Objects: Konen & Kastner 2008
Learning: Zeithamova et al. 2004
Context: Vilberg & Rugg 2012

n = 11  FDR < 0.05
How does the neural representation of real-world objects vary across the typicality continuum?

Typical exemplars are more similar to central category tendency in LOC.

Typical exemplars distinguish more strongly between categories in LOC.
How does the neural representation of real-world objects vary across the typicality continuum?

Evidence for a prototype representation for real-world object categories in LOC
How does the neural representation of real-world objects vary across the typicality continuum?

Evidence for a prototype representation for real-world object categories in LOC

Less typical exemplars exhibit stronger category boundaries in c IPL
How does the neural representation of real-world objects vary across the typicality continuum?

Evidence for a prototype representation for real-world object categories in LOC

Suggests contextual facilitation of categorization for atypical exemplars in cIPL
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William R. Hewlett Stanford Graduate Fellowship (SGF) to M.C.I.
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