Typicality Sharpens Category Representations in Object-Selective Cortex

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DOG

Typical Categories

are recognized and categorized faster than
less typical categories

Rosch 1973

Rosch & Mervis 1975

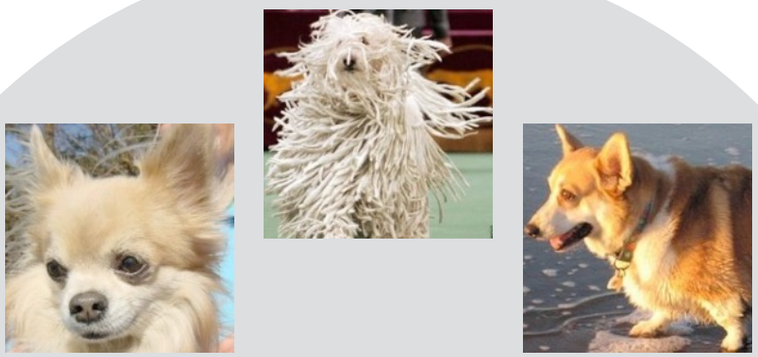
DOG

Neural Correlates of Real-World Object Typicality

more typical — less typical

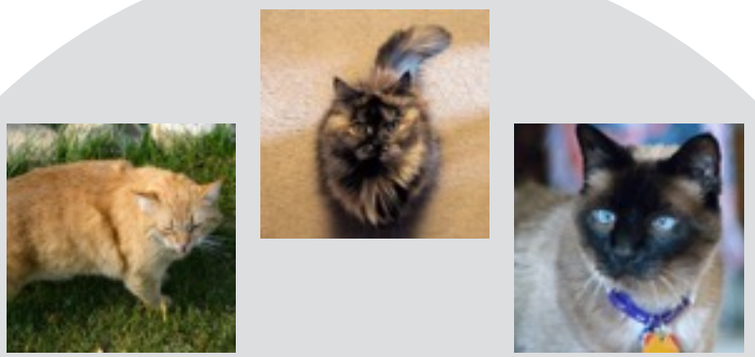
How does the neural representation of real-world objects vary across the typicality continuum ?

#1: Relationship to category central tendency



Posner & Keele (1968), Rosch & Mervis (1975), Davis and Poldrack (2014), and many others

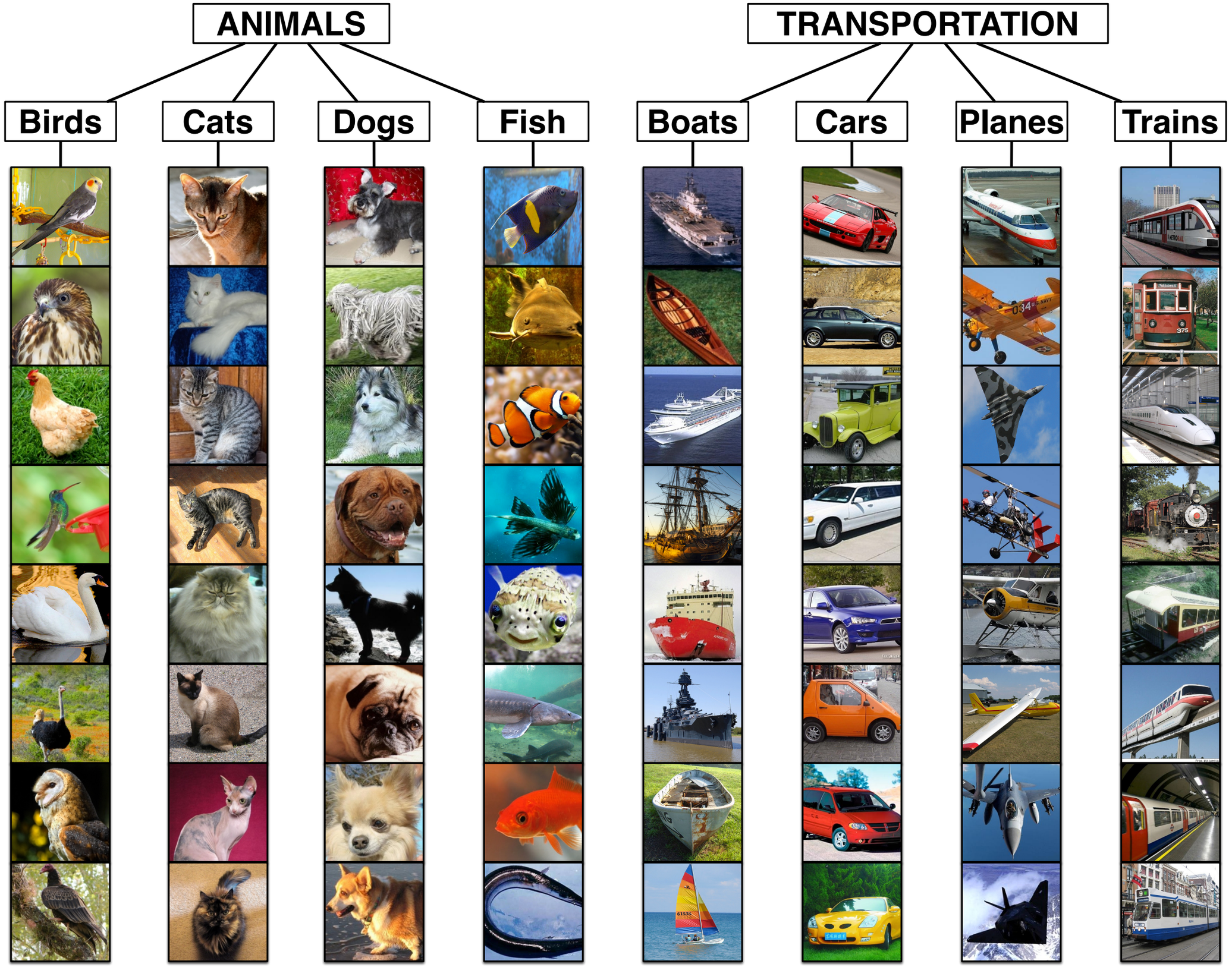
#2: Differentiating between basic level categories



Rosch & Mervis (1975), Sigala & Logothetis (2002), Freedman et al. (2003), and many others

Rosch & Mervis (1975)

Family Resemblance Hypothesis



64 categories x 16 images per category

IMAGENET

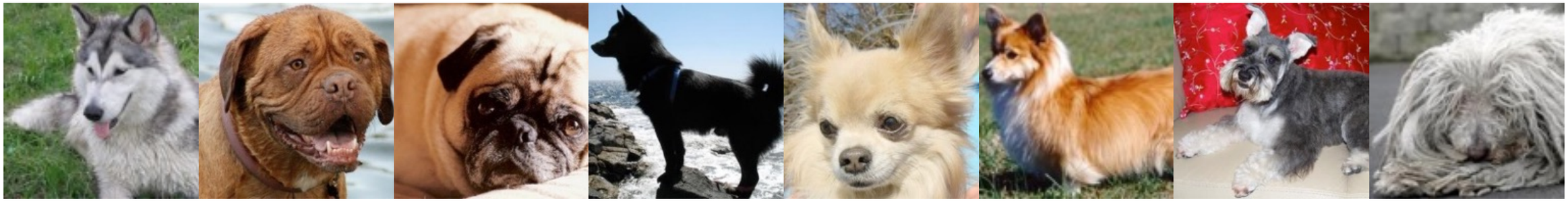
Behavioral Experiment to Assess Category Typicality

DOG

8 subordinates

all pairwise typicality judgments

typicality ranking



more typical

less typical

Typicality Ranking

Birds

Cats

Dogs

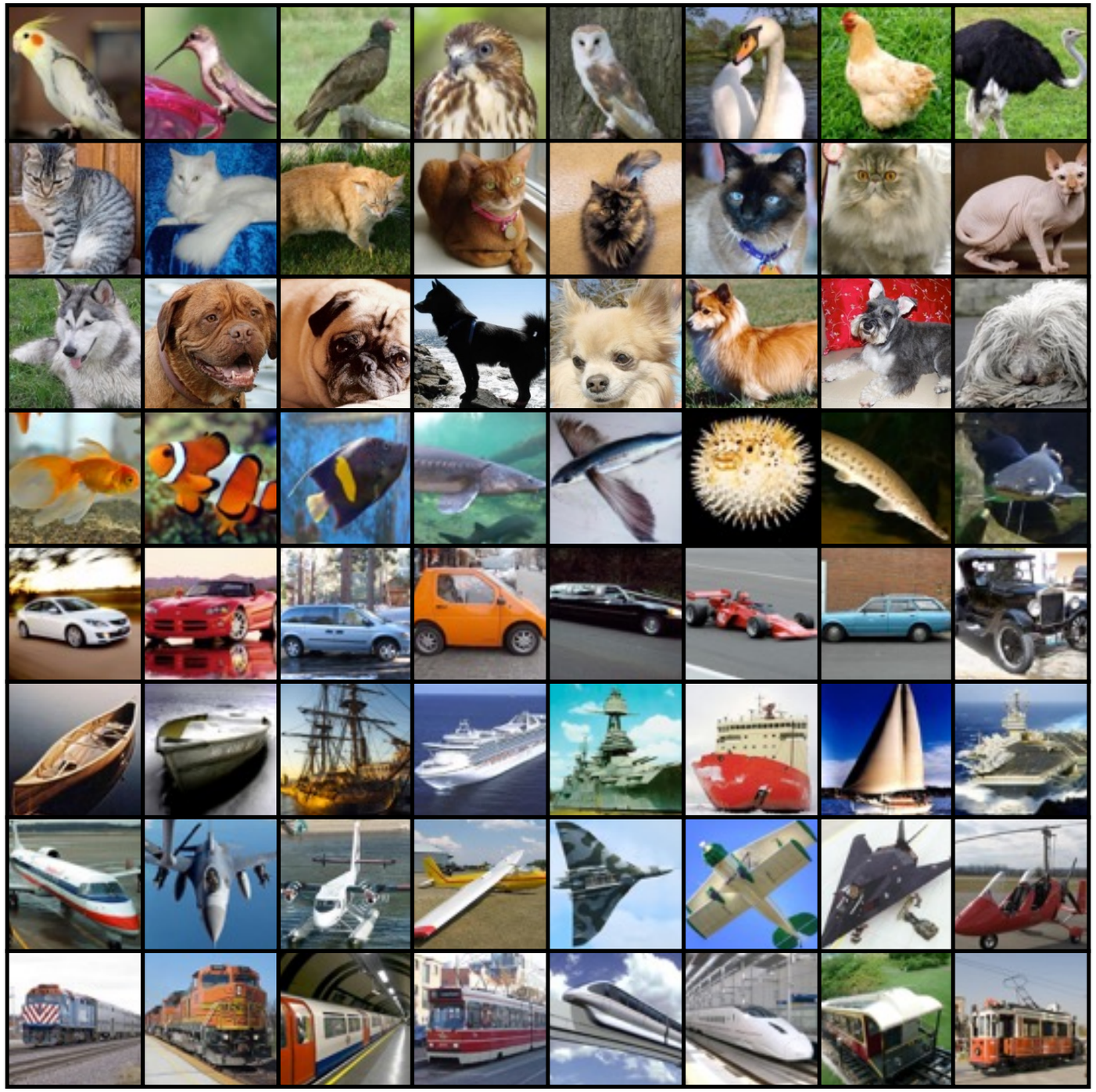
Fish

Cars

Boats

Planes

Trains



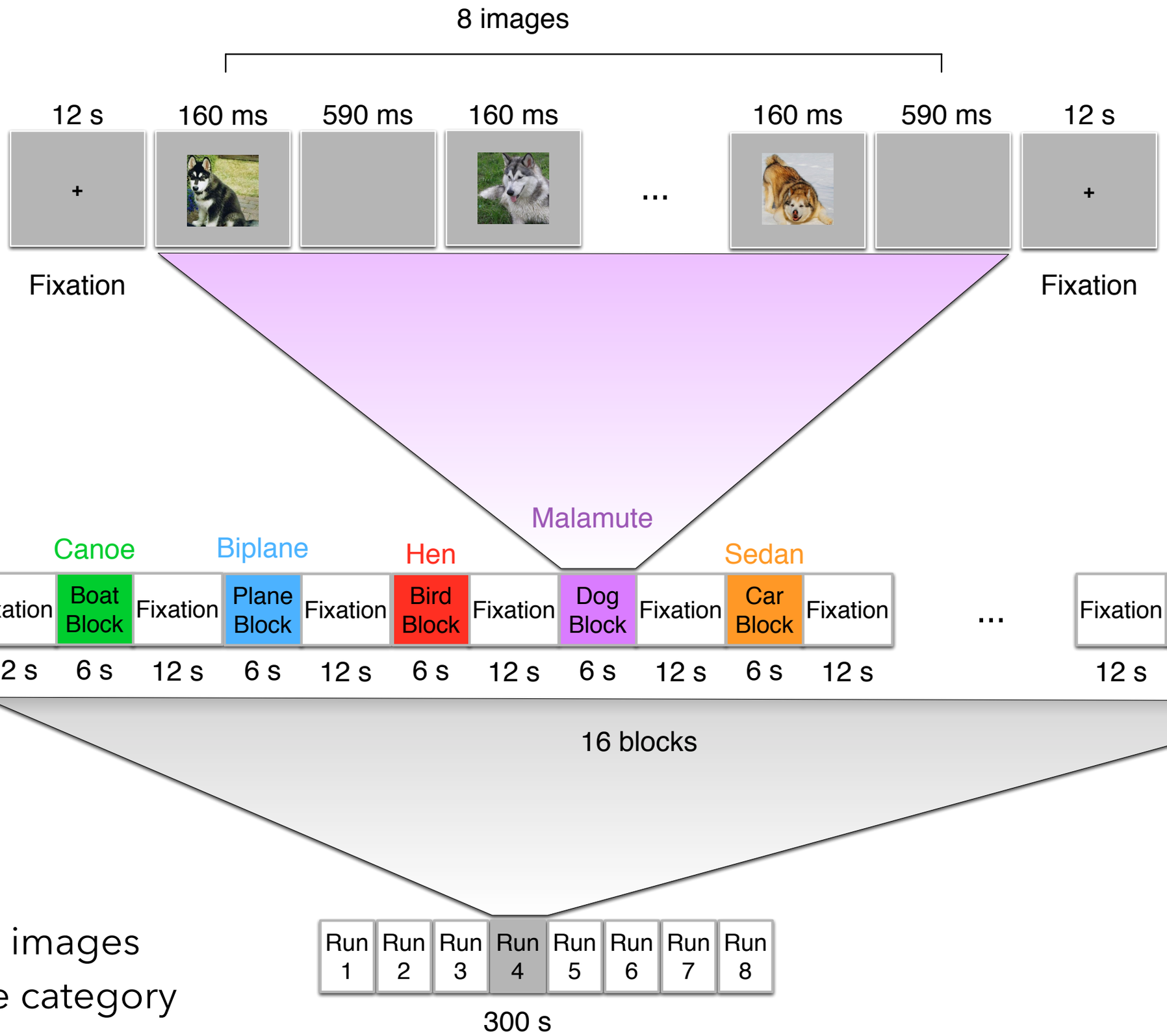
more typical

less typical

fMRI Experiment

Block

1-back
image-level task



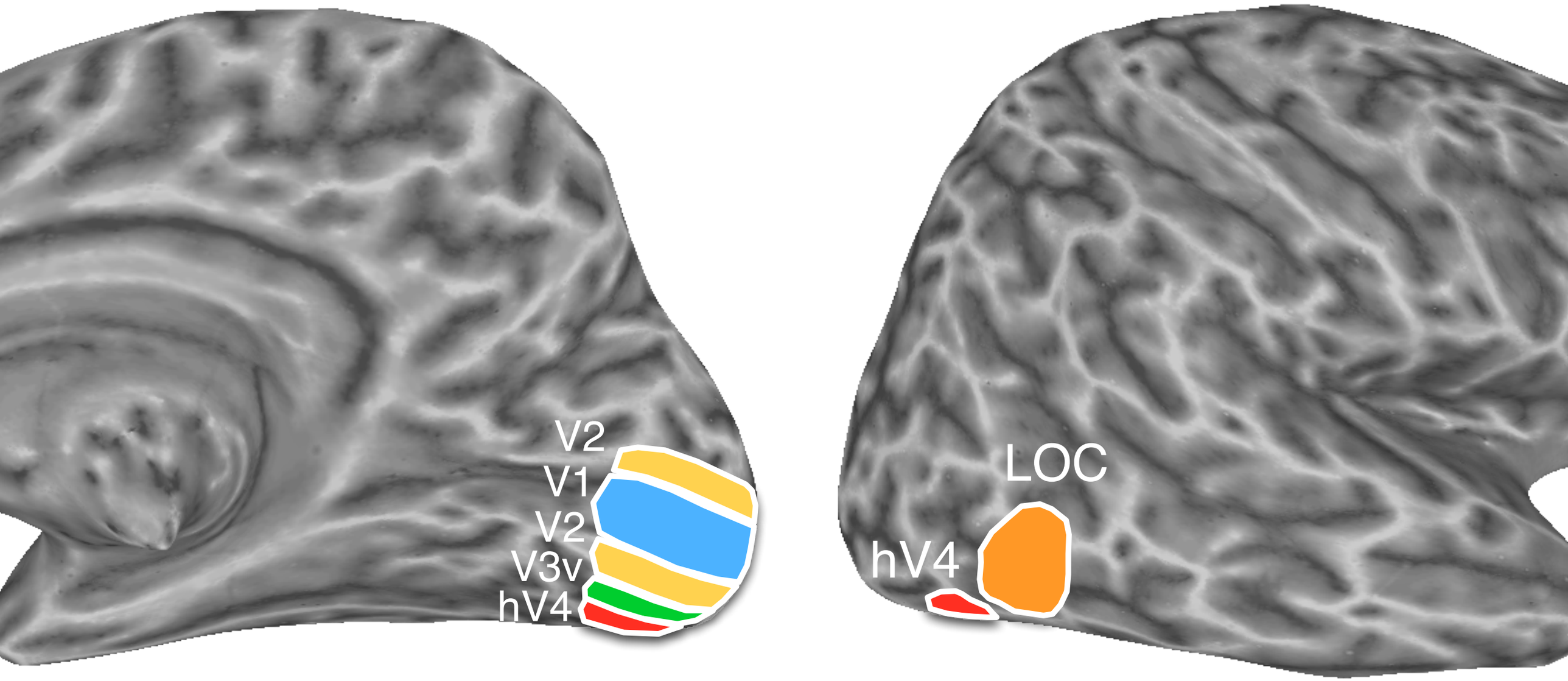
2 blocks = 16 images
per subordinate category

n=11

Cortical Regions of Interest: ROI

early visual cortex:
V1, V2, V3v, hV4

object-selective:
LOC

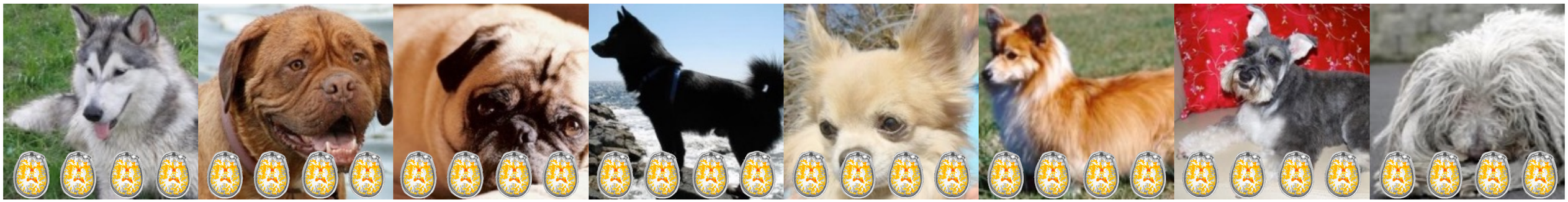


Outline

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

1. Relationship to central category tendency

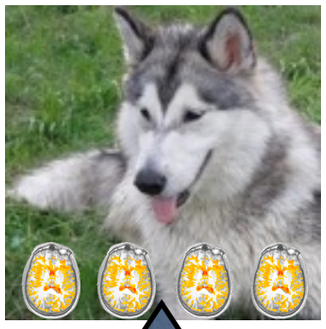
Activity Pattern Similarity



more typical

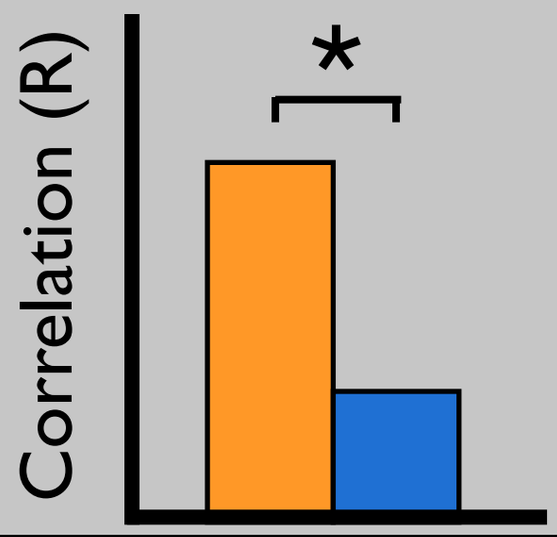
less typical

Activity Pattern Similarity



Correlation with most typical

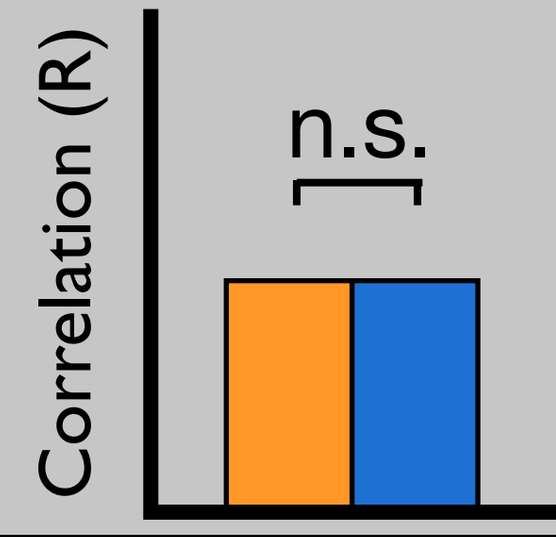
Typicality Effect



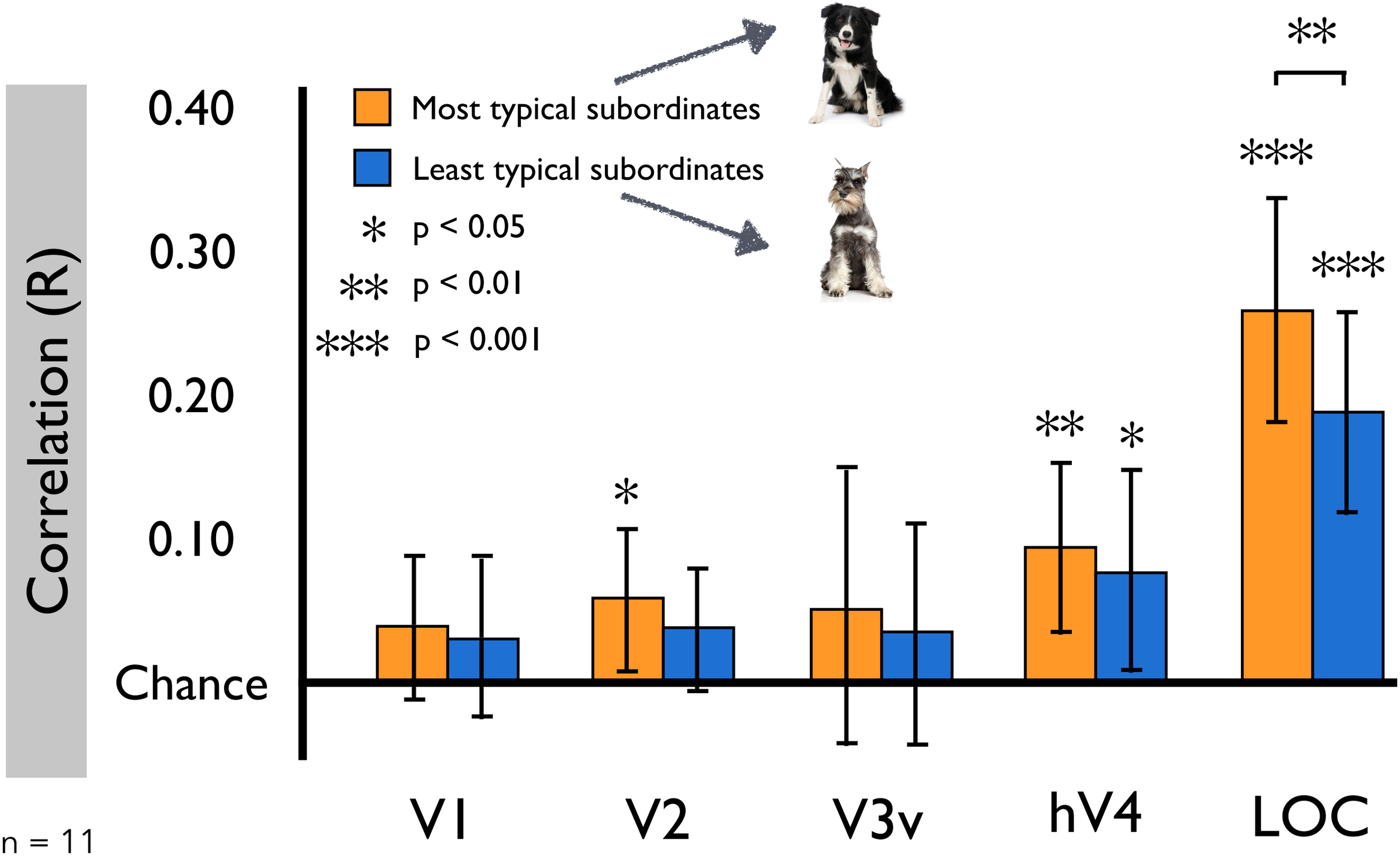
Category Central Tendency

Correlation with least typical

No Typicality Effect



Typical subordinates are more similar to category central tendency in LOC



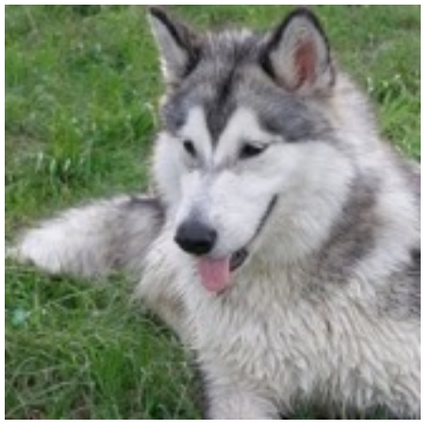
Outline

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



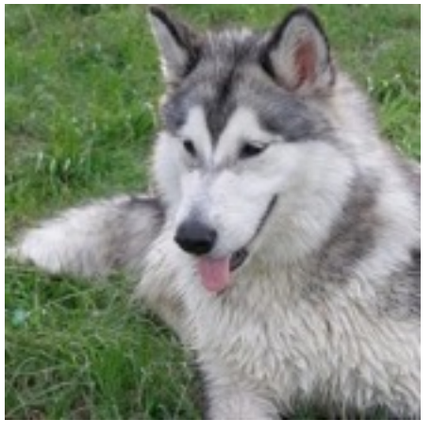
Within-Category Similarity

A

Pearson r

Category Boundary Effect =

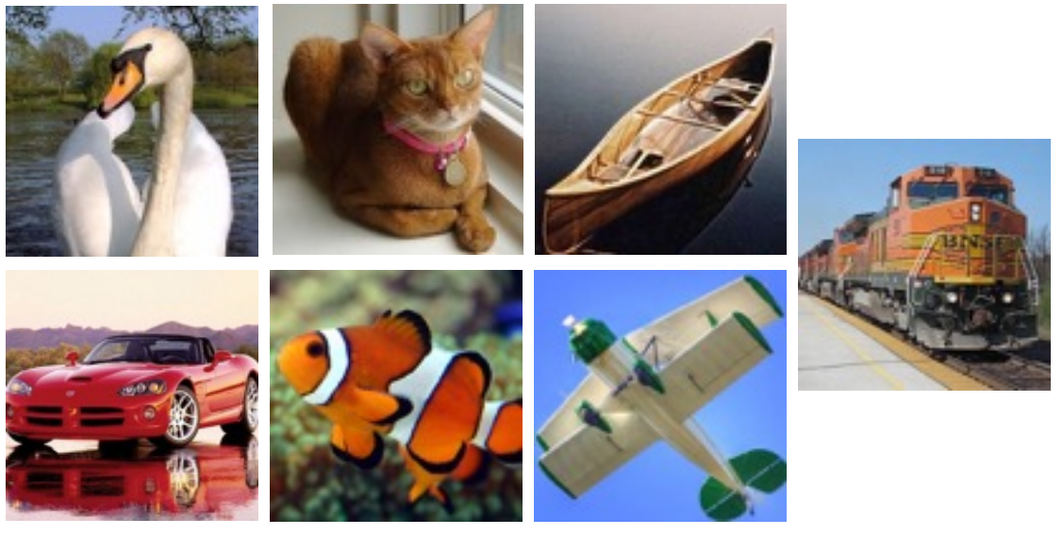
mean(A) − mean(B)



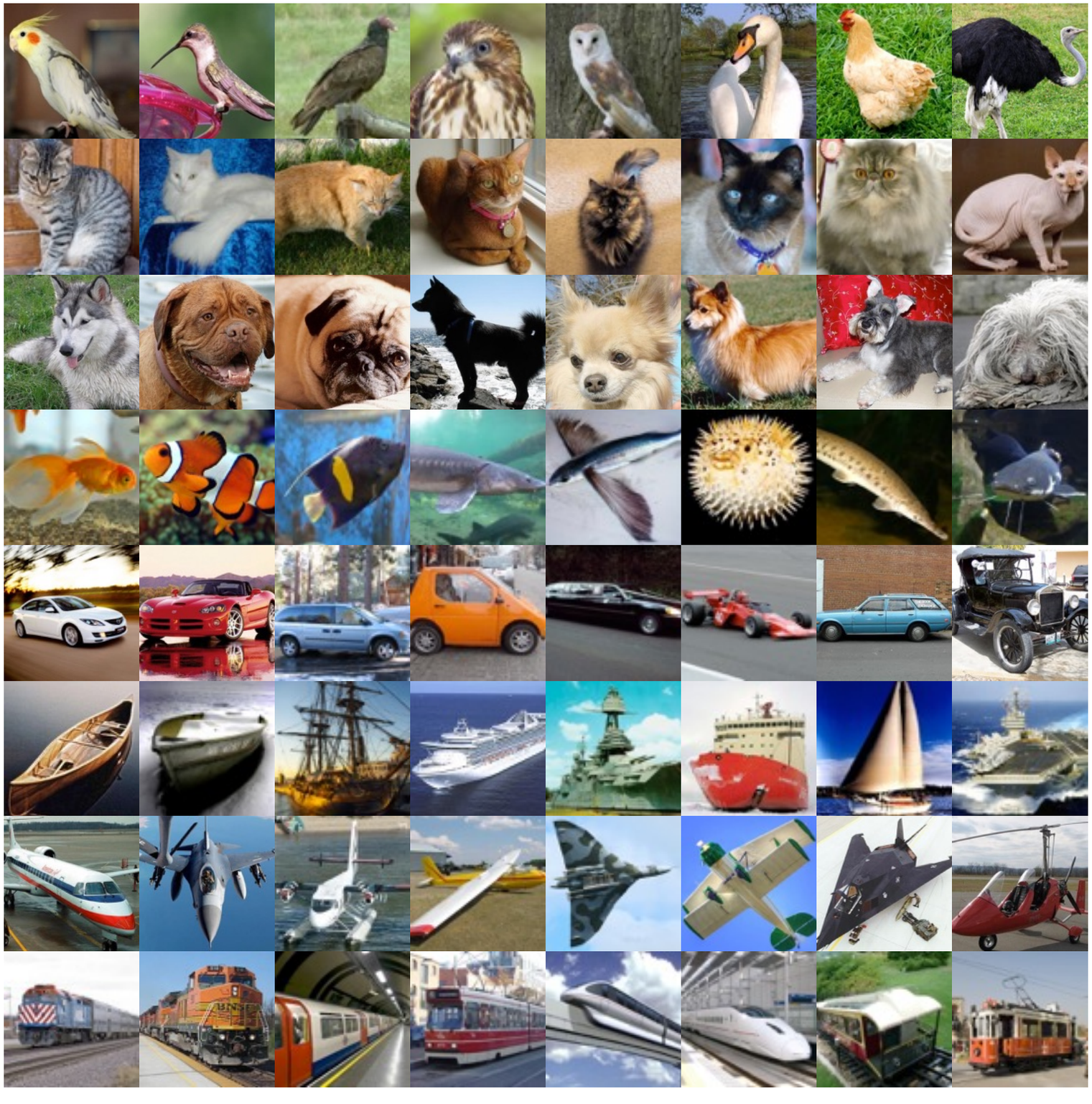
Between-Category Similarity

B

Pearson r



Kriegeskorte et al. (2008), Iordan et al. (2015)



more typical

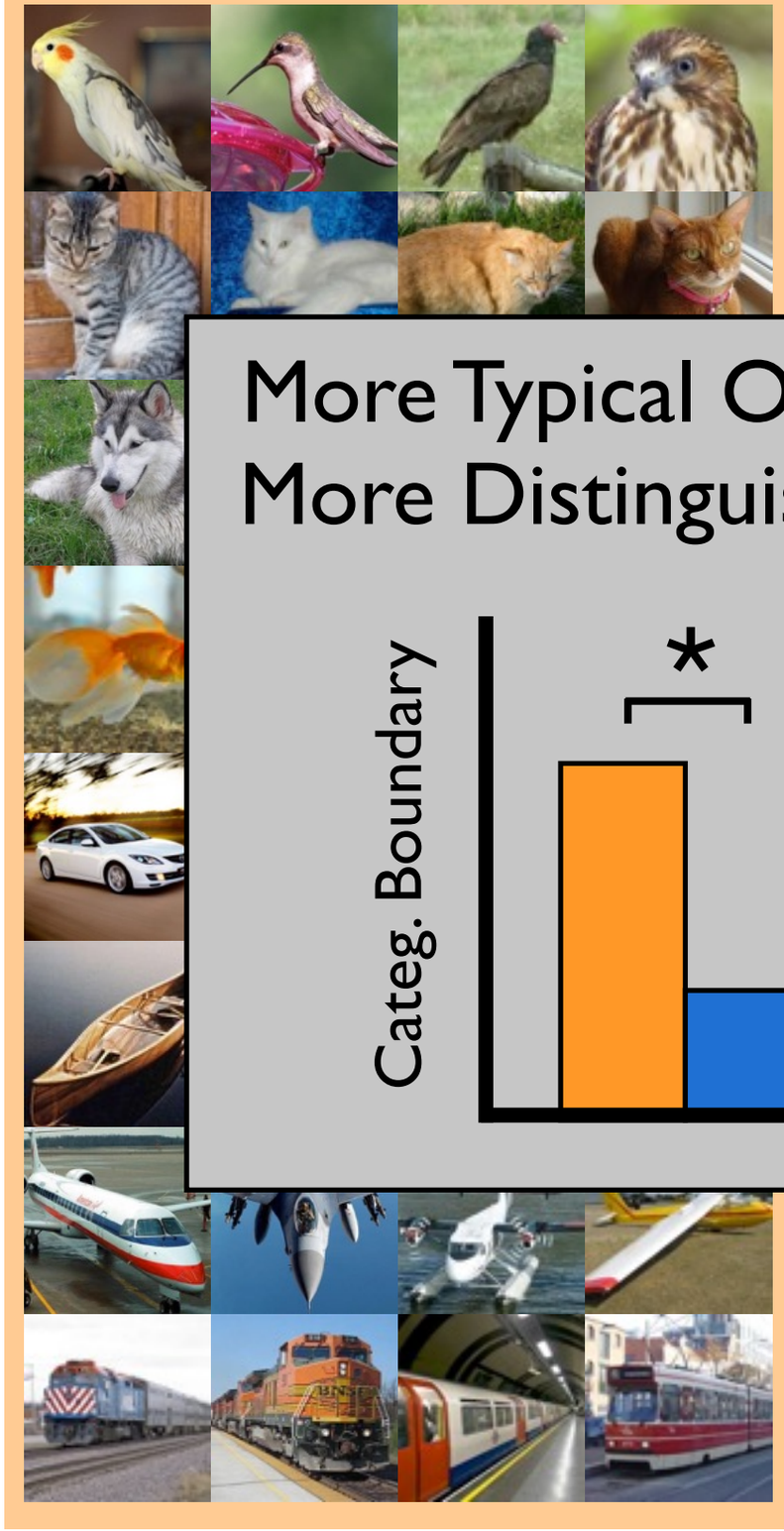
less typical

More Typical
Subordinates
Category Boundary

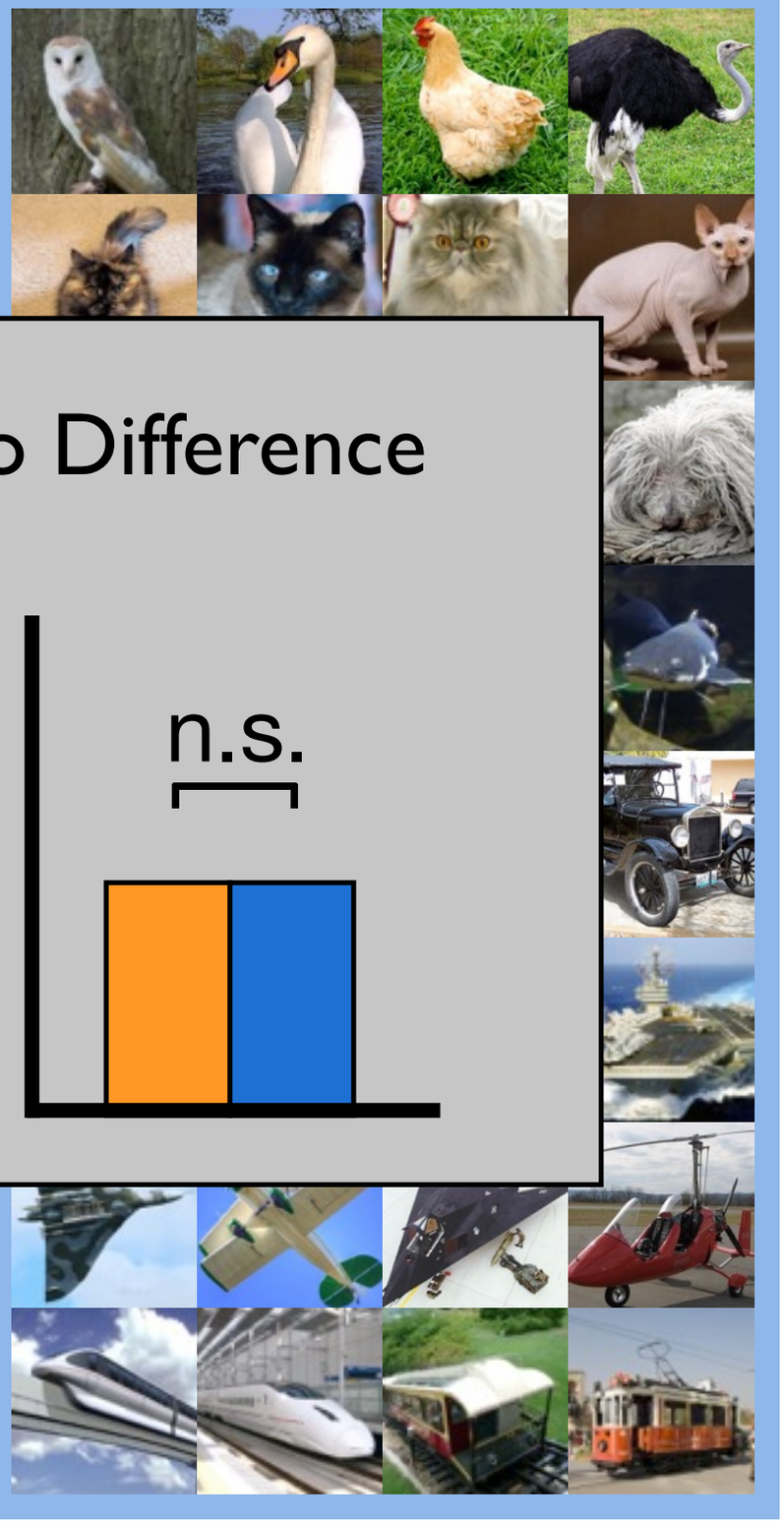
Less Typical
Subordinates
Category Boundary

more typical

less typical



More Typical
Subordinates
Category Boundary



More Typical Objects
More Distinguishable

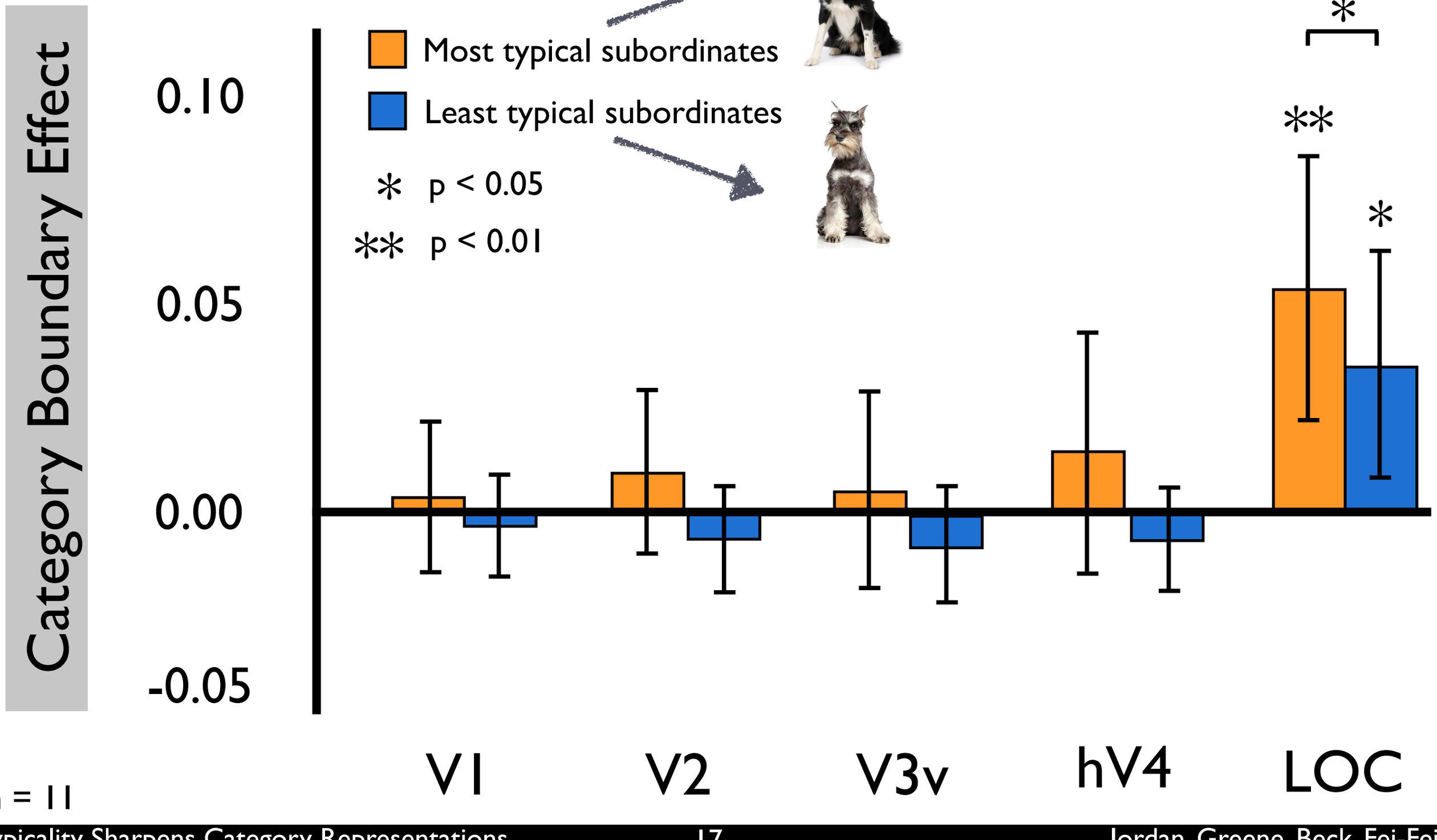
No Difference

Less Typical
Subordinates
Category Boundary

more typical

less typical

Typical exemplars are more similar to each other and more distinguishable from other categories in LOC



n = 11

Outline

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

LH

Voxel cube

RH

TOS

LOC

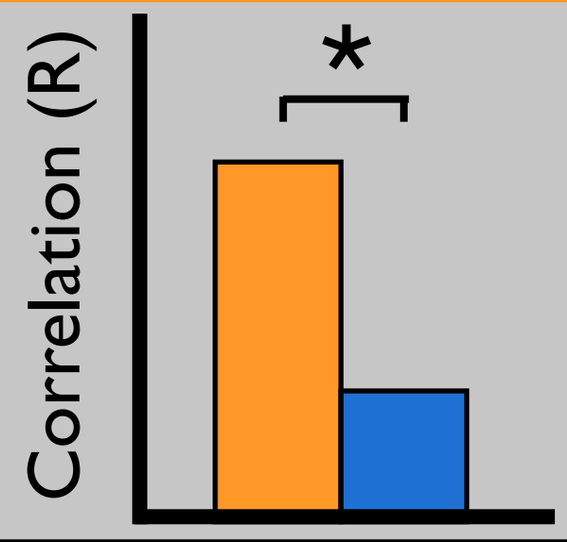
hV4

TOS

hV4

LOC

More Typical Objects
More Distinguishable



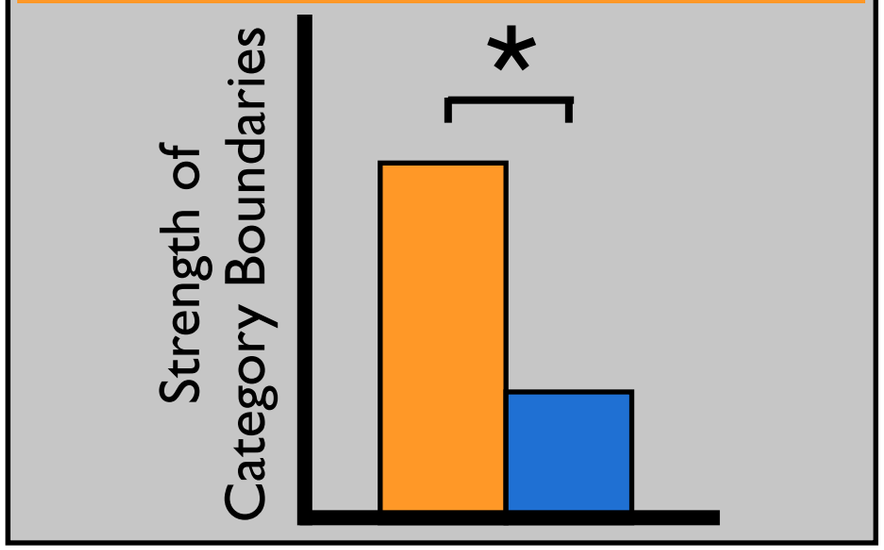
LH

Voxel cube

Category Boundary Effect

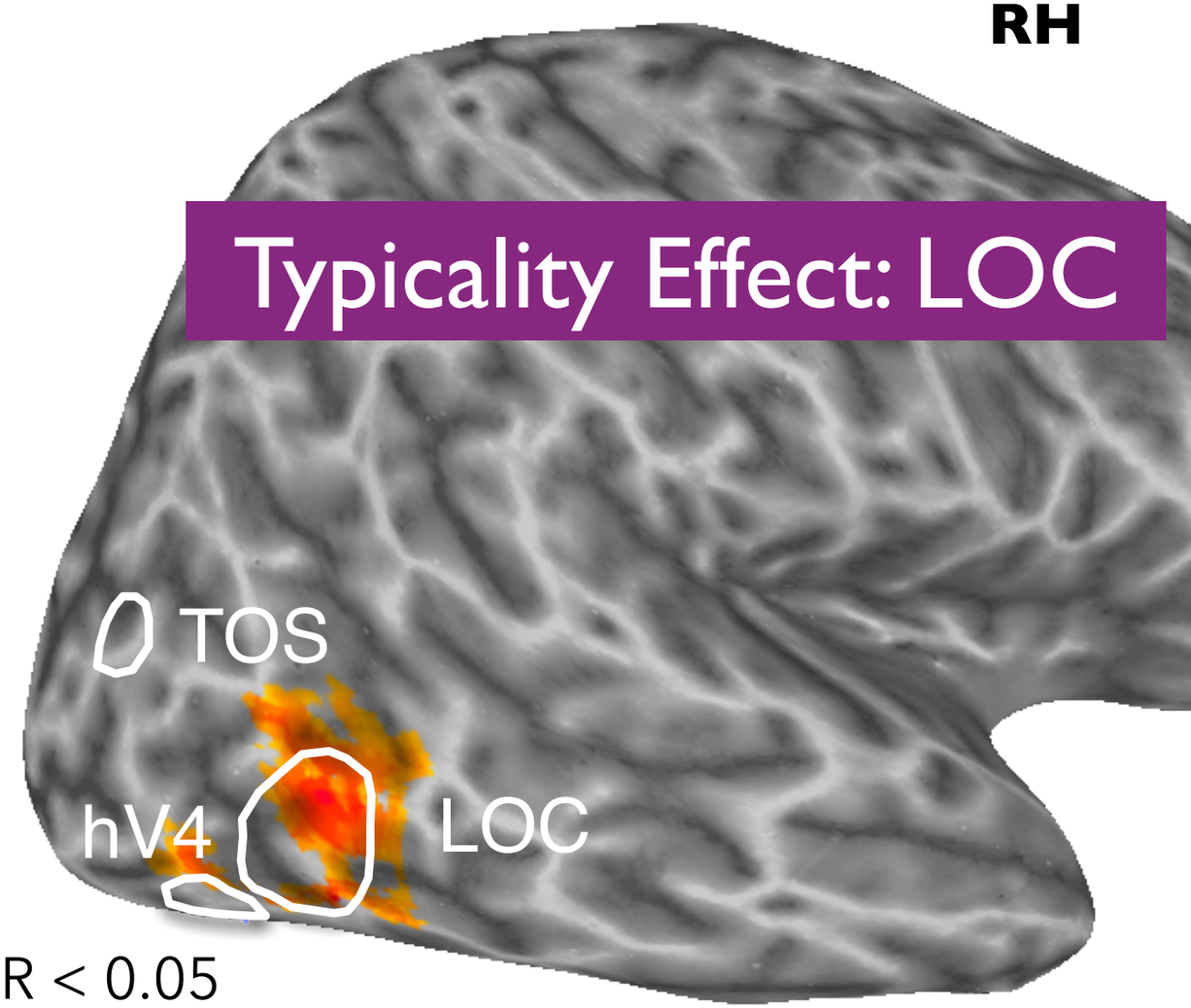
RH

More Typical Objects
More Distinguishable

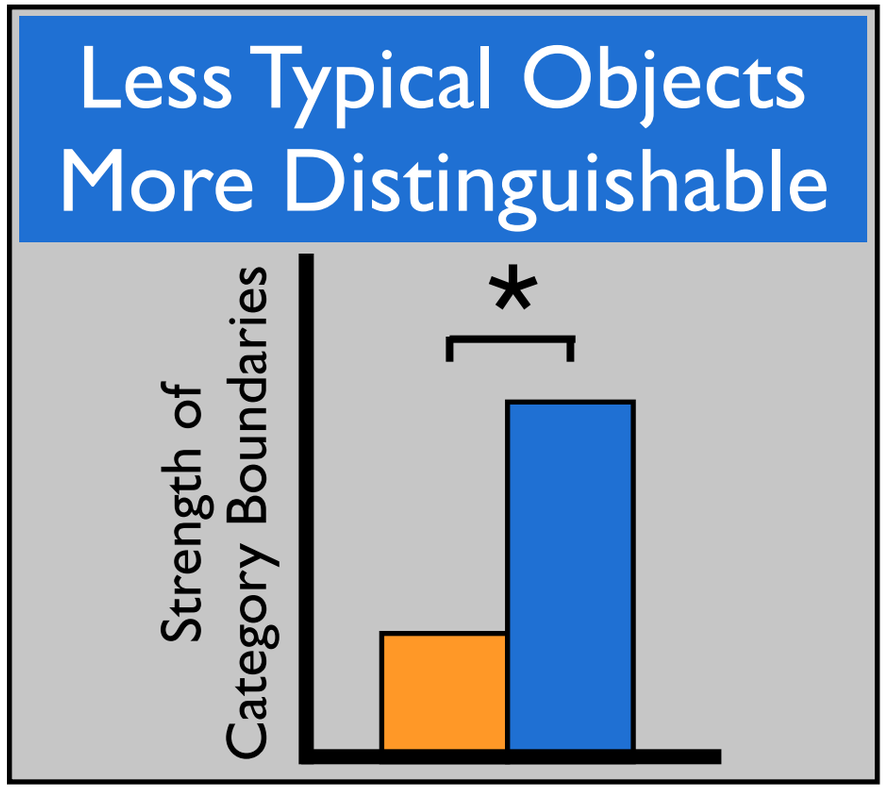


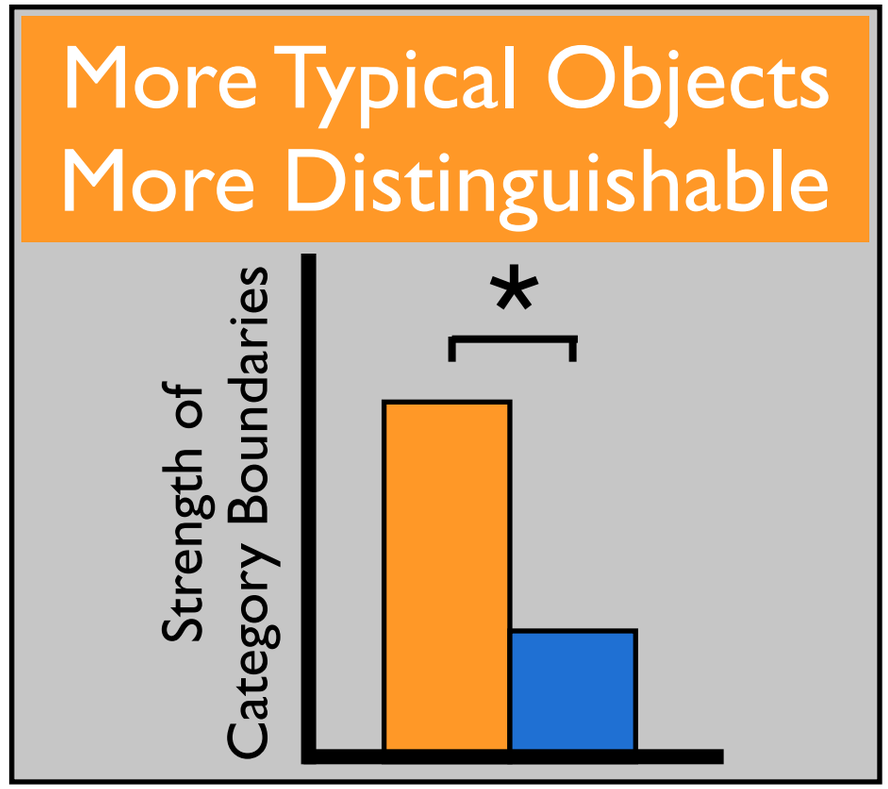
RH

Typicality Effect: LOC



n = 11 FDR < 0.05



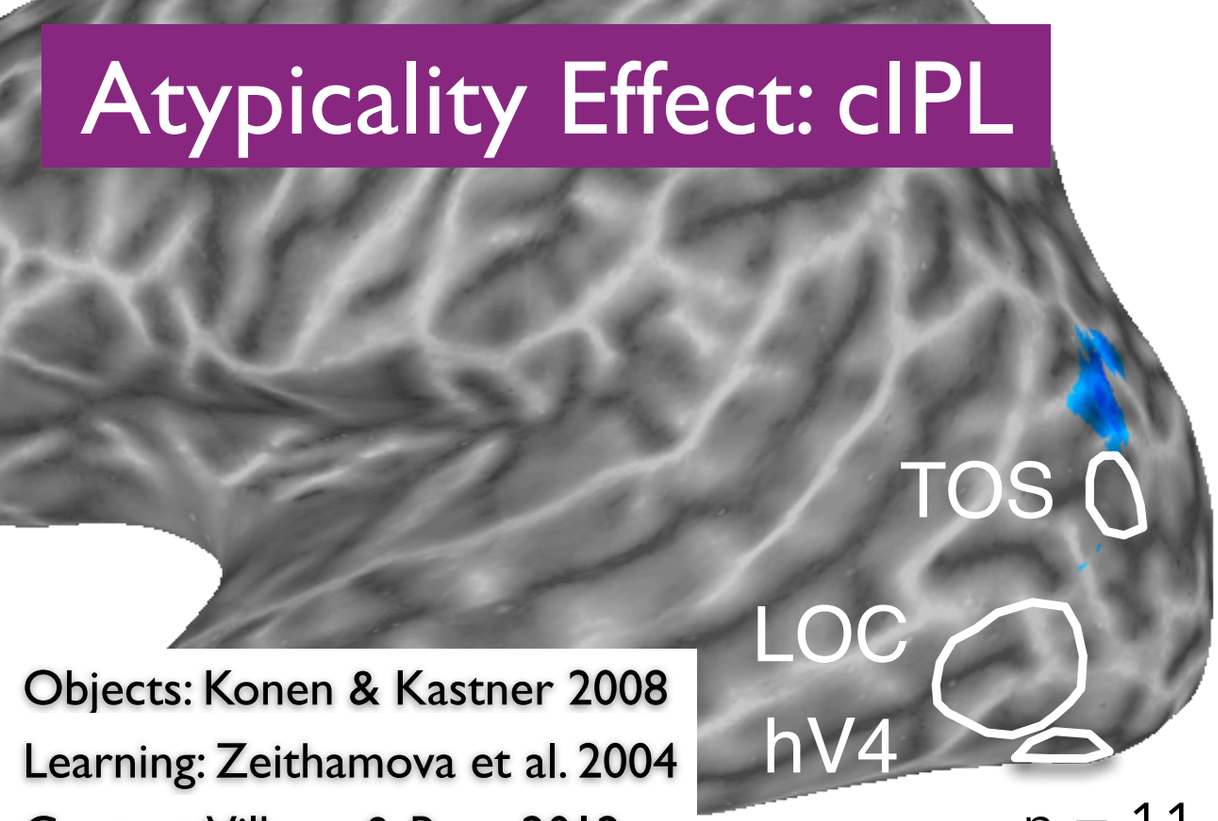


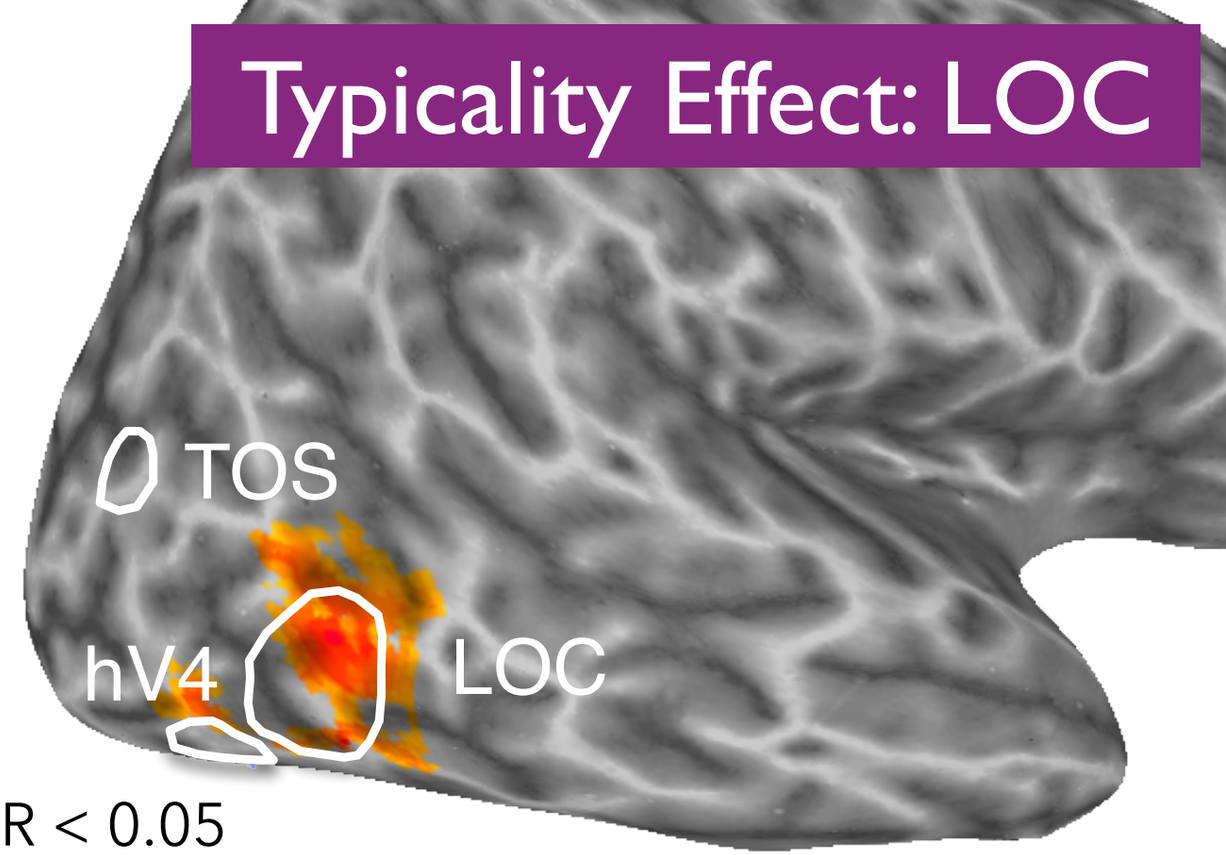
LH

RH

Atypicality Effect: cIPL

Typicality Effect: LOC





Objects: Konen & Kastner 2008

Learning: Zeithamova et al. 2004

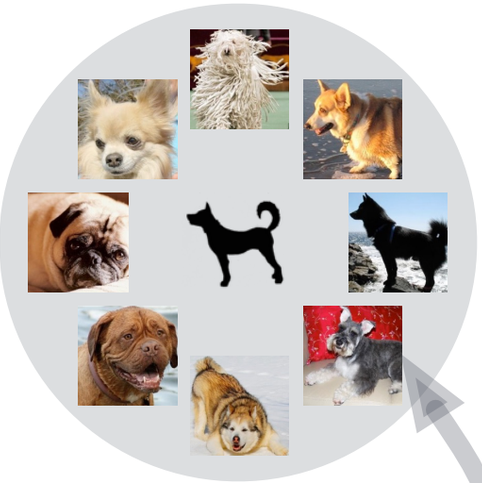
Context: Vilberg & Rugg 2012

n = 11

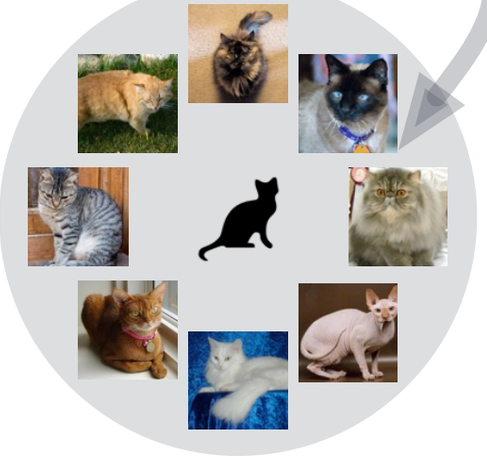
FDR < 0.05

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

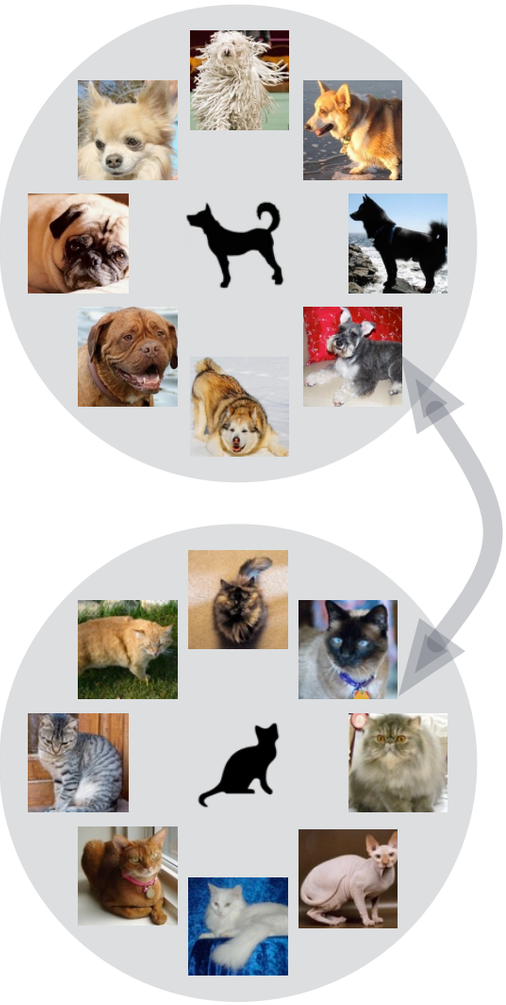


Typical exemplars distinguish more strongly between categories in LOC



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

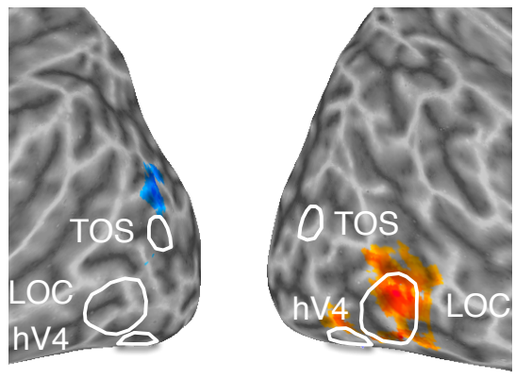
Evidence for a prototype representation for real-world object categories in LOC



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 cIPL



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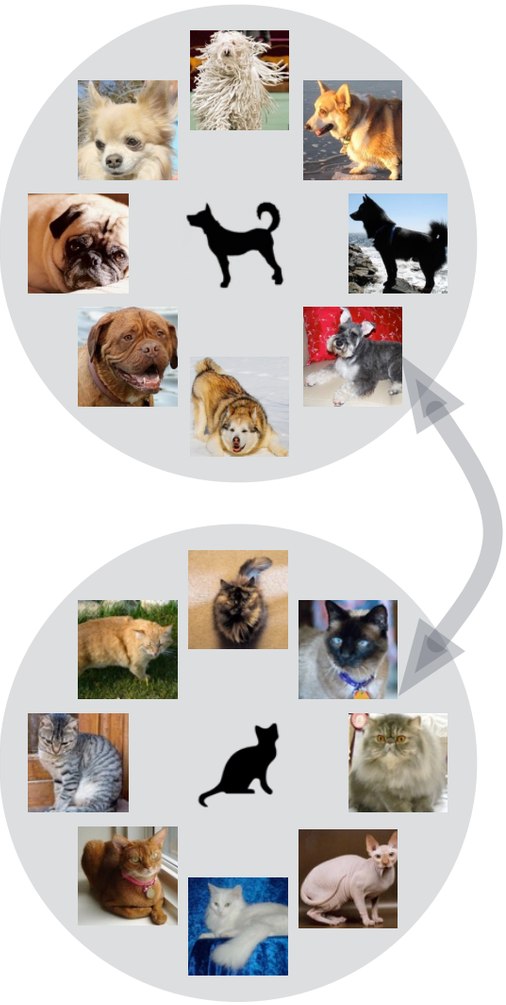
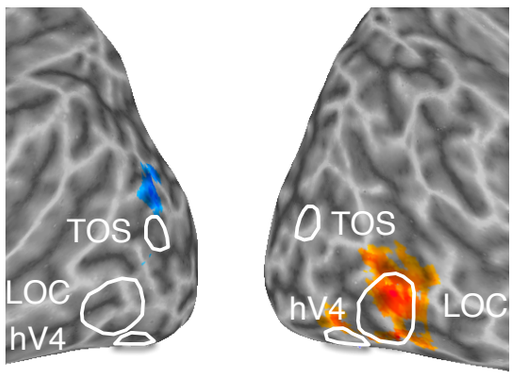
Evidence for a prototype representation for real-world object categories in LOC



Suggests contextual facilitation of categorization for atypical exemplars in cIPL



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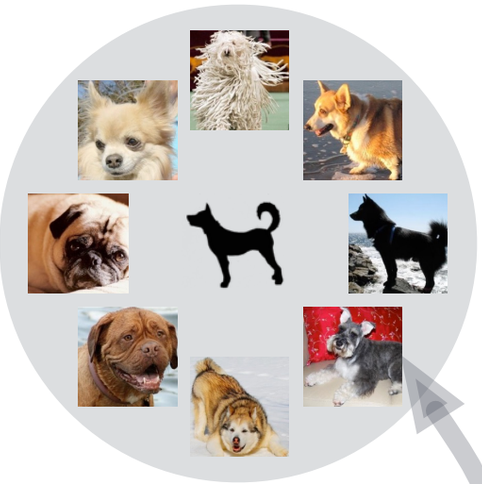
How does the neural representation of real-world objects vary across the typicality continuum ?

Typical exemplars are more similar to central category tendency in LOC



Typical exemplars distinguish more strongly between categories in LOC

Less typical exemplars exhibit stronger category boundaries in cIPL