# Basic Level Category Structure Emerges Gradually Across Human Ventral Visual Cortex

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Vision Lunch — Jan. 2015

# How do category representations change across taxonomic levels in human visual cortex ?

General

SUPERORDINATE — natural object

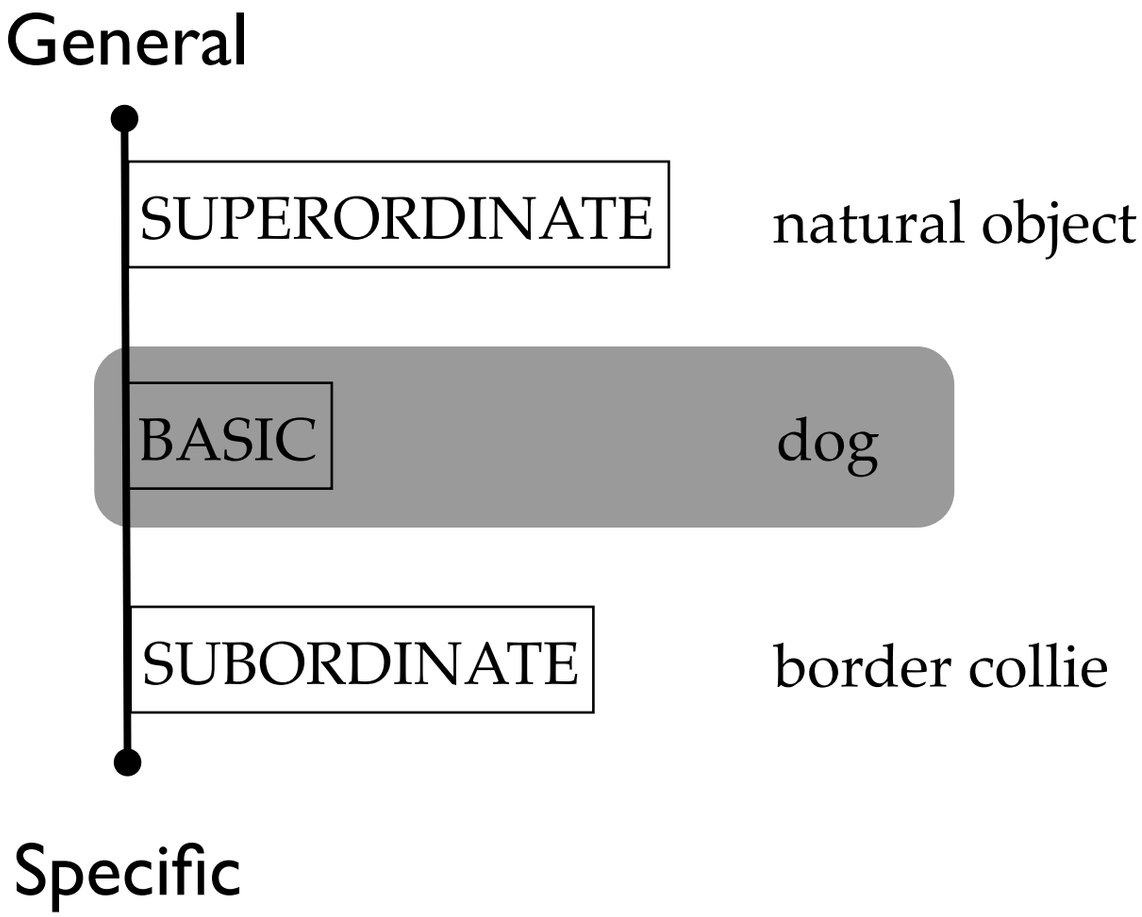
BASIC — dog

SUBORDINATE — border collie

Specific

Rosch et al. (1976)

# How do category representations change across taxonomic levels in human visual cortex ?




1. Experimental Setup
2. Similarity of Neural Patterns
3. Category Information at Each Taxonomic Level

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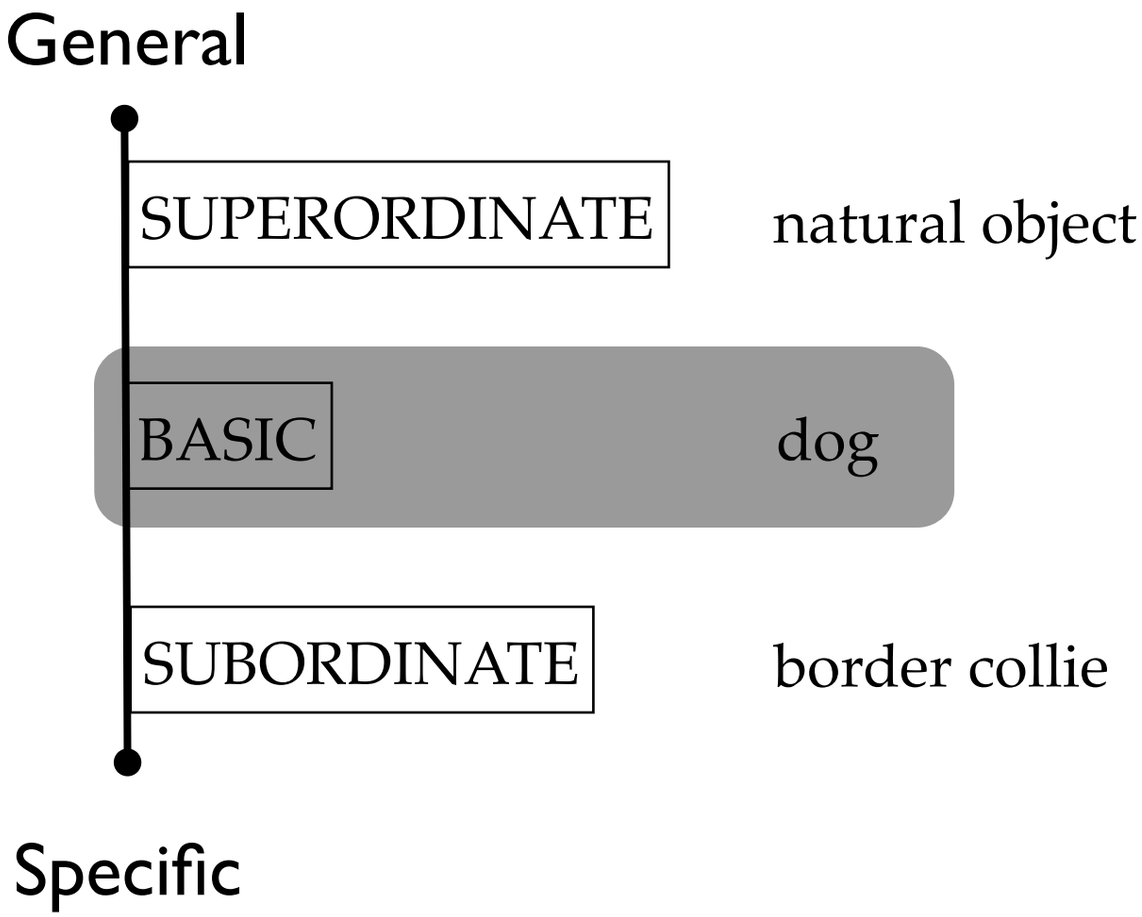


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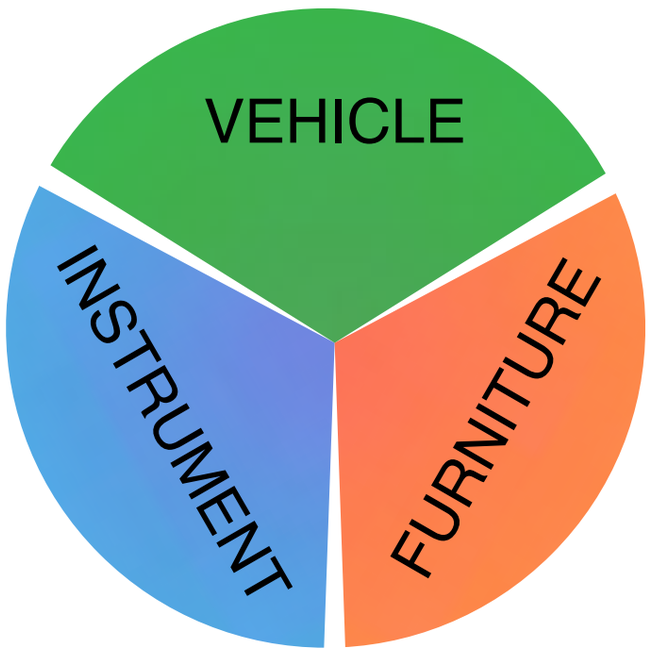
## Is there a privileged taxonomic level ?

big, inanimate objects

subset of Rosch et al. (1976)



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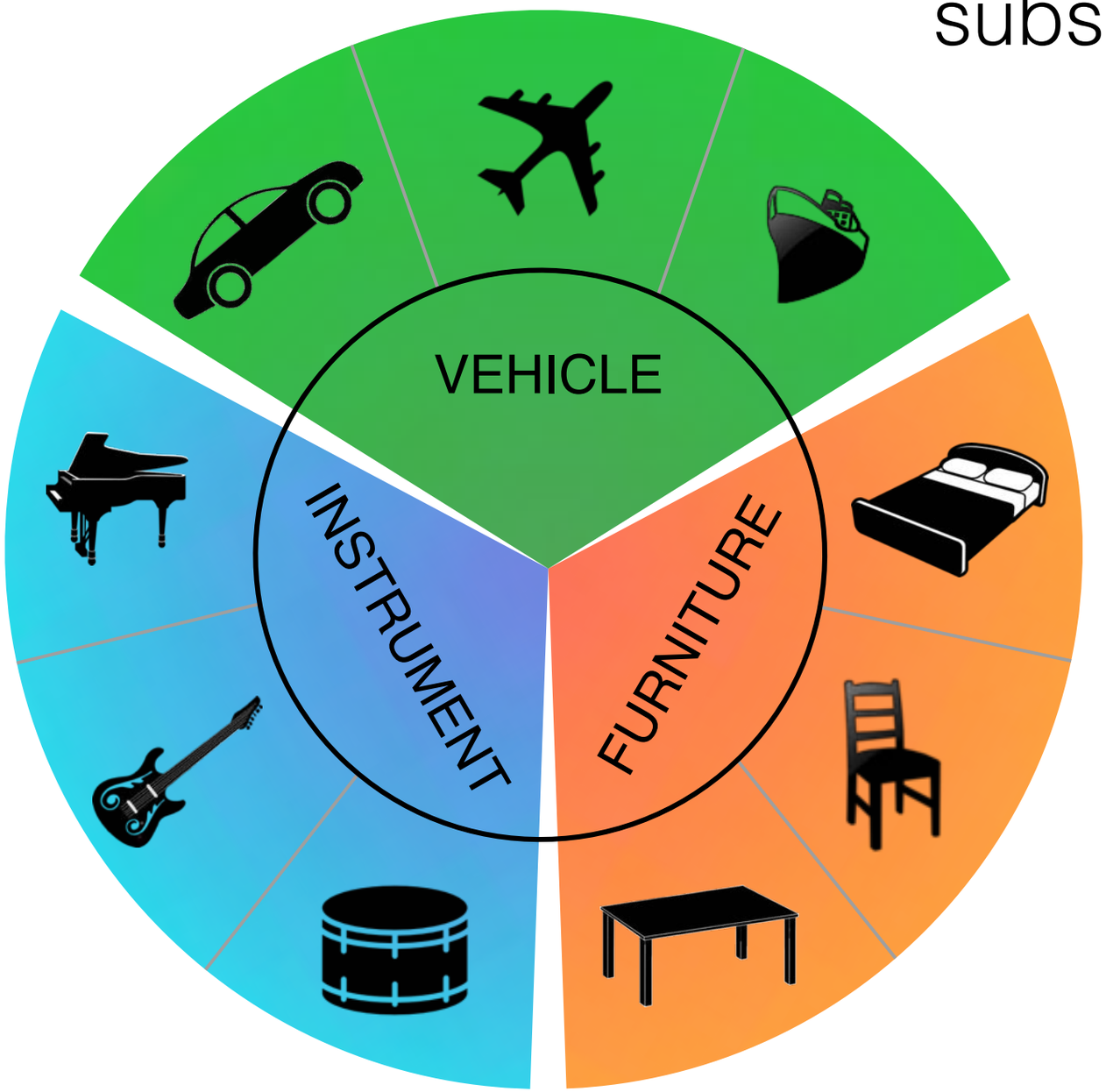
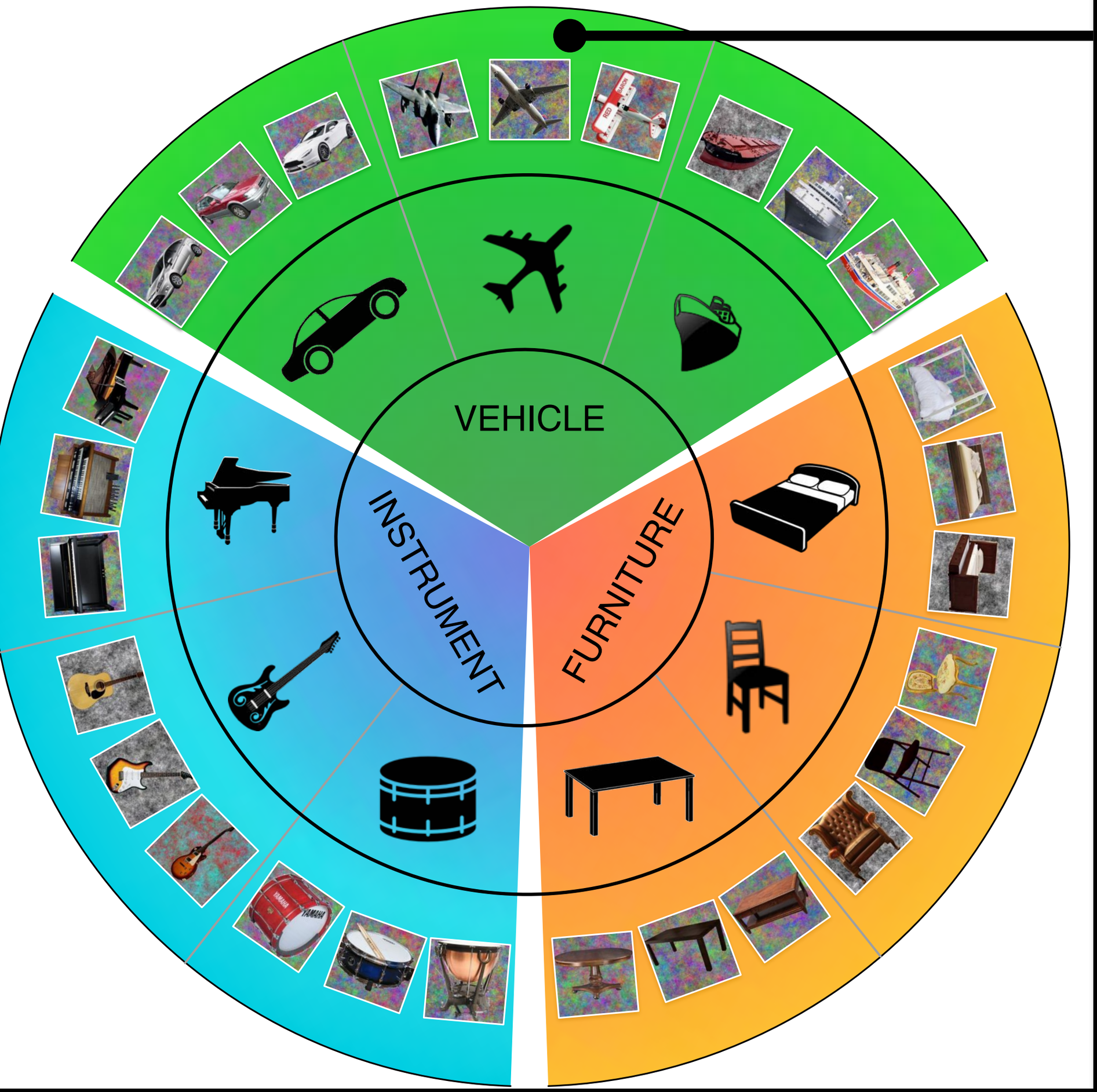
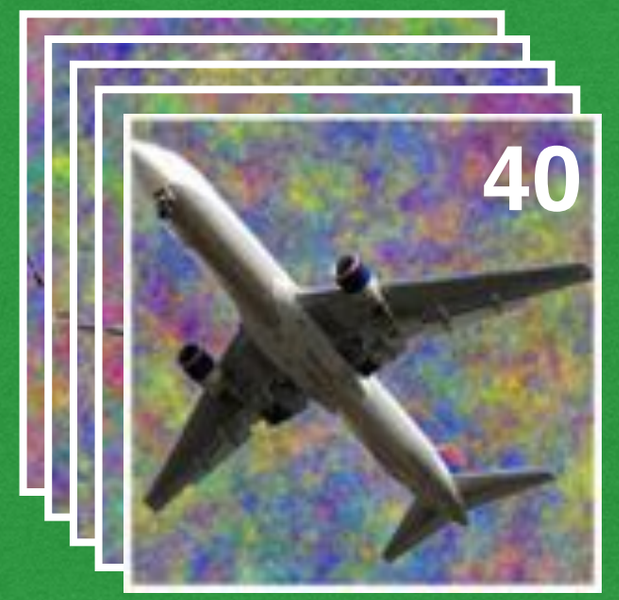



VEHICLE
INSTRUMENT
FURNITURE


40

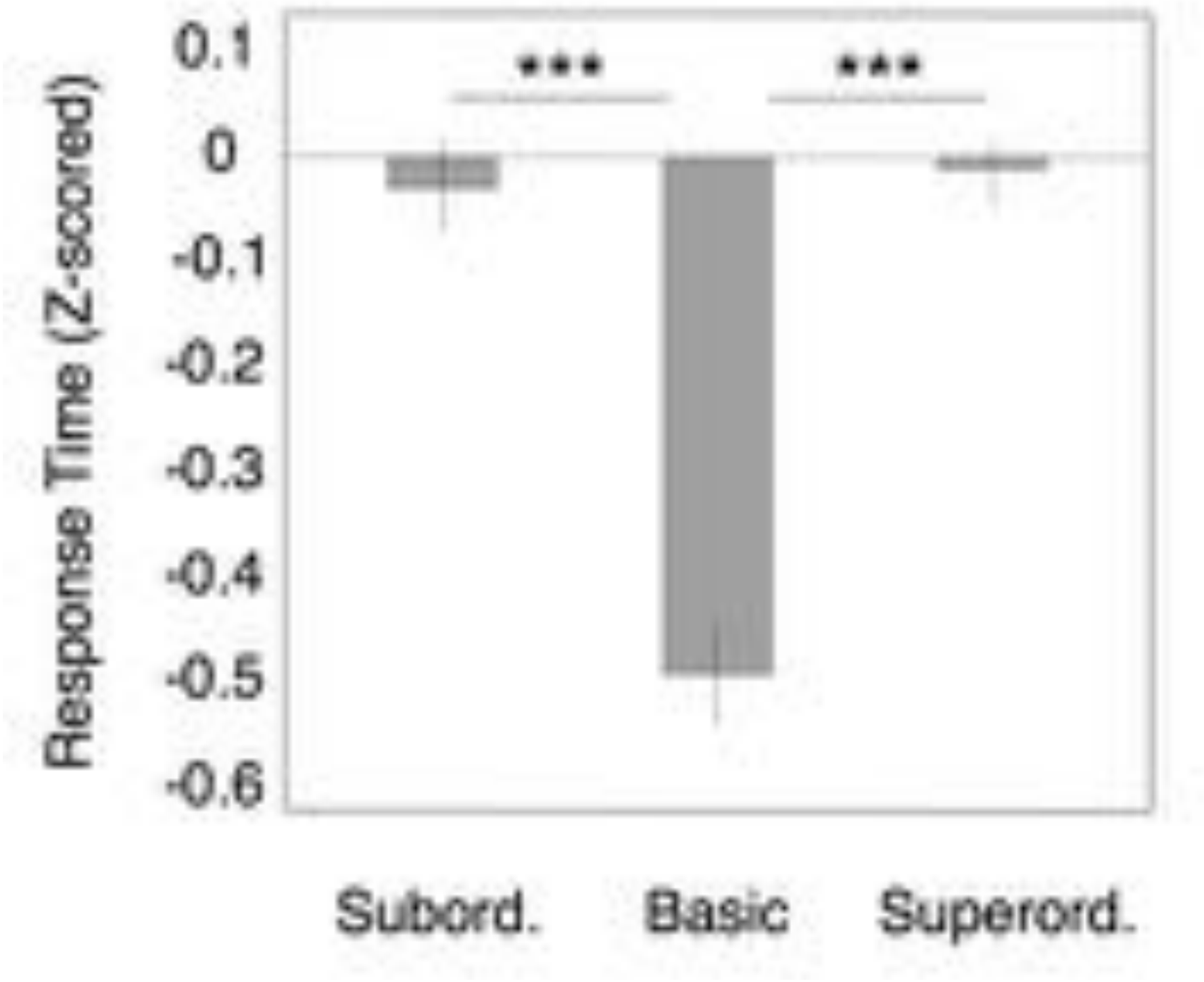

40


40
BARON
RED

# Match-to-Category Behavioral Experiment

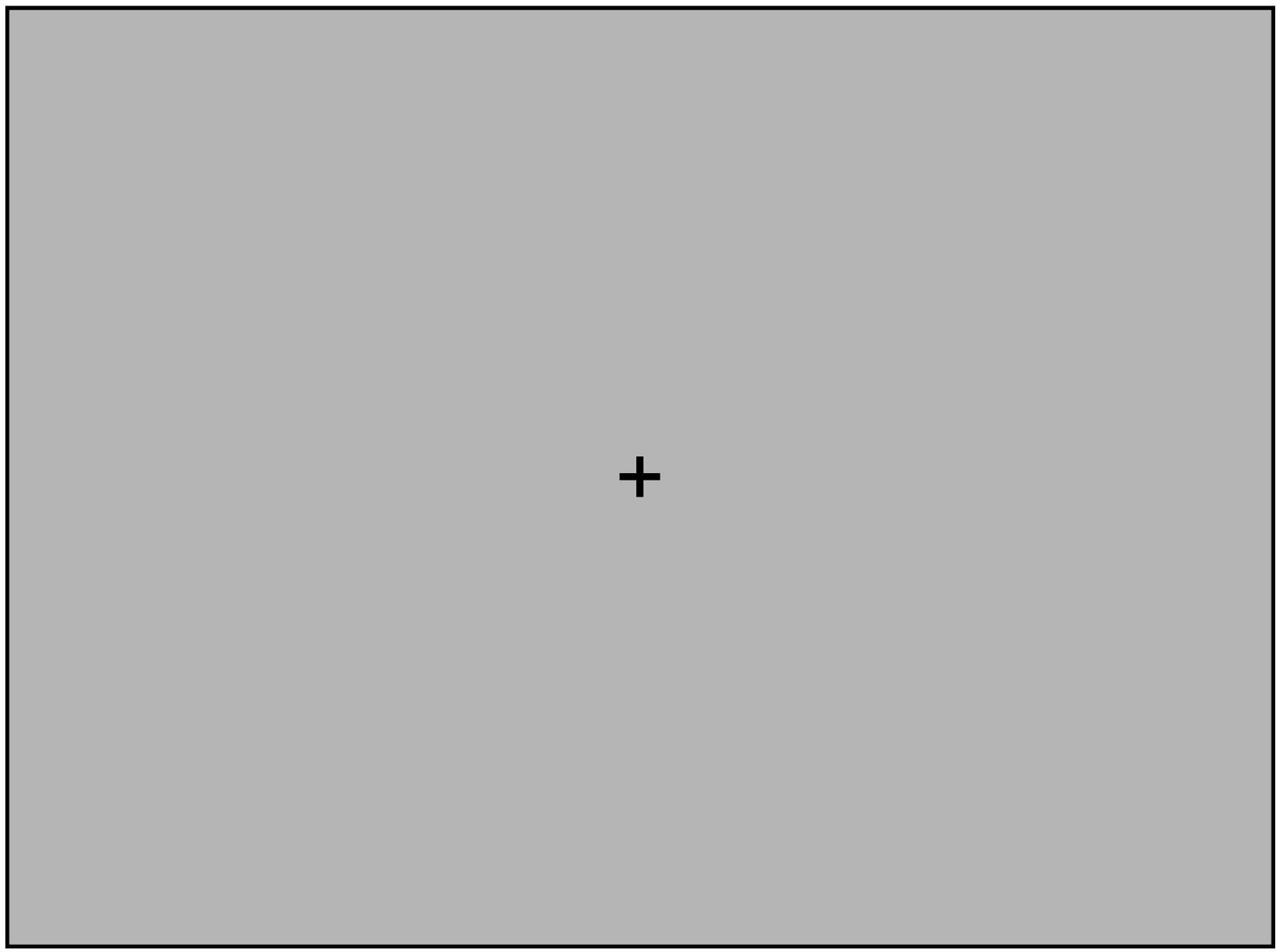
is this a “fighter plane” / “plane” / “vehicle” ?

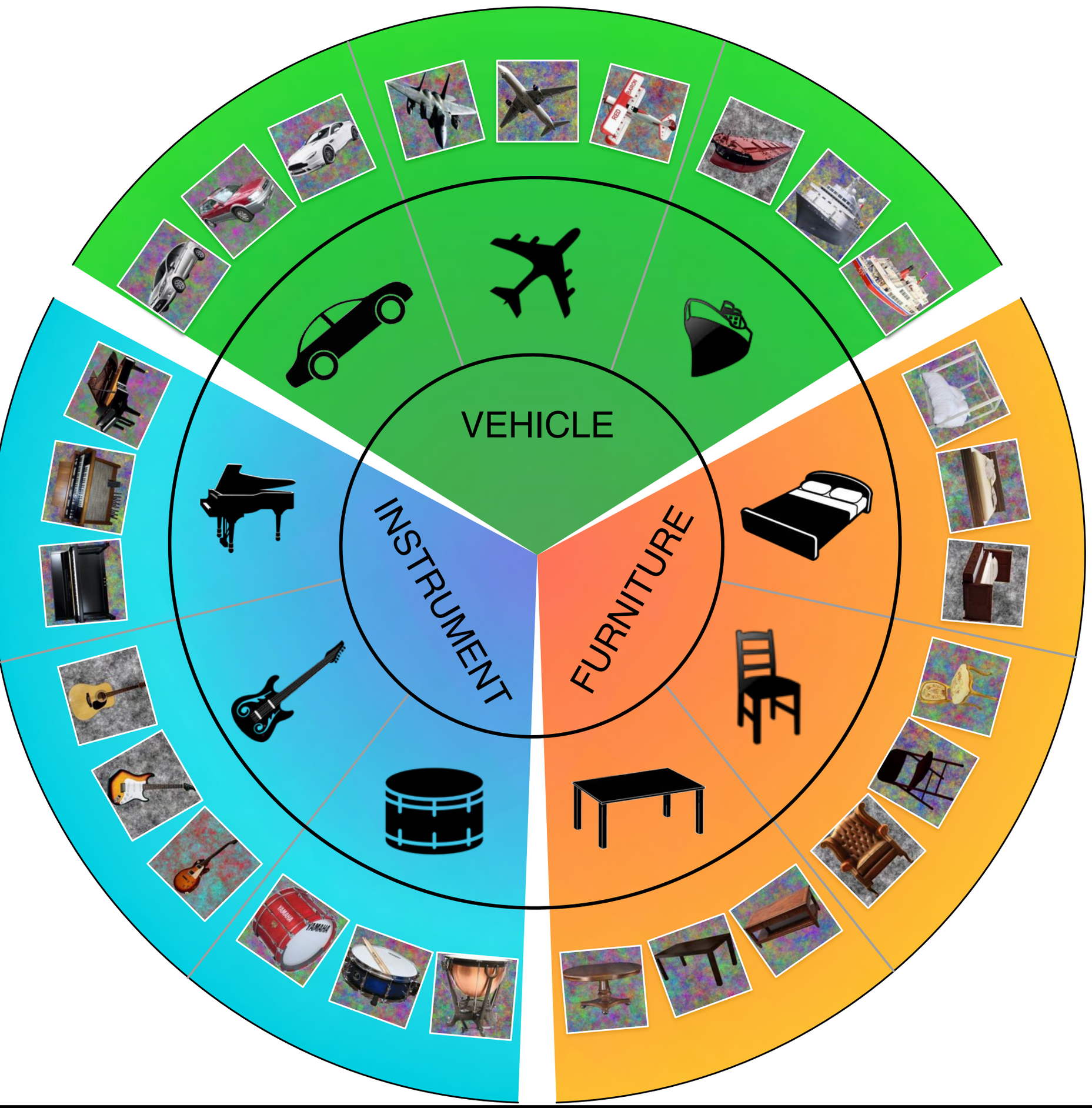
# Match-to-Category Behavioral Experiment



# fMRI Experiment: Example “Fighter Plane” Block

8 images per block ⁎ 5 blocks per category ⁎ 27 categories

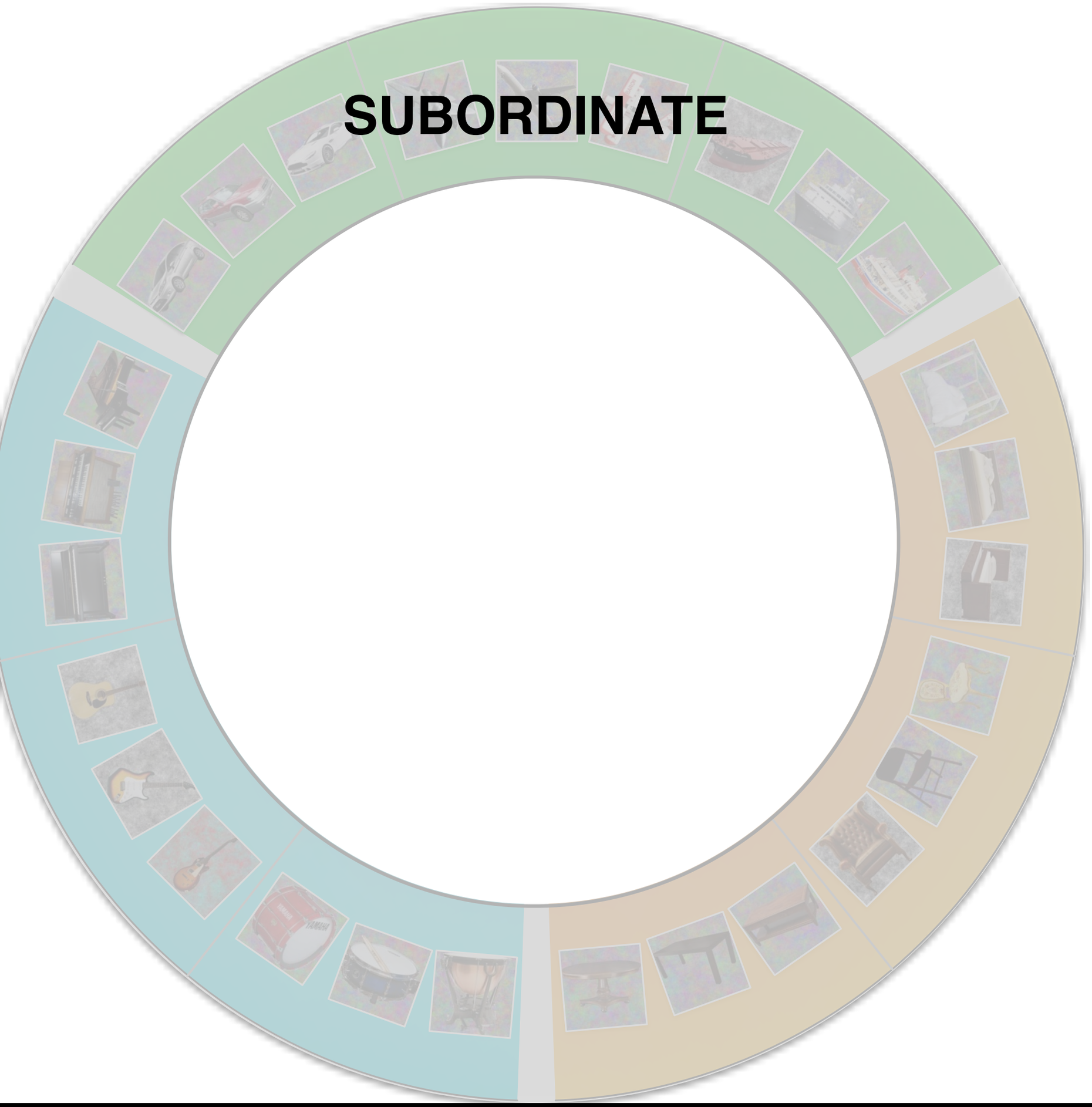





27 categories
x
40 images each

passive viewing
fMRI
experiment

3
taxonomic
levels

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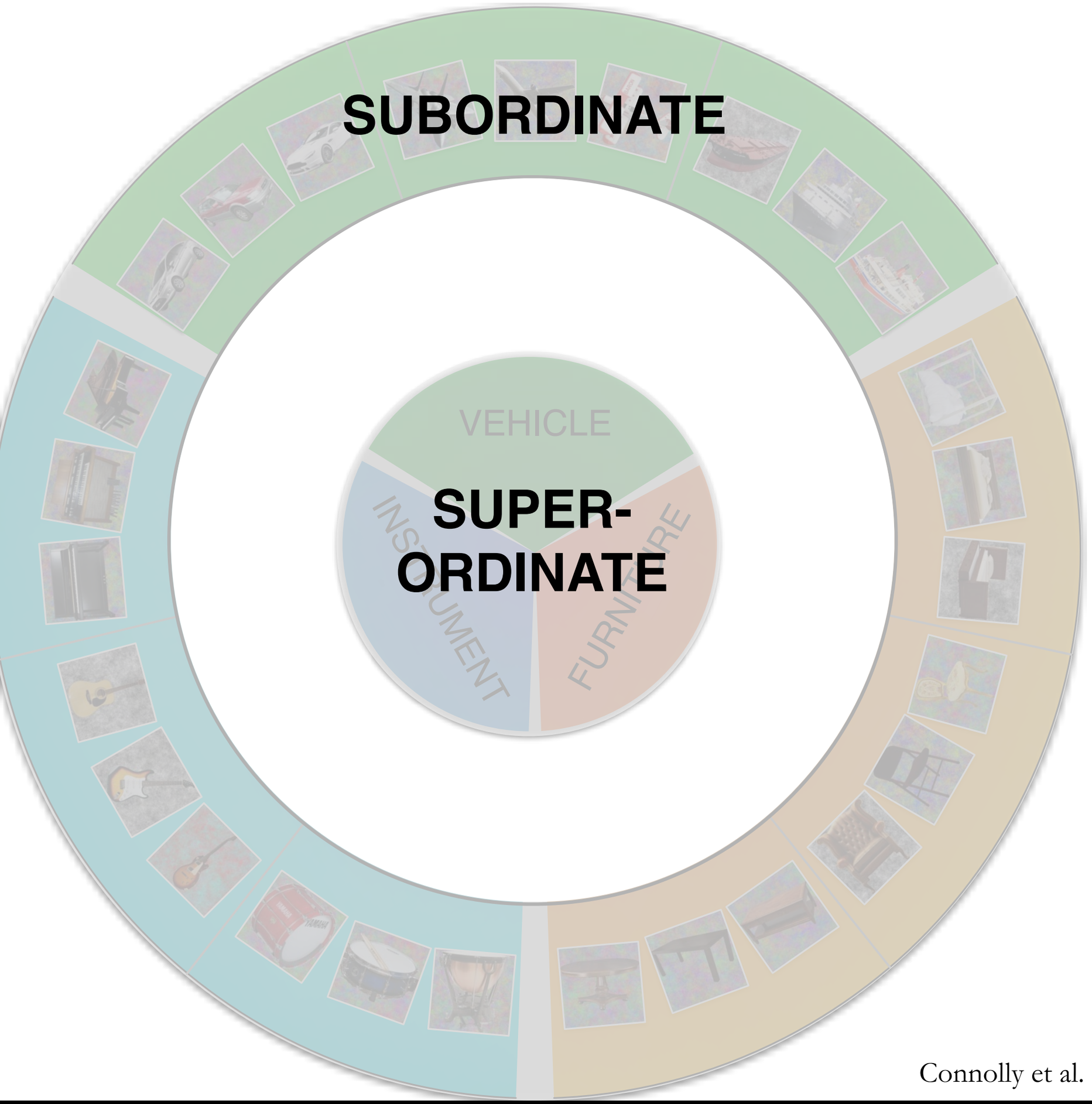


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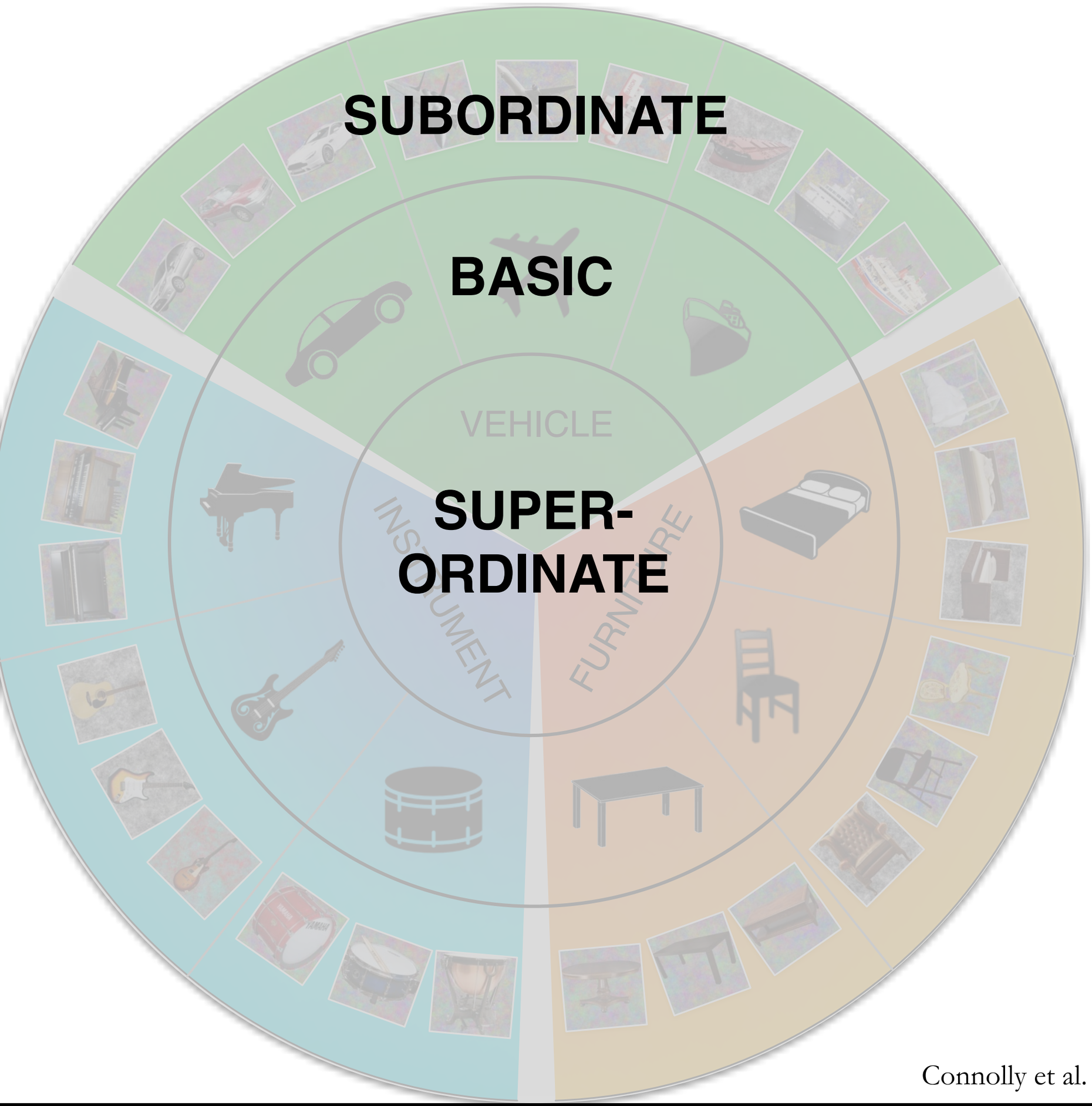
Connolly et al. (2012), Konkle & Caramazza (2013)

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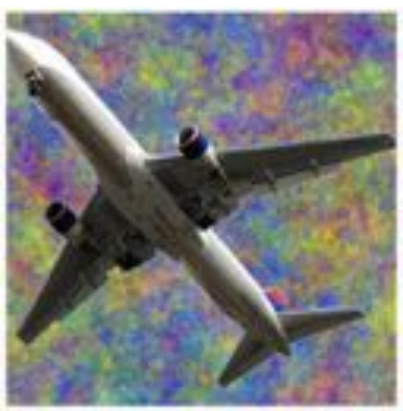
# How category representations change across taxonomic levels in human visual cortex

1. **Experimental Setup**
    - stimulus sets & fMRI scanning
2. **Similarity of Neural Patterns**
    - within- and between-category similarity
3. **Category Information at Each Taxonomic Level**
    - MVPA decoding

# **Category Boundary Effect:** Basic Level Example



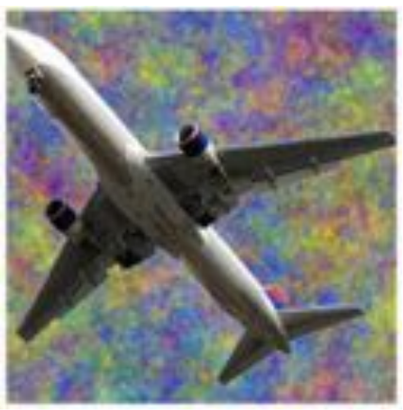
Within-Category Similarity

A

Cohesion


Category Boundary Effect
=
mean( A ) – mean( B )

computed separately
for each
taxonomic level



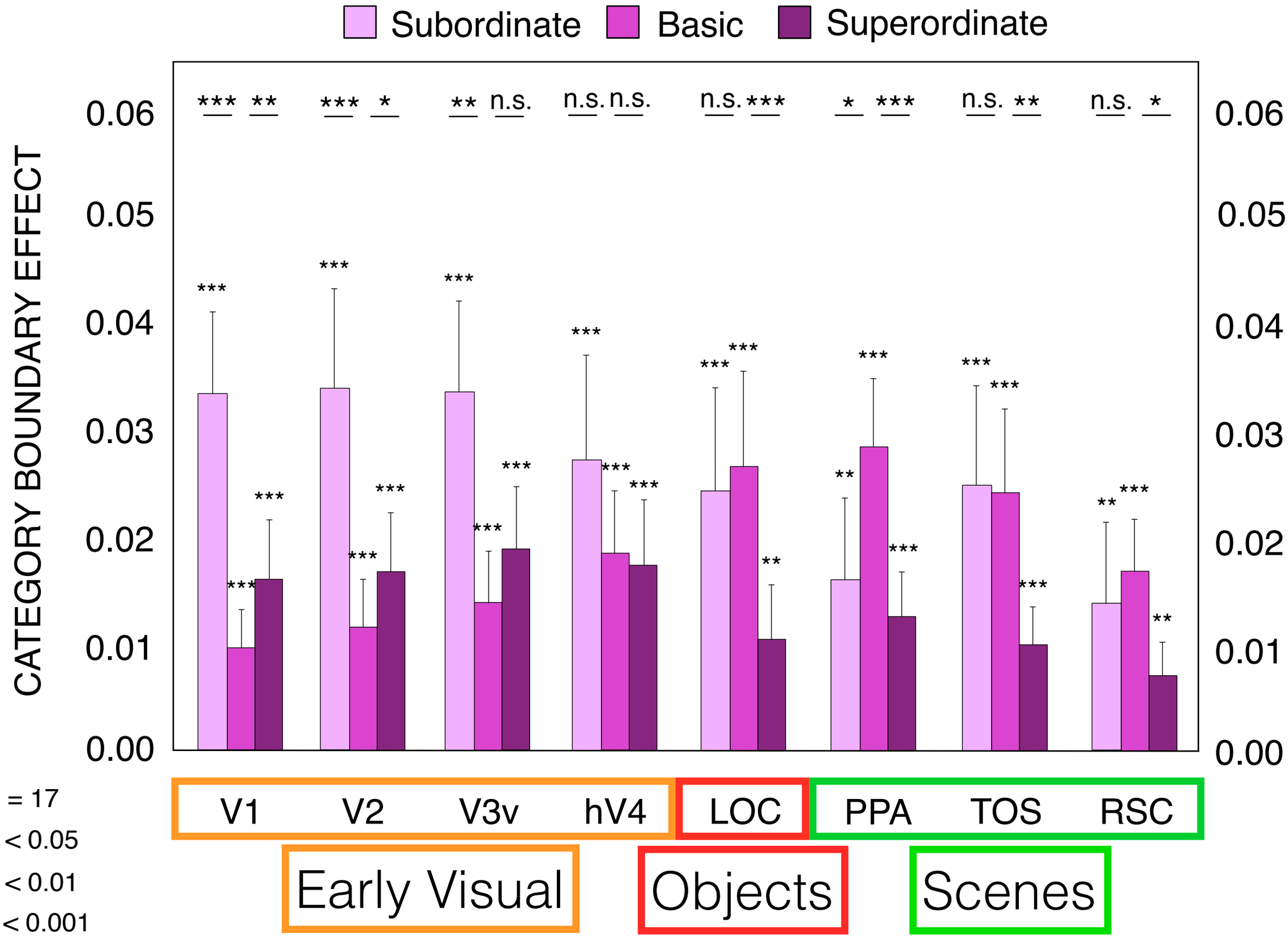
Between-Category Similarity

B

Distinctiveness

Kriegeskorte et al. (2008)

# **Category Boundary Effect:** Results



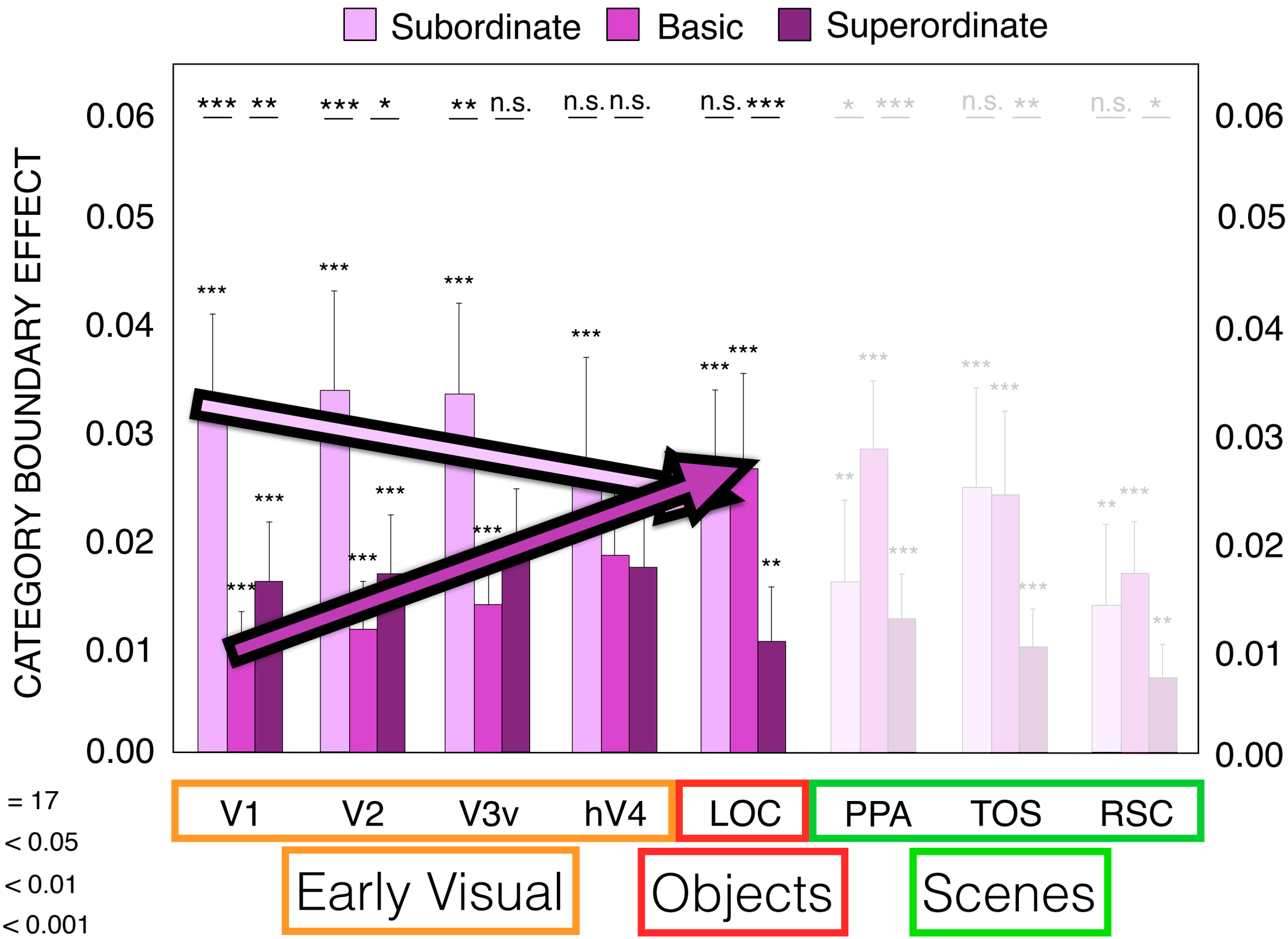

n = 17

* p < 0.05

** p < 0.01

*** p < 0.001

# Gradual trade-off in favor of the basic level




n = 17

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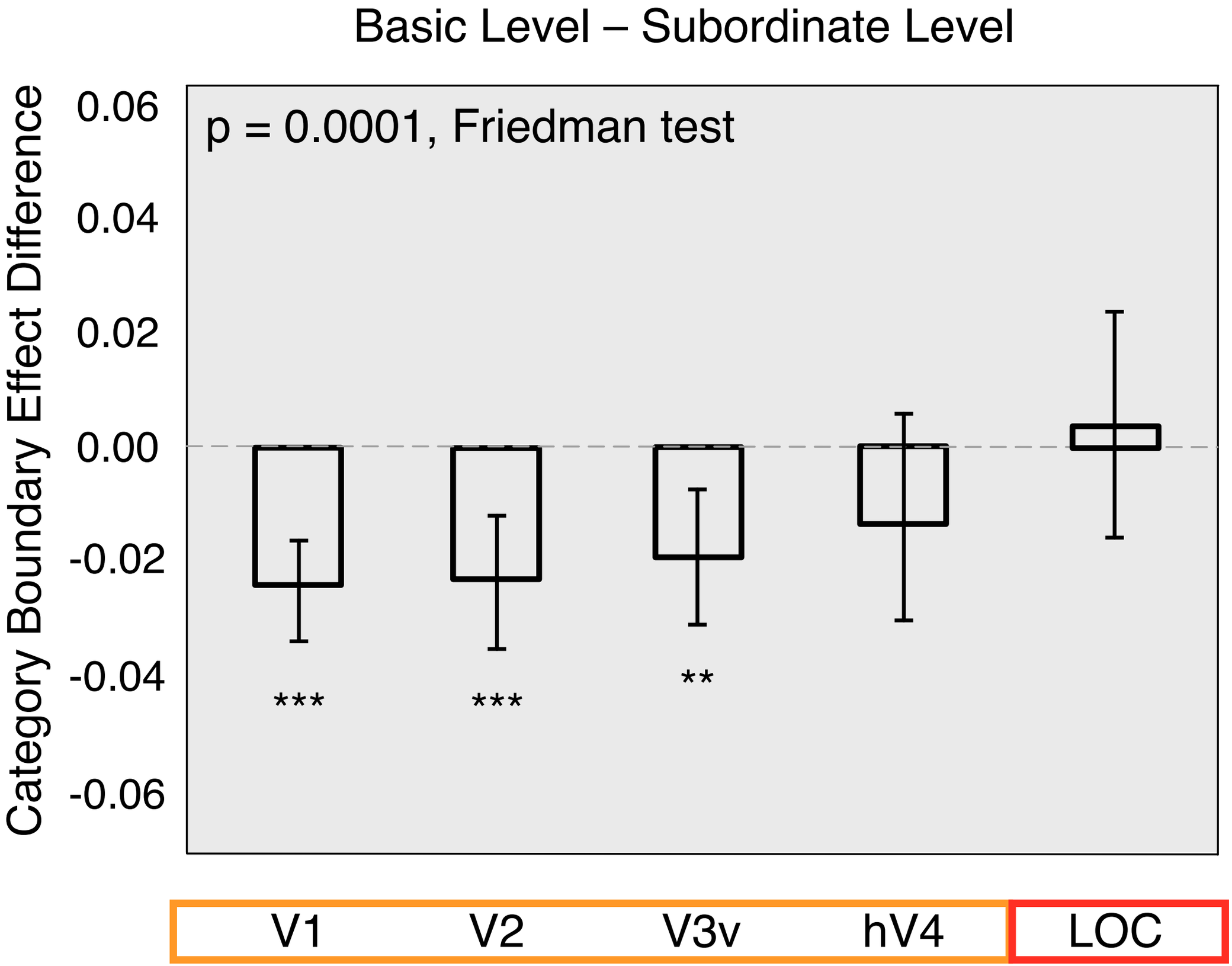

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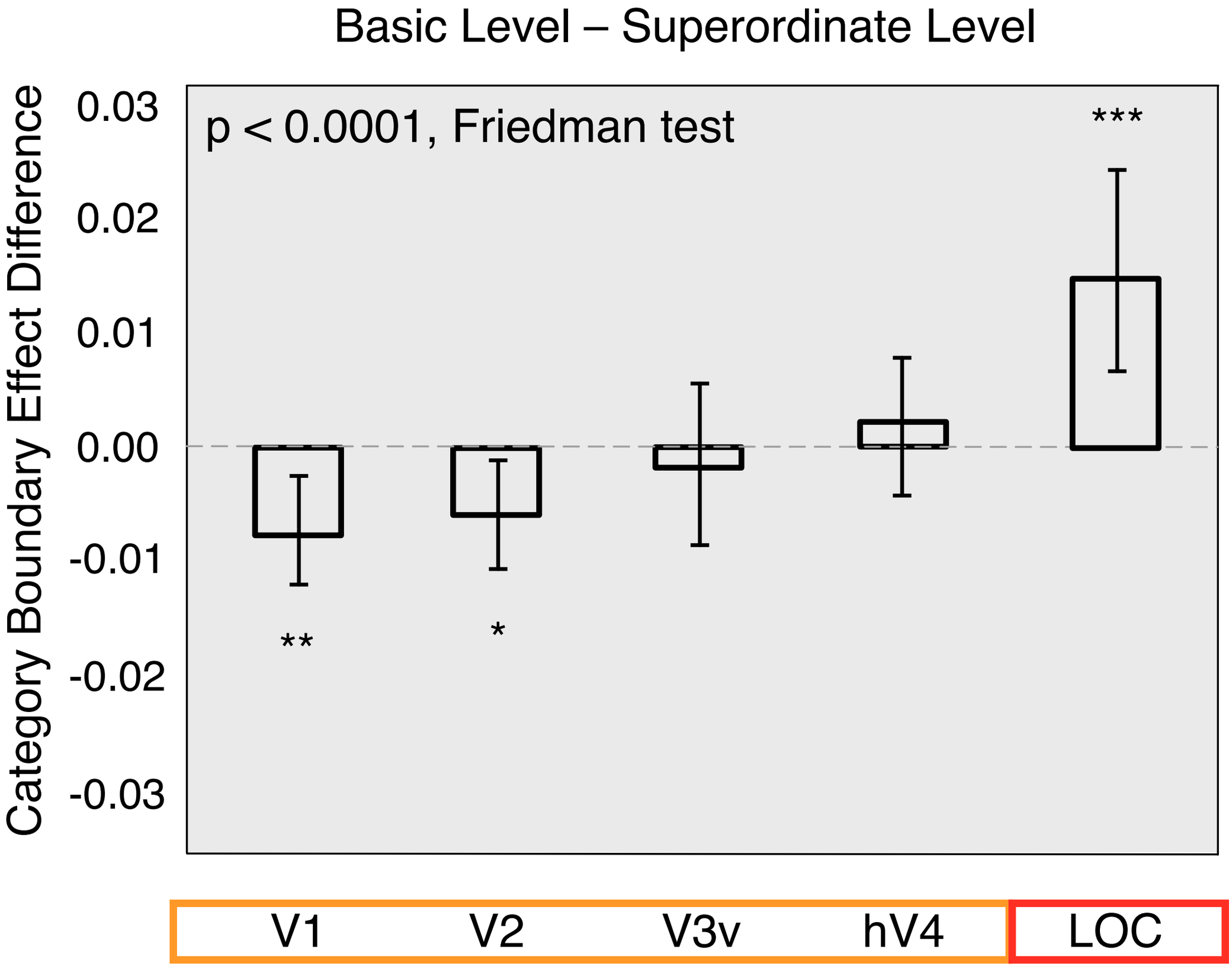
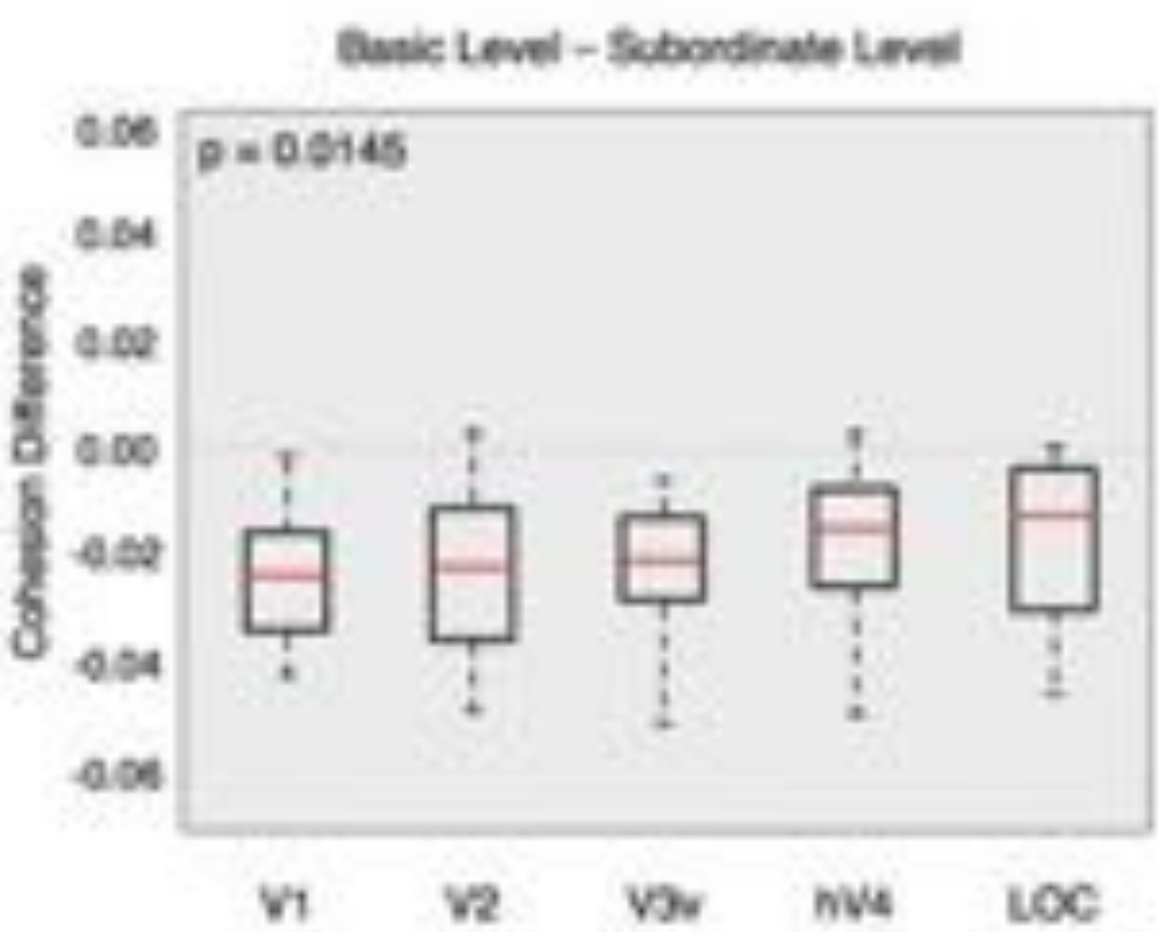
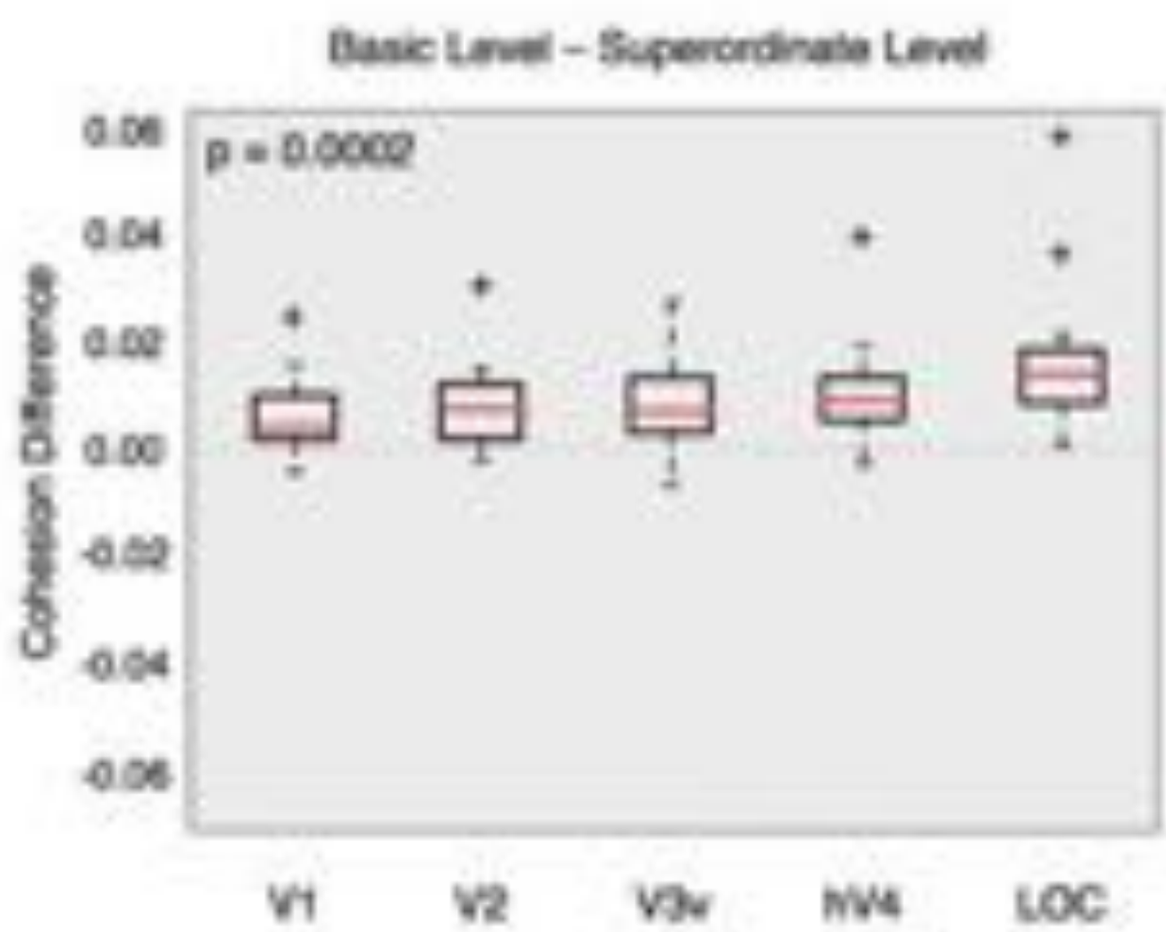
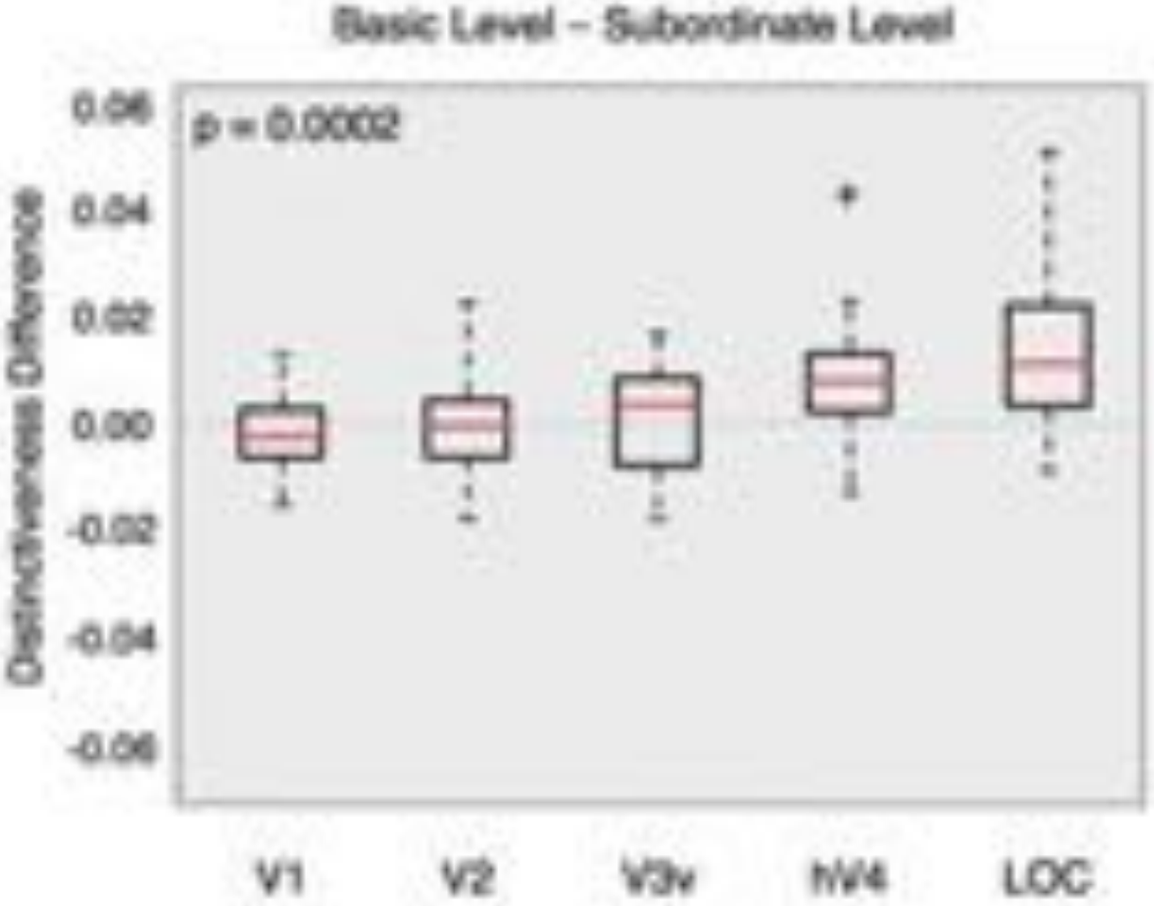
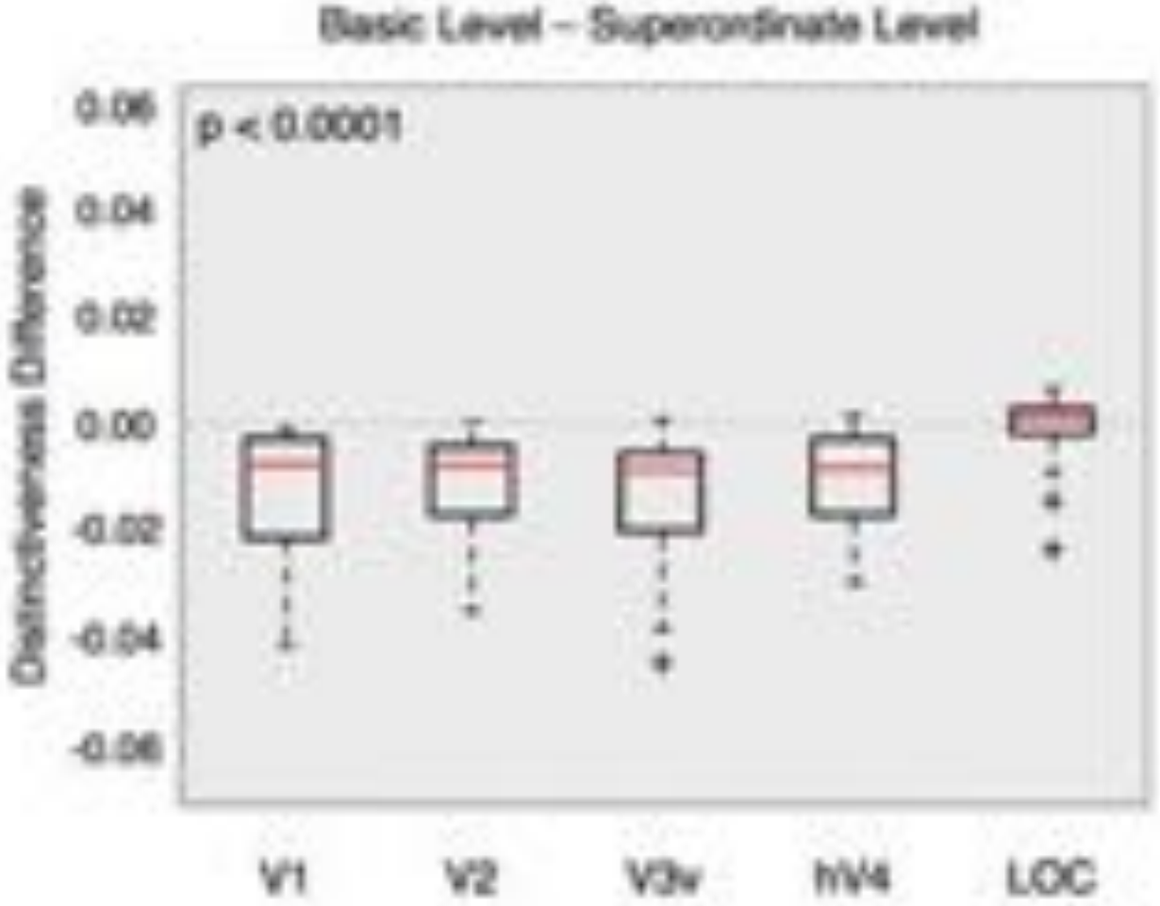



Basic Level – Subordinate Level
p = 0.0145
Cohesion Difference
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
V1
V2
V3v
hV4
LOC


Basic Level – Superordinate Level
p = 0.0002
Cohesion Difference
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
V1
V2
V3v
hV4
LOC


Basic Level – Subordinate Level
p = 0.0002
Distinctiveness Difference
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
V1
V2
V3v
hV4
LOC


Basic Level – Superordinate Level
p < 0.0001
Distinctiveness Difference
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
V1
V2
V3v
hV4
LOC

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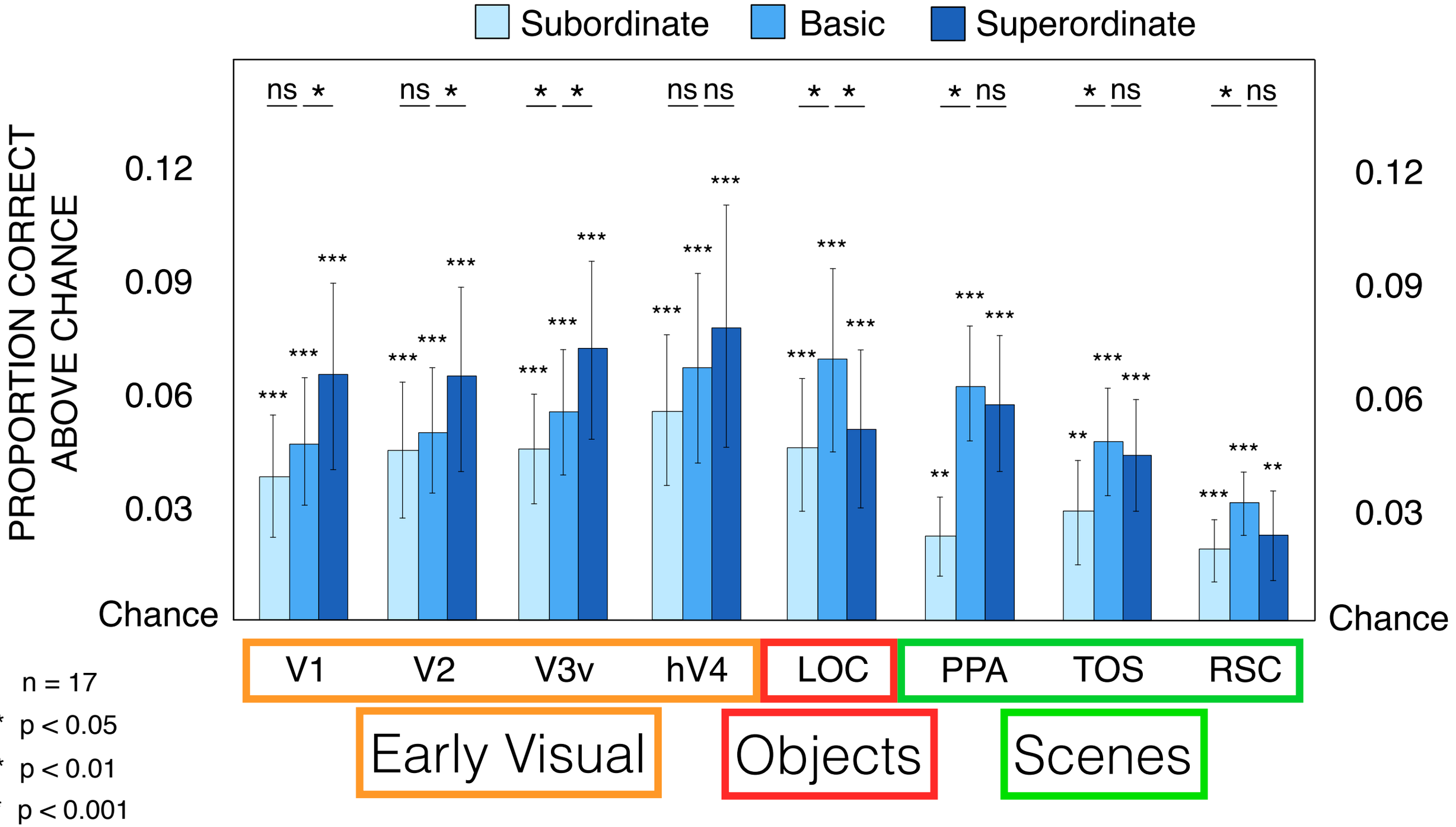
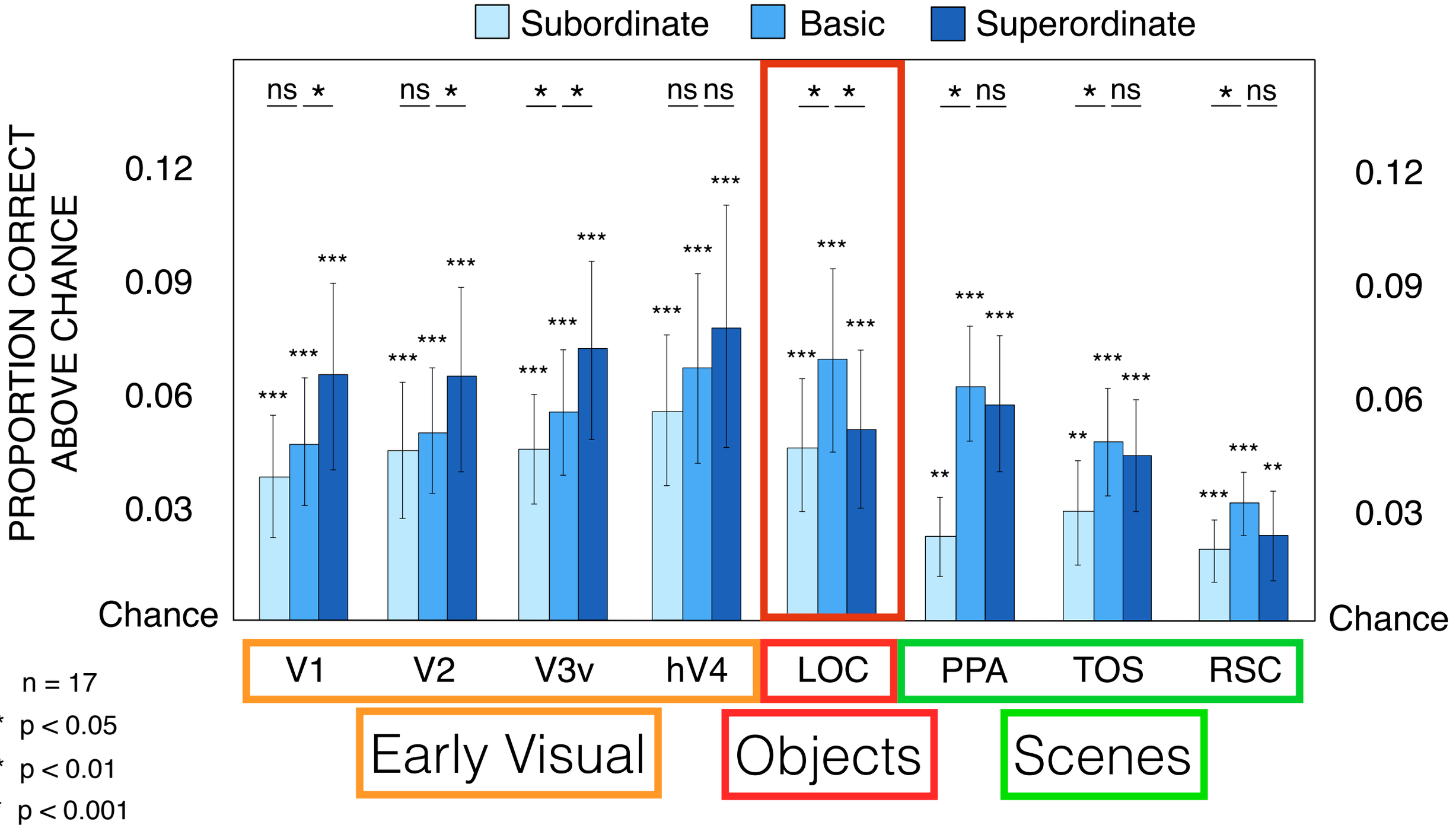
# **MVPA Decoding:** Results

decode category at each taxonomic level independently



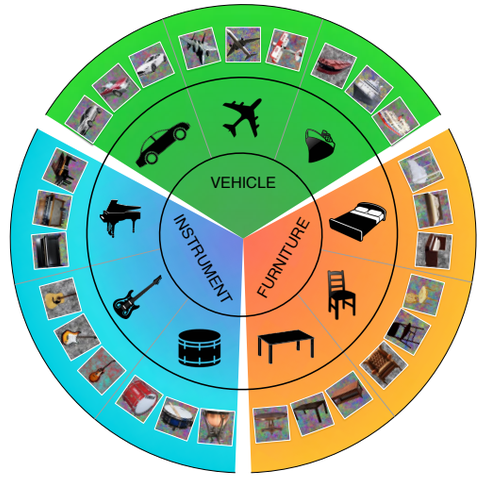
# Basic level is the optimal level of specificity in LOC

decode category at each taxonomic level independently

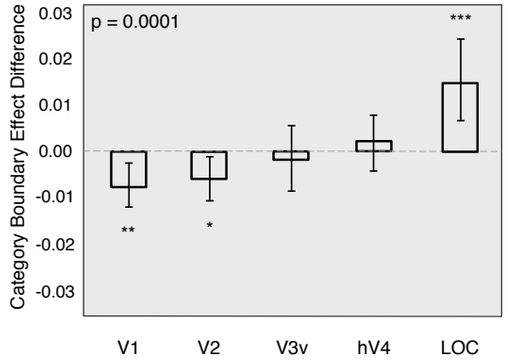


# How category representations change across taxonomic levels in visual cortex

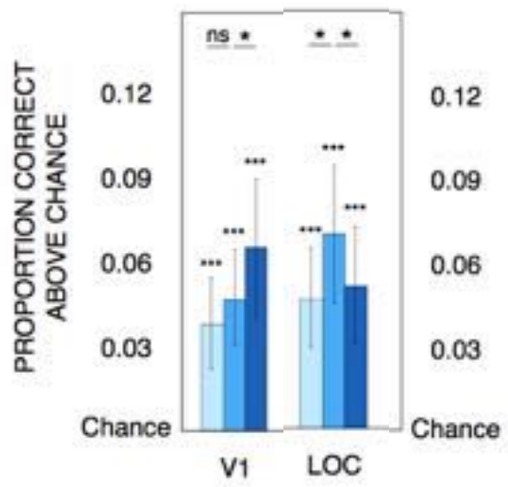
real-world object taxonomy
with behavioral basic level advantage




gradual trade-off between subordinate and basic levels in favor of the latter

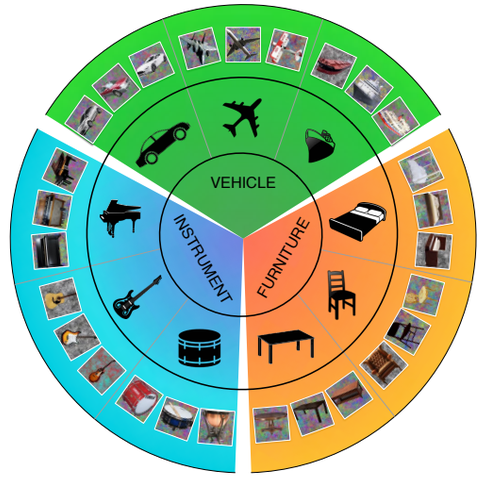



basic level is optimal level of specificity decodable from LOC patterns

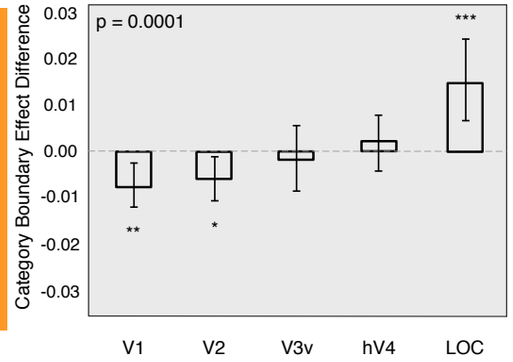


# How category representations change across taxonomic levels in visual cortex

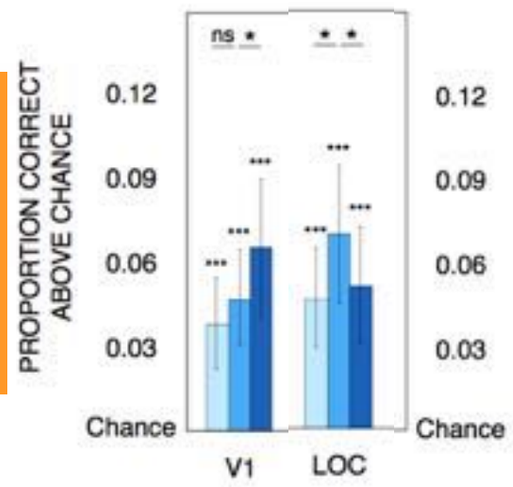
basic level representation may be an emergent property of the visual system




high-level visual areas may share computations geared at specifically separating categories




categorization may be part of visual processing



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