Category Typicality Modulates Goal Directed Retrieval of Living and Nonliving Things

CENTER FOR COGNITIVE NEUROSCIENCE

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How do we selectively retrieve task-relevant versus irrelevant information about objects?

- Behavioral performance decreases during Living vs. Nonliving judgments of atypical objects
- For atypical objects, living status conflicts with ostensible animacy or naturalness
- This response profile is most prominent when executive functioning is:
  - *underdeveloped* [1] (in young children)
  - *impaired* [2] (in elderly adults and Alzheimer's patients)
  - *limited* [3] (requiring speeded responses)

Predictions

When category membership is task-relevant (during Living vs. Nonliving judgments):

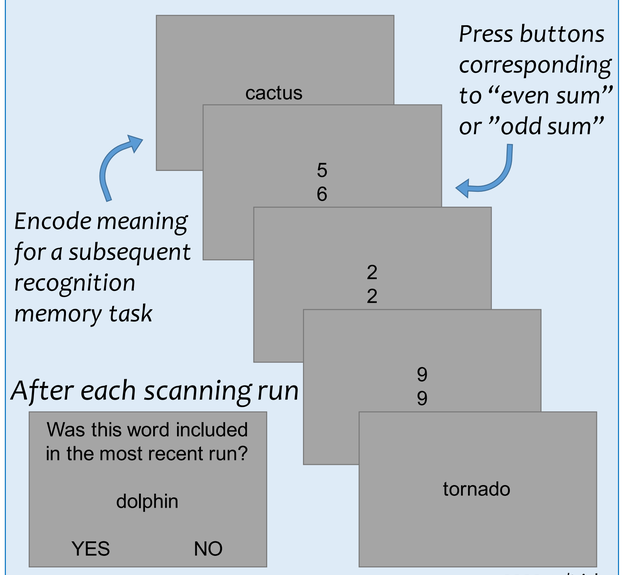
- Increased response in brain areas involved in cognitive control (e.g., prefrontal cortex) for atypical objects
- Decreased neural dissimilarity between typical and atypical members of the same object category
- Increased neural dissimilarity between objects from different categories

CATEGORY	LIVING?	EXHIBITS ACTIVITY?	NATURAL?
Active Living Things	YES	YES	YES
Static Living Things	YES	NO	YES
Static Artifacts	NO	NO	NO
Active Artifacts	NO	YES	NO
Static Natural Kinds	NO	NO	YES
Active Natural Kinds	NO	YES	YES

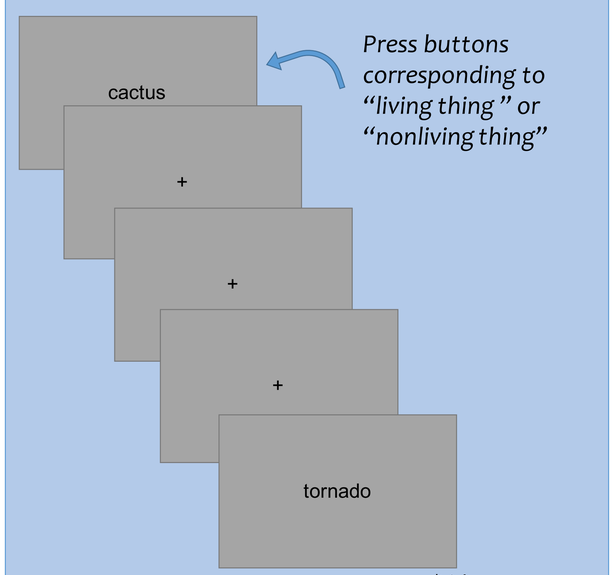
Methods

- Stimuli: 40 words per category (Living Things; Nonliving Artifacts; Nonliving Natural Kinds)
  - 20 typical & 20 atypical objects per category (determined by independent behavioral ratings)
- The same stimuli appear twice in Part A and once in Part B
- Living/Nonliving status is explicitly task relevant in Part B but not in Part A

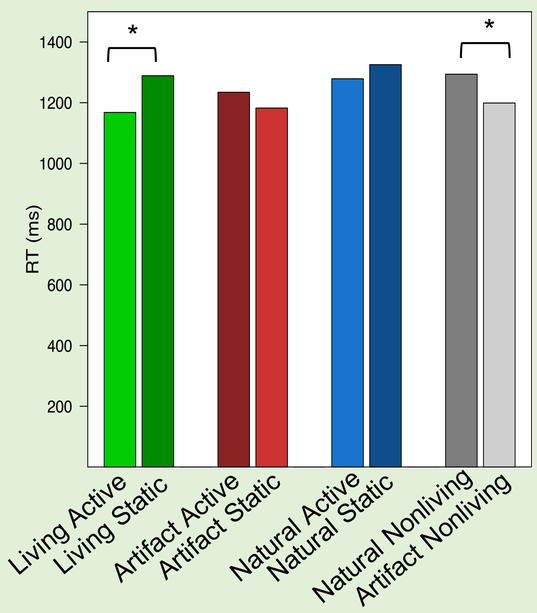
Scanning runs 1-10: Part A
General Semantic Retrieval



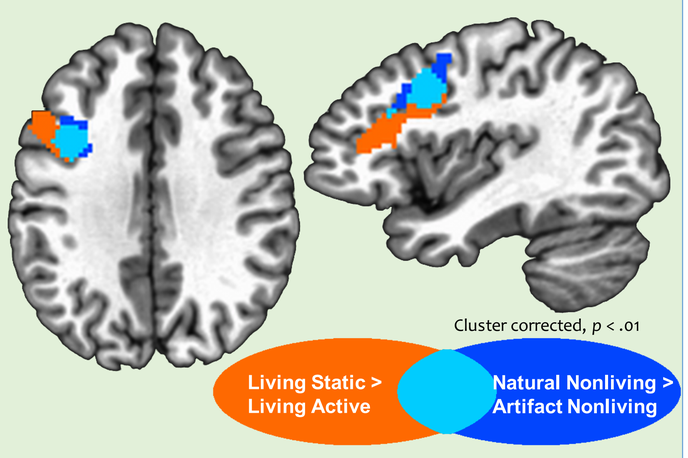
Scanning runs 11-14: Part B
Goal-Directed Retrieval



Behavioral Results (Part B)



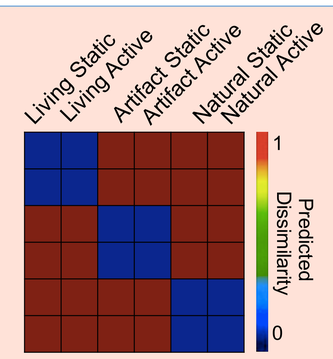
Univariate Results (Part B)



- Whole-brain, group-level analysis
- *In left middle frontal gyrus:*
  greater response during judgments of atypical vs. typical living things and nonliving things

Multivariate Results (Part A vs. B)

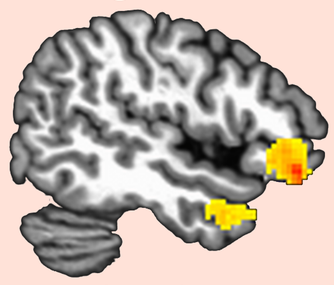
- Category-Level Model of Pairwise Dissimilarities:
  more similar multi-voxel patterns between objects of the same versus different object categories
- Feature selection:
  1. Whole-brain searchlight analysis (radius = 10 mm)
  2. Subject-level ROIs: ventral temporal grey matter
     - 500 voxels with the most reliable responses to repeated stimulus presentations in Part A



Compute match between category-level model and neural dissimilarities, separately for Part A and Part B data [4]

Neural category selectivity increases during Living vs. Nonliving judgments

Searchlight Results: Category-level multi-voxel pattern similarity in Part B > Part A



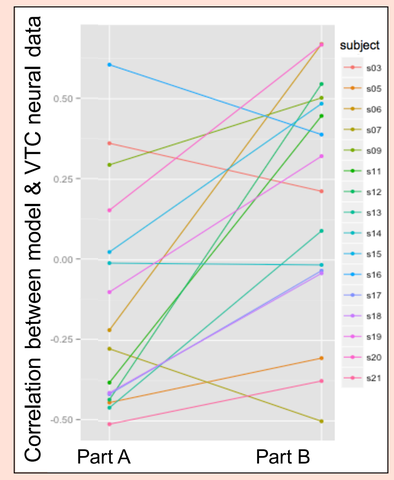
right inferior frontal gyrus
right temporal pole

right precentral gyrus

left inferior frontal gyrus

ROI Results:

- In ventral temporal cortex (VTC), category-level boundaries *(Living Things vs. Artifacts vs. Natural Kinds)* increase from Part A to Part B, $t(15) = 3.50$, $p = .003$
- Pairwise distinctions that become stronger in VTC:
  Natural Kinds vs. Artifacts, $t(15) = 4.21$, $p = .001$
  Natural Kinds vs. Living Things, $t(15) = 2.25$, $p = .04$



Discussion

- The Natural Kinds vs. Artifacts distinction increases in Part B, even though this category boundary is not behaviorally relevant for the Living vs. Nonliving judgment
- Ongoing analyses: relate (1) item-level category typicality ratings and (2) trial-level changes in prefrontal BOLD response to (3) item-level changes in neural category selectivity

References

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