Parahippocampal cortex and fusiform gyrus integrate conceptual and perceptual features of object images

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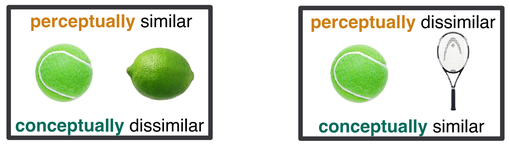
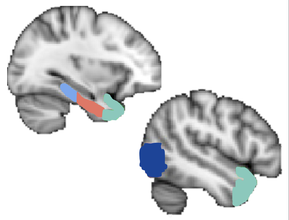
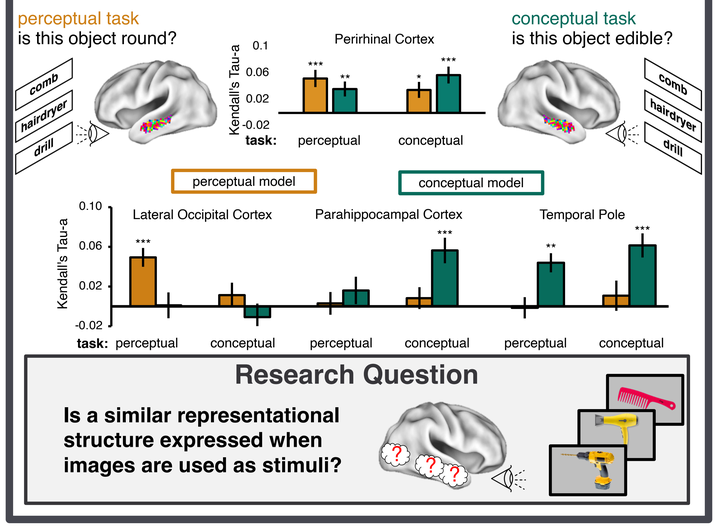
Introduction

- Understanding what we see requires the transformation of visual input into conceptually meaningful representations
- This process must accommodate the fact that perceptual and conceptual similarity can vary independently across objects



Prior neuroimaging research[1] using words as stimuli suggests that lateral occipital cortex (**LOC**), temporal pole (**TP**), and parahippocampal cortex (**PHC**) distinctly represent conceptual and perceptual features of objects, whereas perirhinal cortex (**PRC**) represents both conceptual and perceptual features.





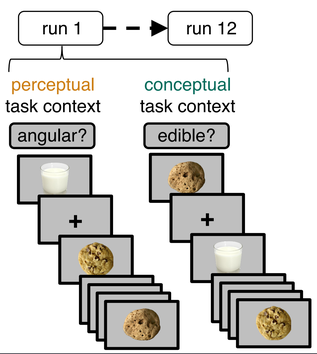
Research Question

Is a similar representational structure expressed when images are used as stimuli?

fMRI Experimental Design

Each participant (N = 28, M_{age} = 20.96, Women = 17) completed a scanned feature verification task that required judgements about perceptual or conceptual properties of the objects.

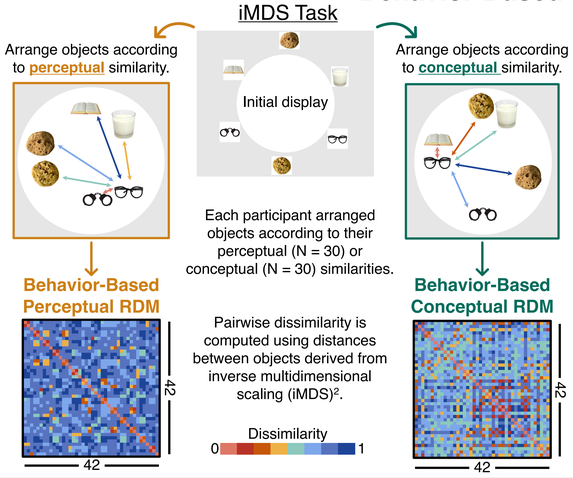
Feature Verification Task

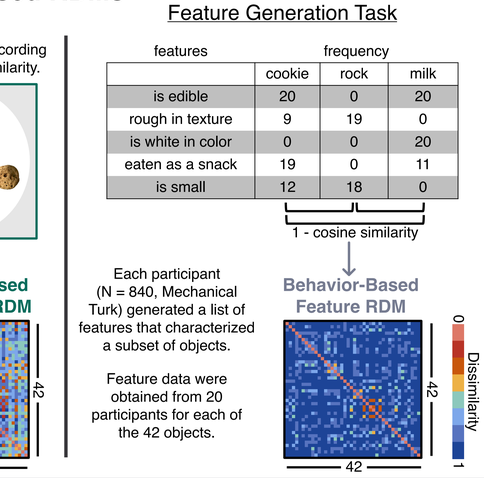


- 42 objects
- Each object was matched to at least one other object based on either perceptual or conceptual features but not both
- Normative data from an independent sample confirmed that all objects were equivalent in terms of prototypicality, lifetime familiarity, and naming

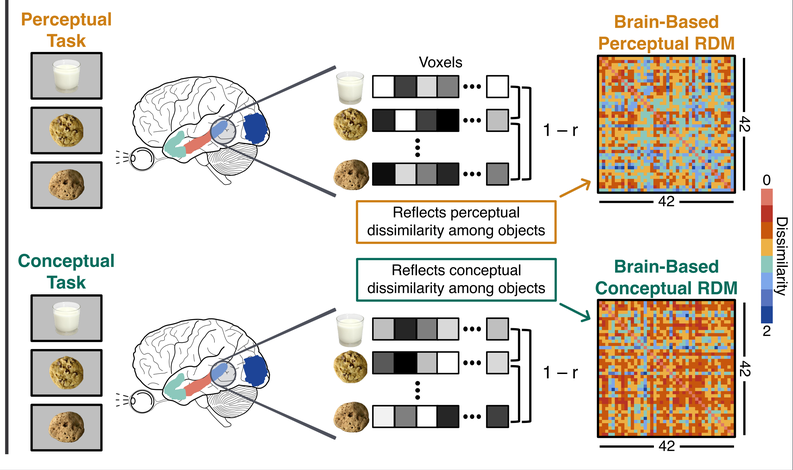
Characterizing object dissimilarity patterns in behavioral and neural data

Behavior-Based RDMs



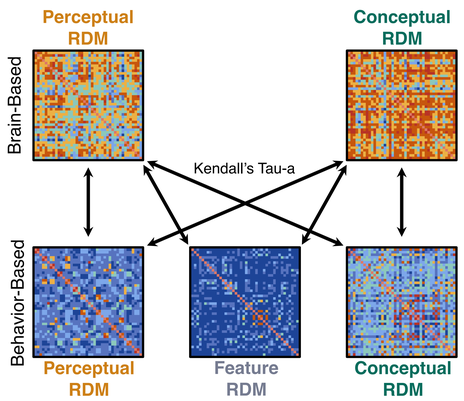


Brain-Based RDMs



Comparison of brain-based and behavior-based RDMs

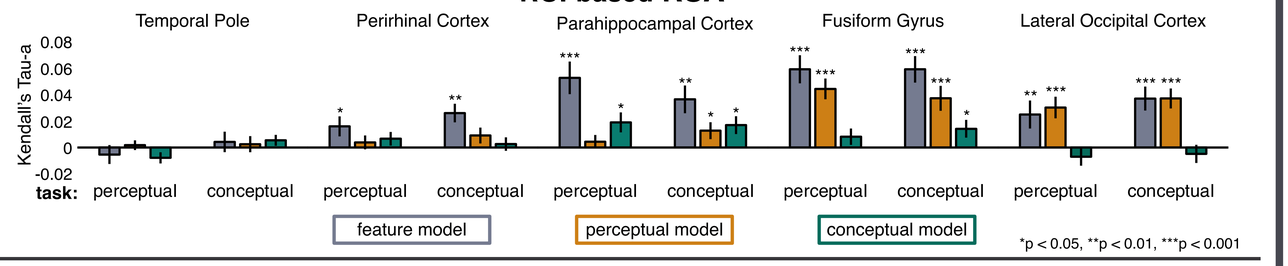
Compare RDMs



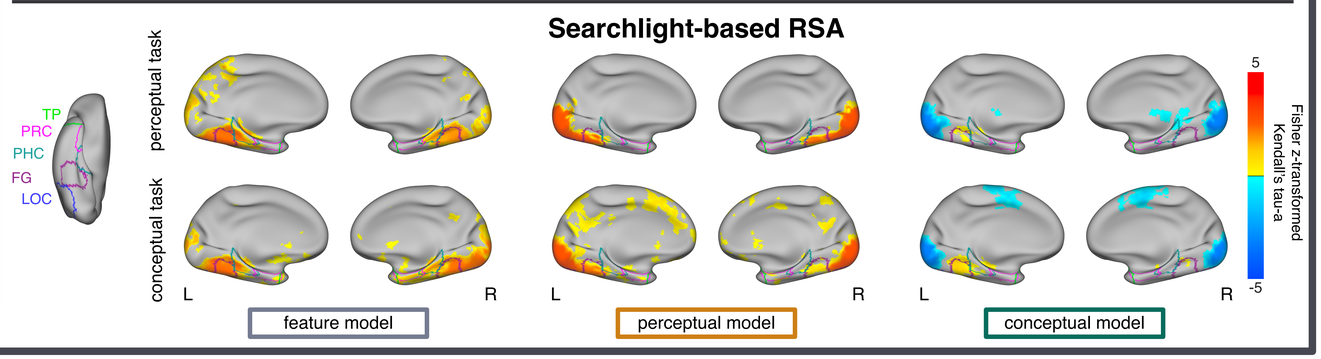
Compare Behavioral RDMs

Behavioral Model Comparison	Kendall's Tau-a	p-value
Feature vs Conceptual	0.372	< .001
Feature vs Perceptual	0.149	< .001
Perceptual vs Conceptual	0.049	0.06

ROI-based RSA

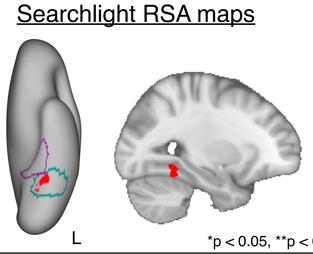


Searchlight-based RSA

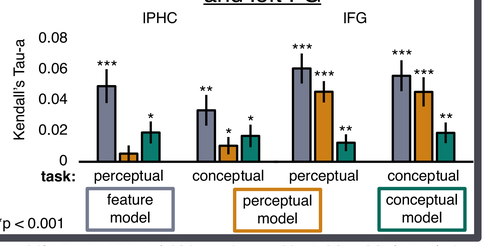


Integration of perceptual & conceptual features

Intersection of Searchlight RSA maps



ROI-based RSA in left PHC and left FG



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

Conclusions

- We used RSAs to determine whether the activity evoked by objects was predicted by behavior-based models that captured their conceptual and perceptual similarities.
- The feature-generation model tended to better account for variability in the brain than iMDS-derived models.
- We found task invariant perceptual coding in LOC, aligning with our prior findings using words as stimuli.
- The searchlight analyses revealed perceptual coding in PRC during the conceptual task context. This result diverges from the integrative coding we revealed using words suggesting that representational landscapes in the ventral visual pathways vary across stimulus modalities, i.e., perceptual apprehension vs. conceptual retrieval.
- **The left PHC and left FG were the only regions where neural similarity in both task contexts were correlated with all behavior-based similarity models. This indicates that these structures uniquely represent fine-grained conceptual and perceptual object features in an integrative code.**

References: 1.) Martin, C.B., et al. (2018) Integrative and distinctive coding of visual and conceptual object features in the ventral visual stream eLife 7:e31873. 2.) Kriegeskorte, N., & Mur, M. (2012). Inverse MDS: Inferring dissimilarity structure from multiple item arrangements. Front. psychol, 3.