

Characterizing the Spatiotemporal Neural Representations of Perceived Similarity Using Implicit and Explicit Tasks.

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Introduction

Linking neural and behavioral activity is crucial for understanding and replicating the mechanisms behind visual stimulus recognition. Perceived similarity judgments have become increasingly popular in visual experiments, providing behavioral representations that strongly correlate with visual system activity ^{1,2}. Representational similarity analysis (RSA) facilitates identification of commonalities between neural and behavioral activity representations by comparing dissimilarity between all pairwise combinations of stimuli ³. For large stimulus sets, the multiple arrangements (MA) task ⁴ has been instrumental in successfully relating explicit behavioral information about stimuli to representational geometries of brain activity patterns ^{5,6,7,8} in both space and time ^{5,7}, owing to its efficiency in collecting pairwise similarity judgments. However, explicit similarity judgments may not fully reflect representational geometries across the entire visual cortex ⁹. Here, we aim to investigate how implicit and explicit similarity judgments capture complementary aspects of brain-behavior relations. By relating data from three tasks with varying levels of processing to recorded neural responses, we explore how they associate with the spatial (fMRI) and temporal (EEG) unfolding of object representations encoded in the ventral stream.

Methods

Explicit Pairwise Similarity Judgments: The Multiple Arrangements Task

Arrange these images according to their similarity.

Implicit Pairwise Similarity Judgments: The Same-Different Task

Stimuli Blank Dynamic Mask Response

Time

Were the stimuli the same or different?

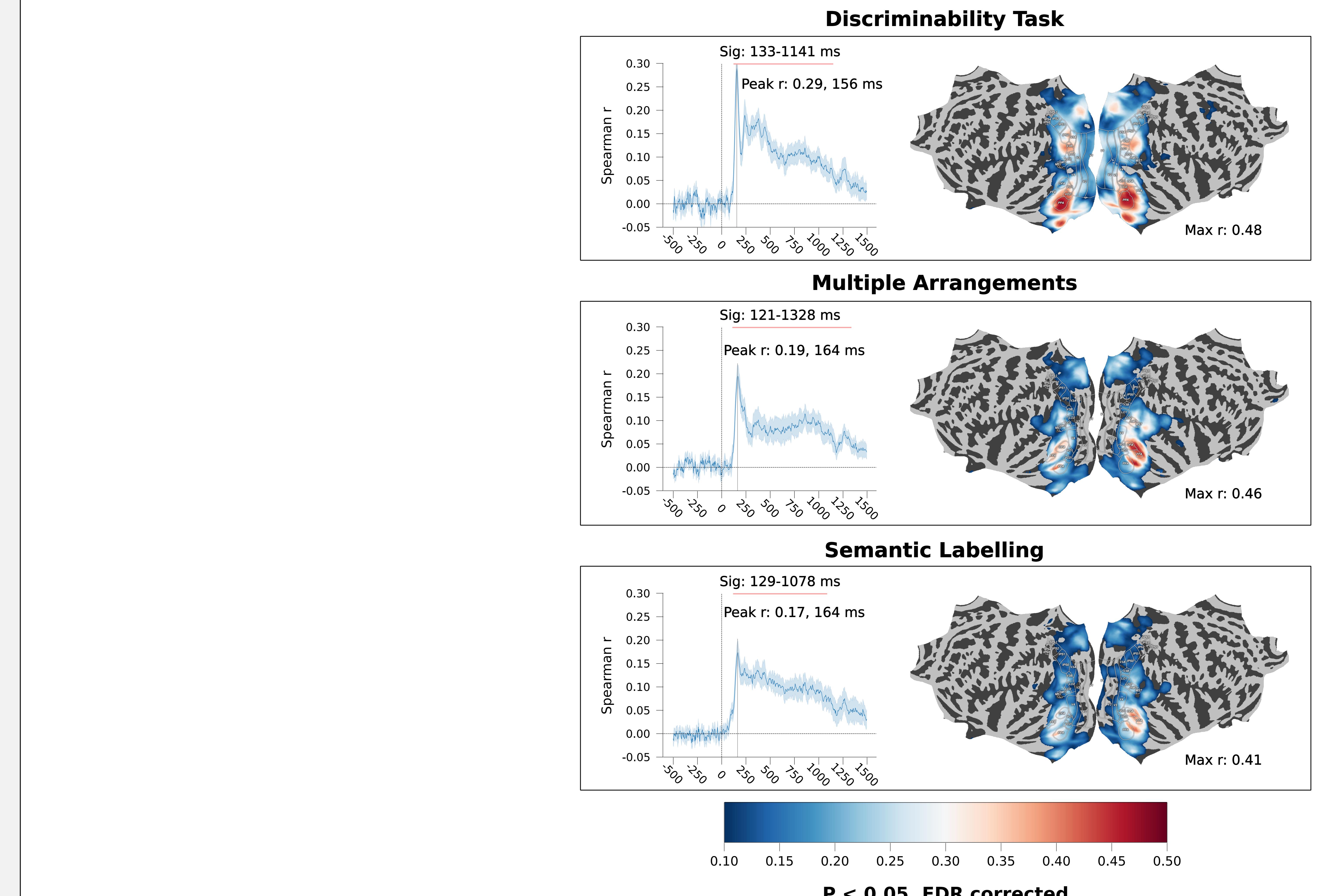
Press 1 if they were the same.

Press 2 if they were different.

Highly Explicit Stimulus Descriptions: The Image Captioning Task

Describe each of the following images in a sentence.

Results



Discussion

References

- Hebart MN, Zheng CY, Pereira F, Baker CI. Revealing the multidimensional mental representations of natural objects underlying human similarity judgements. *Nature Human Behaviour*. 2020;4(11):1173-85. doi:10.1038/s41562-020-00951-3
- Waraich SA, Victor JD. A psychophysics paradigm for the collection and analysis of Similarity judgments. *Journal of Visualized Experiments*. 2022;(181). doi:10.3791/63461
- Kriegeskorte N. Representational similarity analysis – connecting the branches of Systems Neuroscience. *Frontiers in Systems Neuroscience*. 2008; doi:10.3389/fnsys.06.0004.2008
- Kriegeskorte N, Mur M. Inverse MDS: Inferring dissimilarity structure from multiple item arrangements. *Frontiers in Psychology*. 2012;3. doi:10.3389/fpsyg.2012.00245
- Banksom BB, Hebart MN, Groen IIA, Baker CI. The temporal evolution of conceptual object representations revealed through models of behavior, semantics and Deep Neural Networks. *NeuroImage*. 2018;178:172-82. doi:10.1016/j.neuroimage.2018.05.037
- Charest I, Kievit RA, Schmitz TW, Deca D, Kriegeskorte N. Unique semantic space in the brain of each beholder predicts perceived similarity. *Proceedings of the National Academy of Sciences*. 2014;111(40):14565-70. doi:10.1073/pnas.1402594111
- Cichy RM, Kriegeskorte N, Jozwik KM, van den Bosch JF, Charest I. The spatiotemporal neural dynamics underlying perceived similarity for real-world objects. *NeuroImage*. 2019;194:12-24. doi:10.1016/j.neuroimage.2019.03.031
- Mur M, Meys M, Bodurka J, Goebel R, Bandettini PA, Kriegeskorte N. Human object-similarity judgments reflect and transcend the prime-it-object representation. *Frontiers in Psychology*. 2013;4. doi:10.3389/fpsyg.2013.00128
- King ML, Groen IIA, Steel A, Kravitz DJ, Baker CI. Similarity judgments and cortical visual responses reflect different properties of object and scene categories in naturalistic images. *NeuroImage*. 2019;197:368-82. doi:10.1016/j.neuroimage.2019.04.079