

Characterizing the spatiotemporal neural representations of perceived similarity using implicit and explicit tasks.

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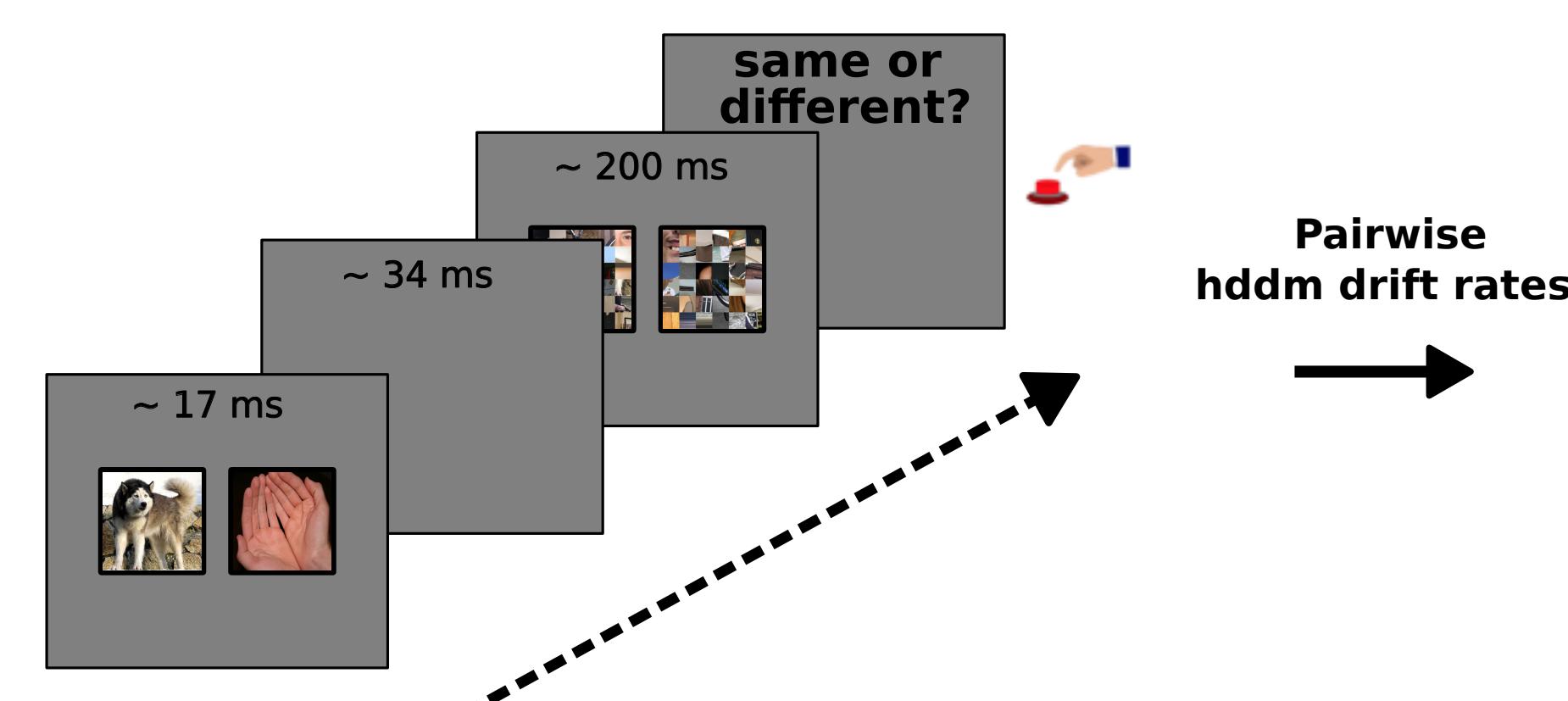
Introduction

Perceived similarity judgments are used to probe the behavioural relevance of visual representations ^{1,2,3}. Many behavioural experiments using this paradigm utilise highly explicit, conscious judgements of similarity, such as the multiple arrangements (MA) task ⁴, which has been instrumental in successfully relating explicit behavioural information about stimuli to representational geometries of brain activity patterns ^{5,6,7,8}. However, such 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-behaviour 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.

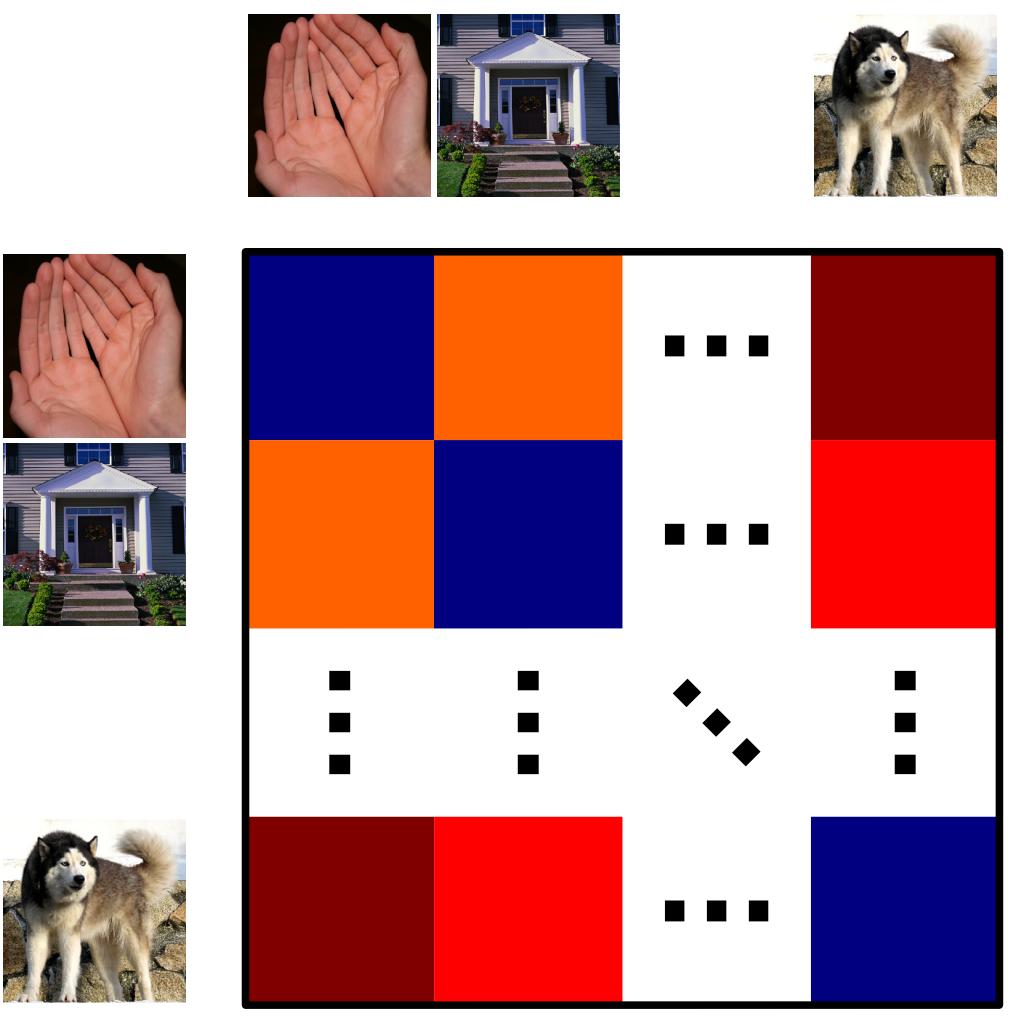
Methods

Implicit pairwise similarity judgements: the discriminability task

A) Participants are rapidly presented with two images in sequence and asked to indicate whether or not they were the same image.



B) Pairwise hddm drift rates are stored in an RDM

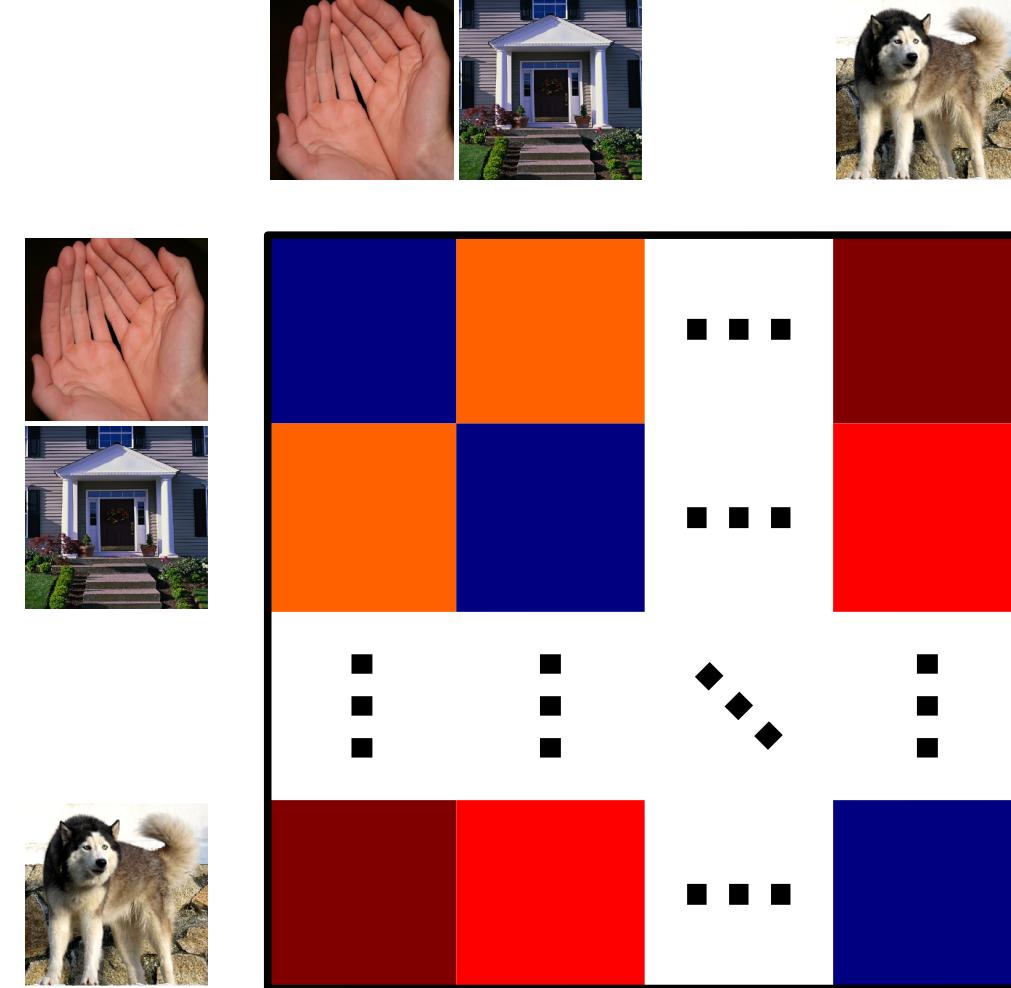


Explicit similarity judgements: the multiple arrangements task

A) Participants arrange stimuli on a 2D arena according to their perceived similarity.

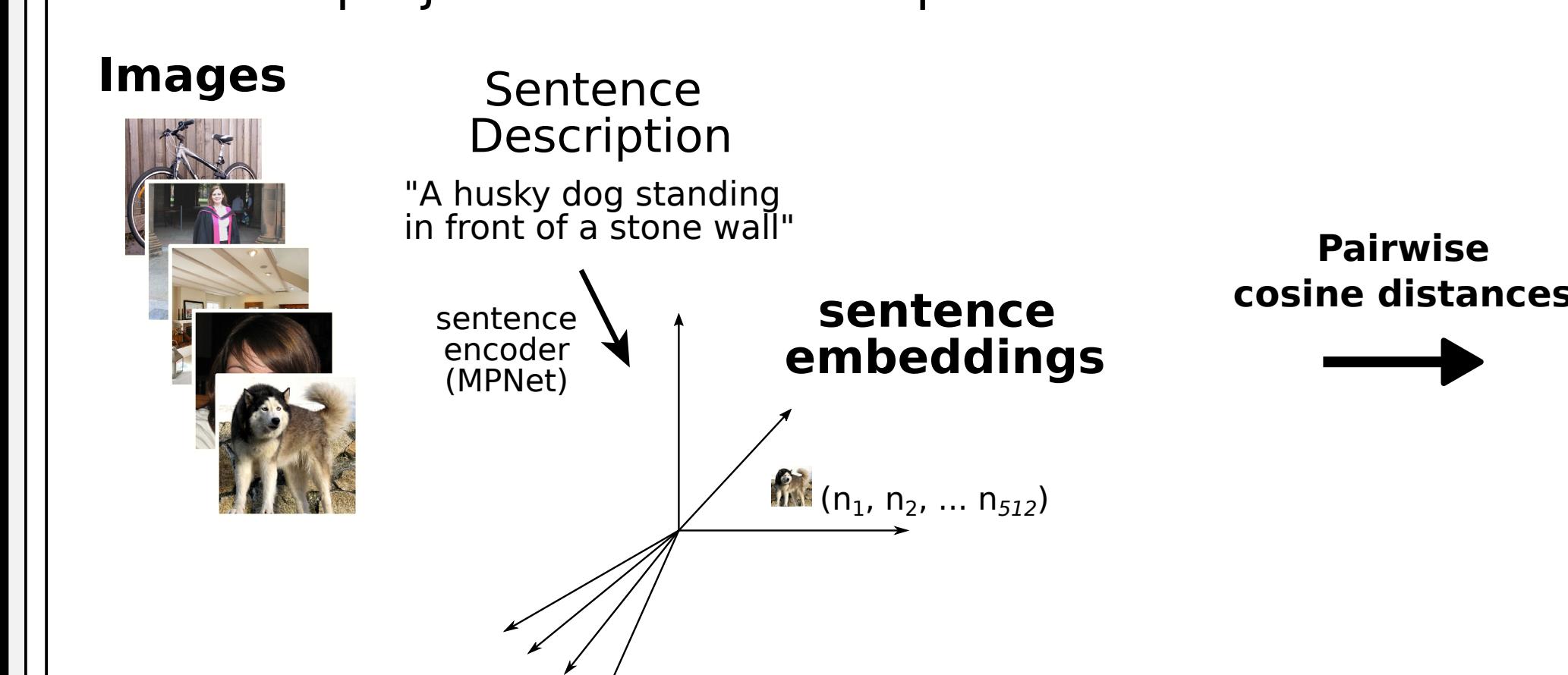


B) Pairwise euclidean distances are stored in an RDM

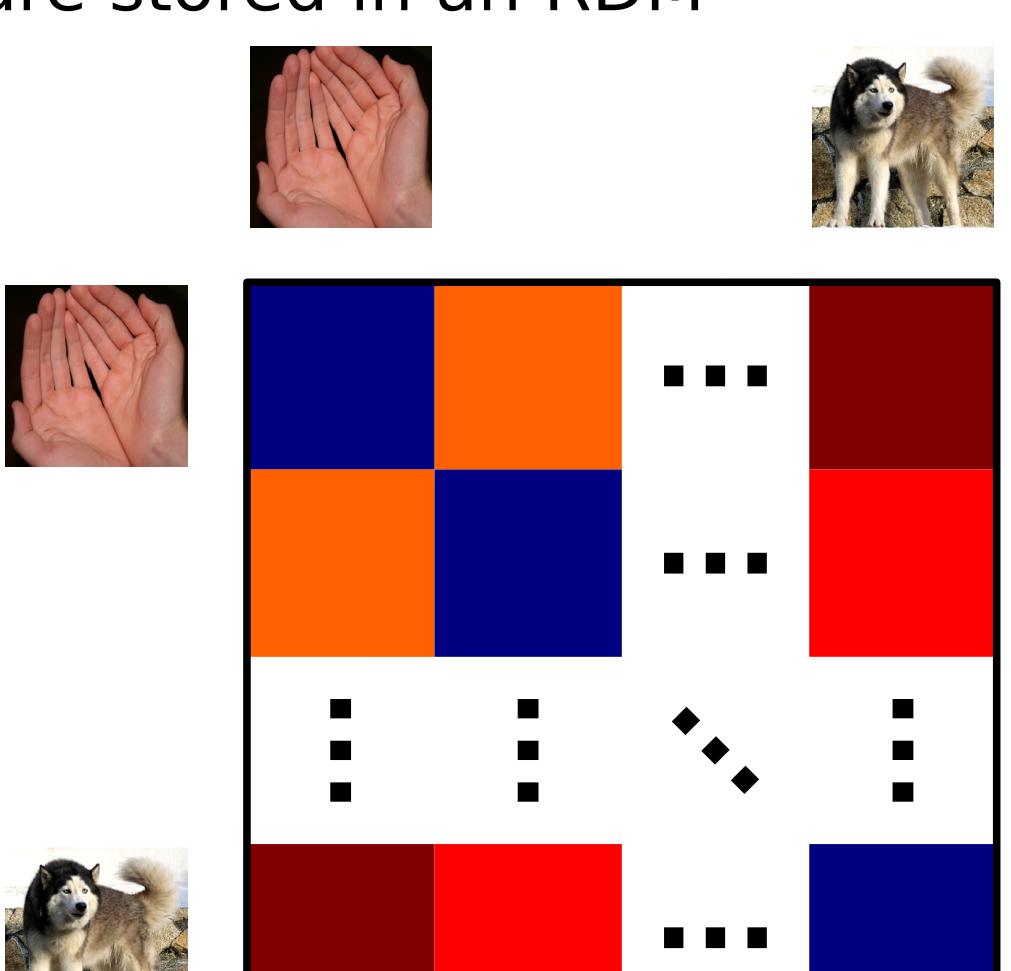


Highly explicit stimulus descriptions: the image captioning task

A) Participants are shown a series of images and asked to describe each one in a sentence. Which was then projected into latent space.

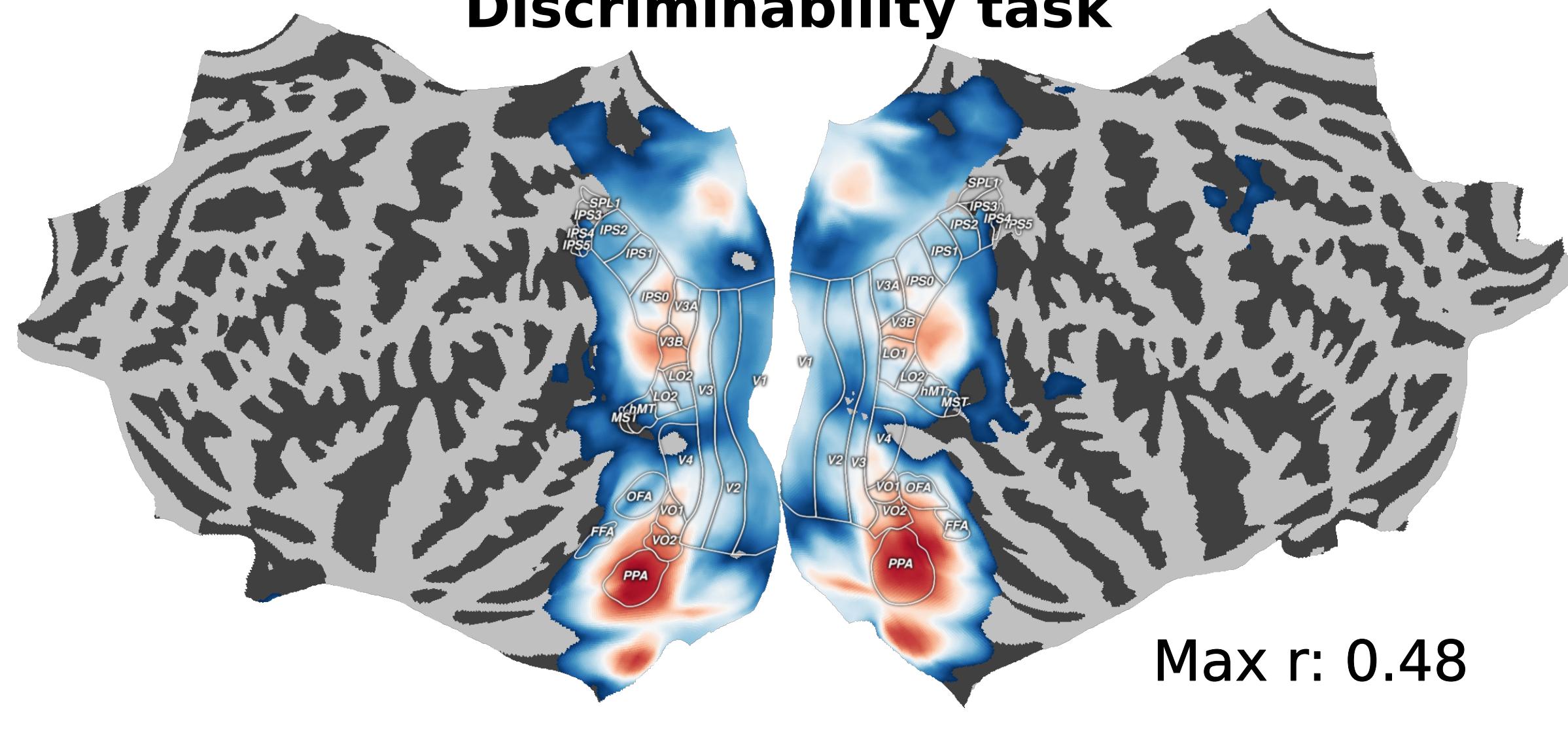


B) All pairwise cosine distances are stored in an RDM



Results

fMRI searchlight mapping Discriminability task



Multiple arrangements

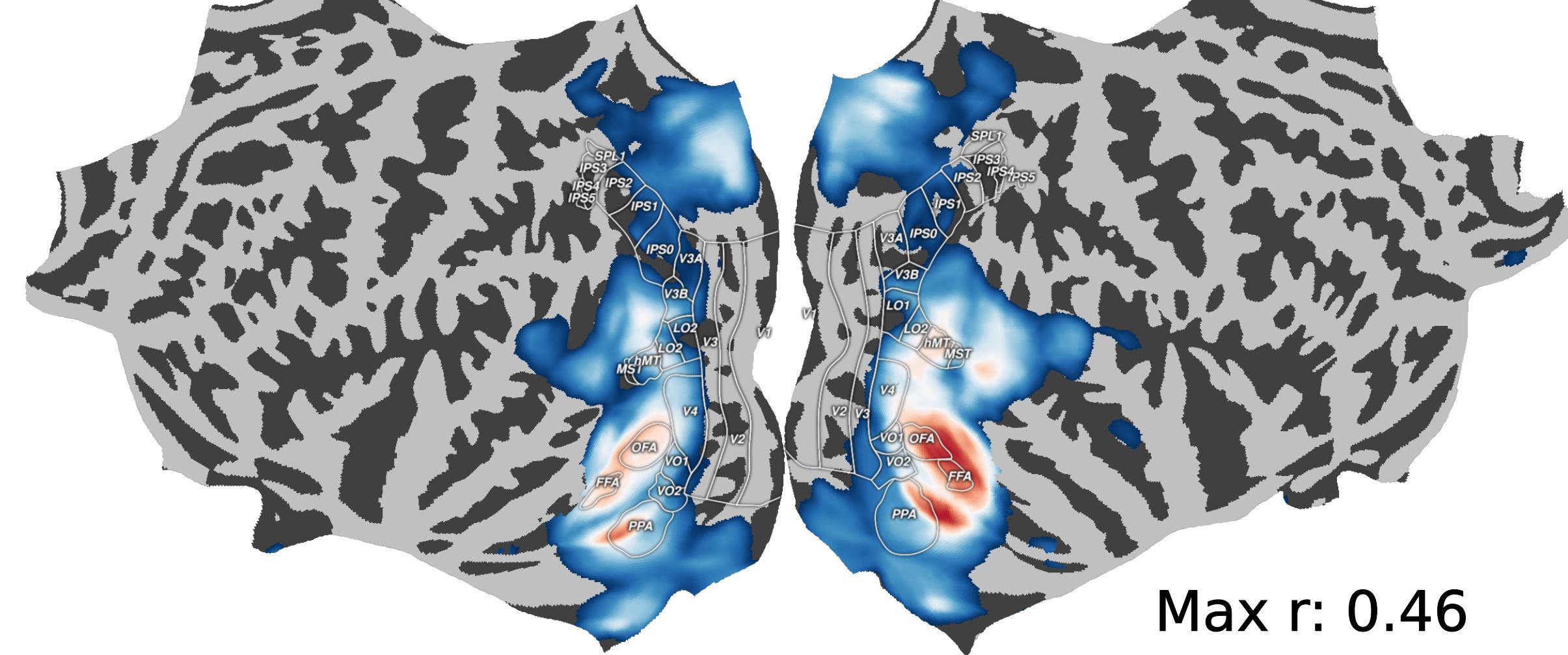
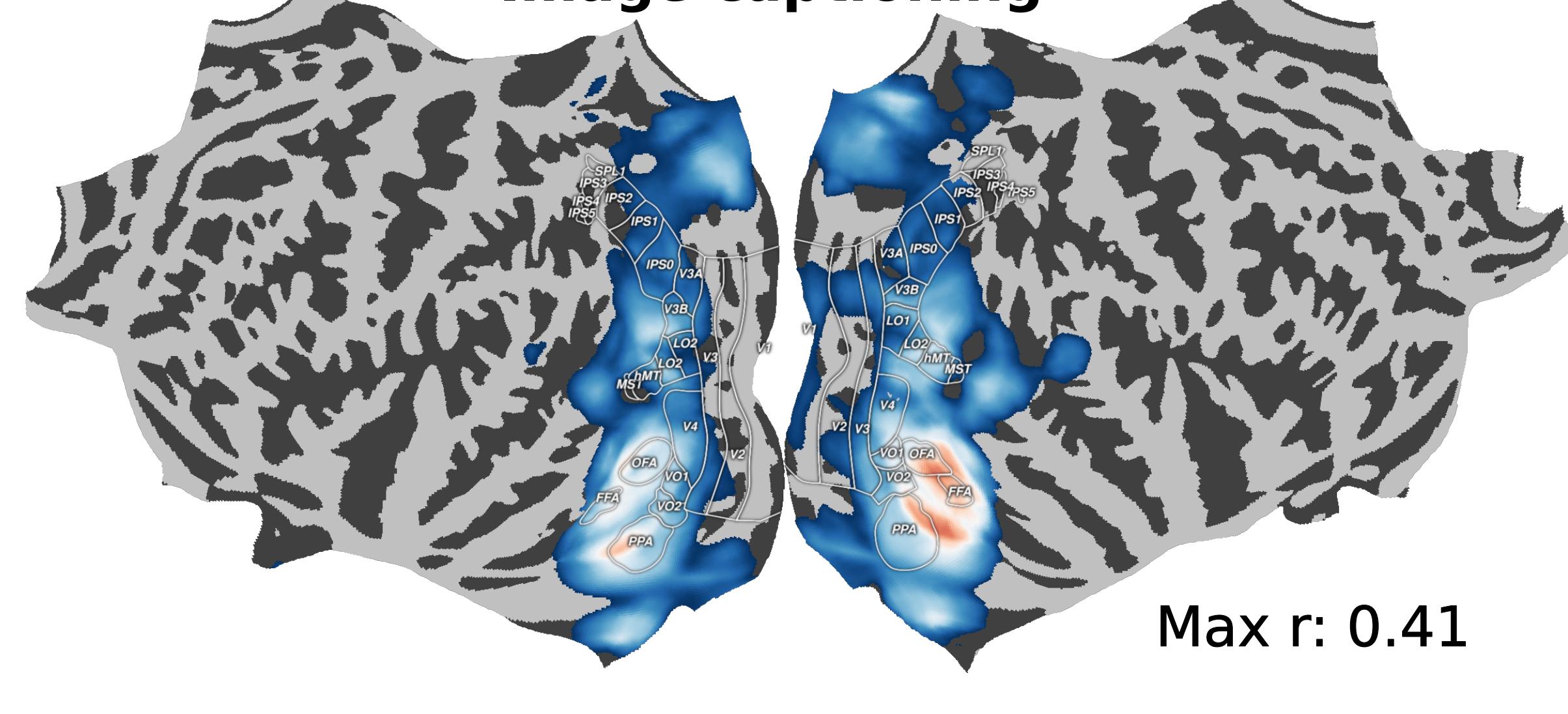
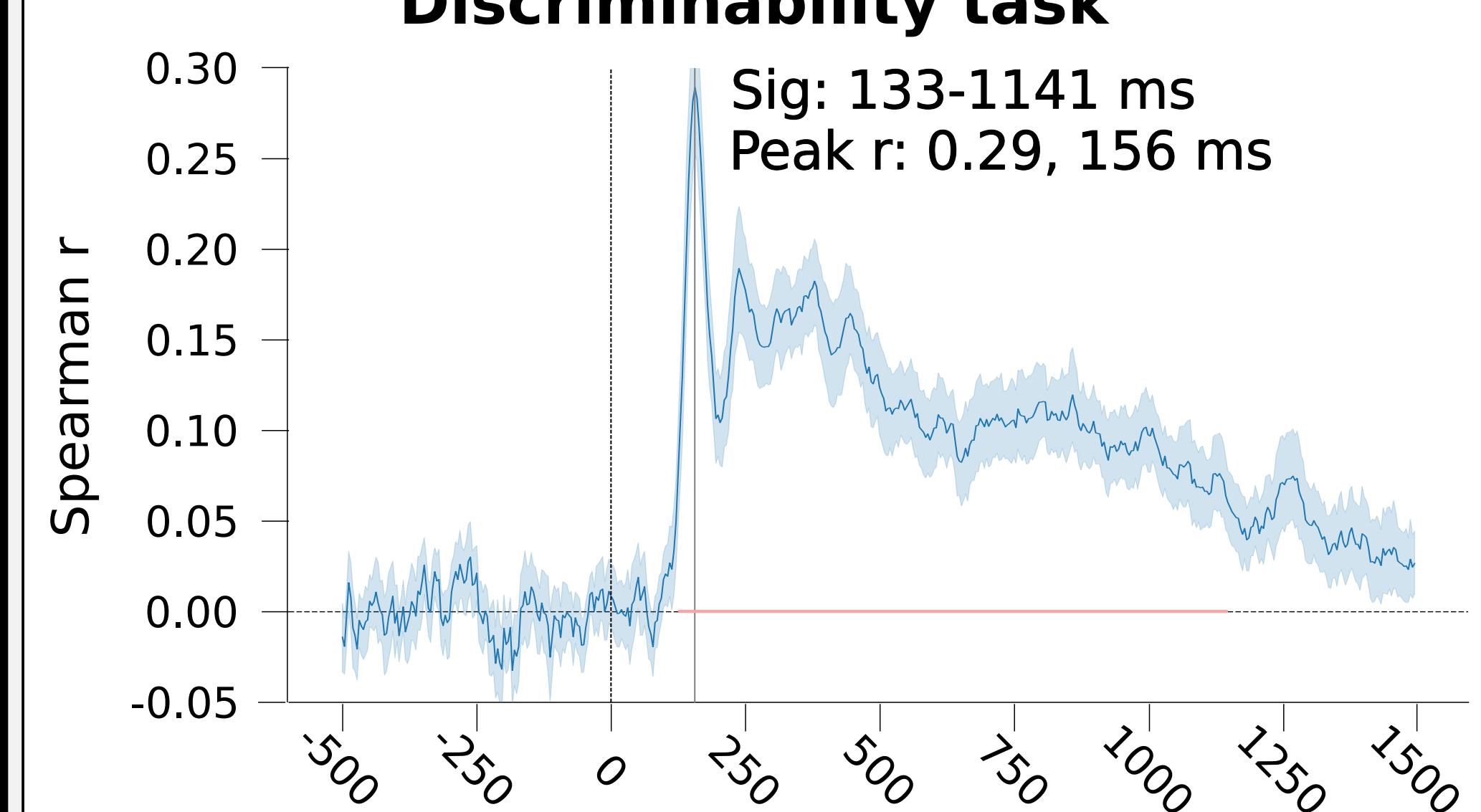


Image captioning



Spearman R Coefficient
 $P < 0.05$, FDR corrected

Discriminability task



EEG temporal dynamics

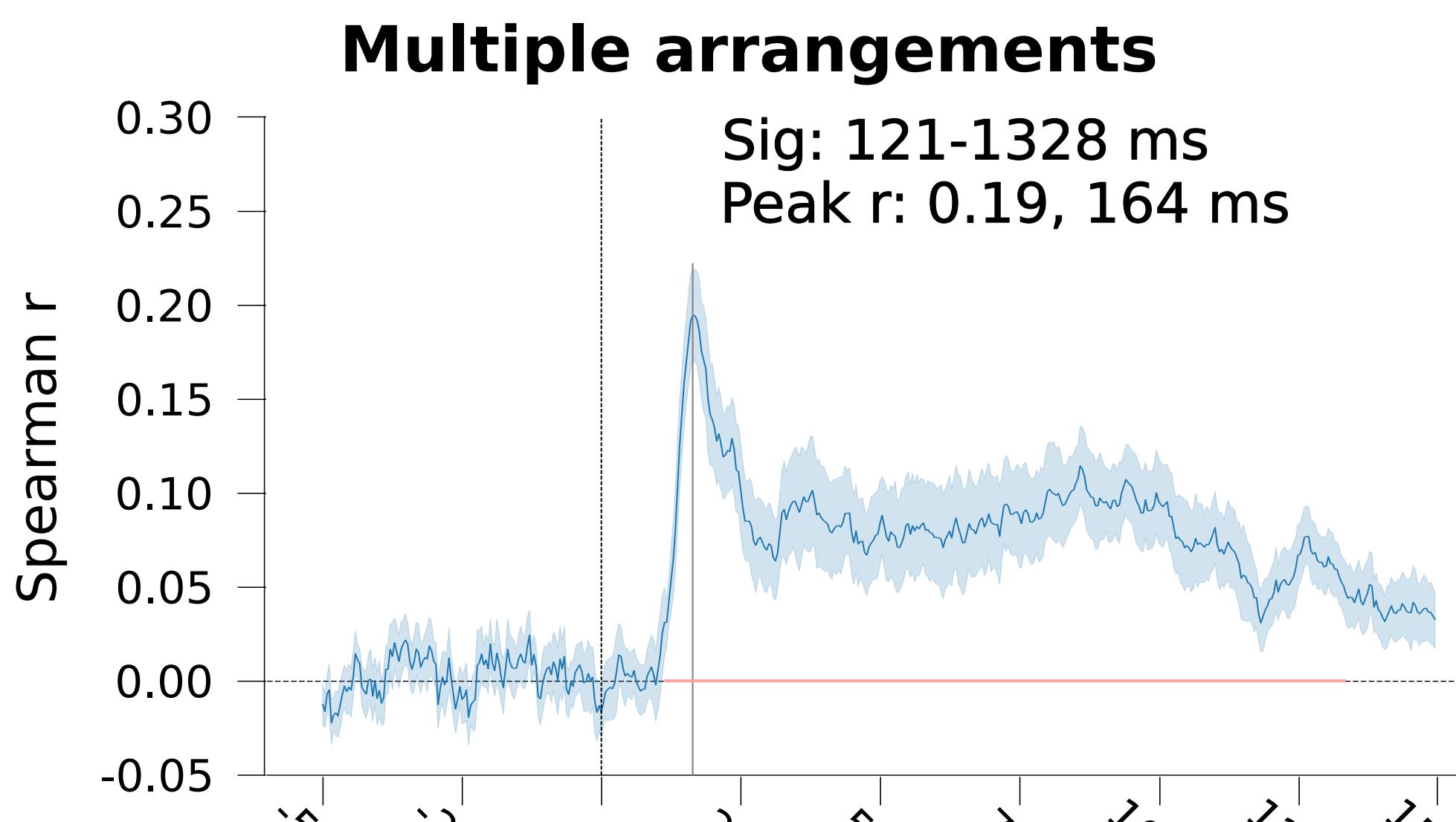
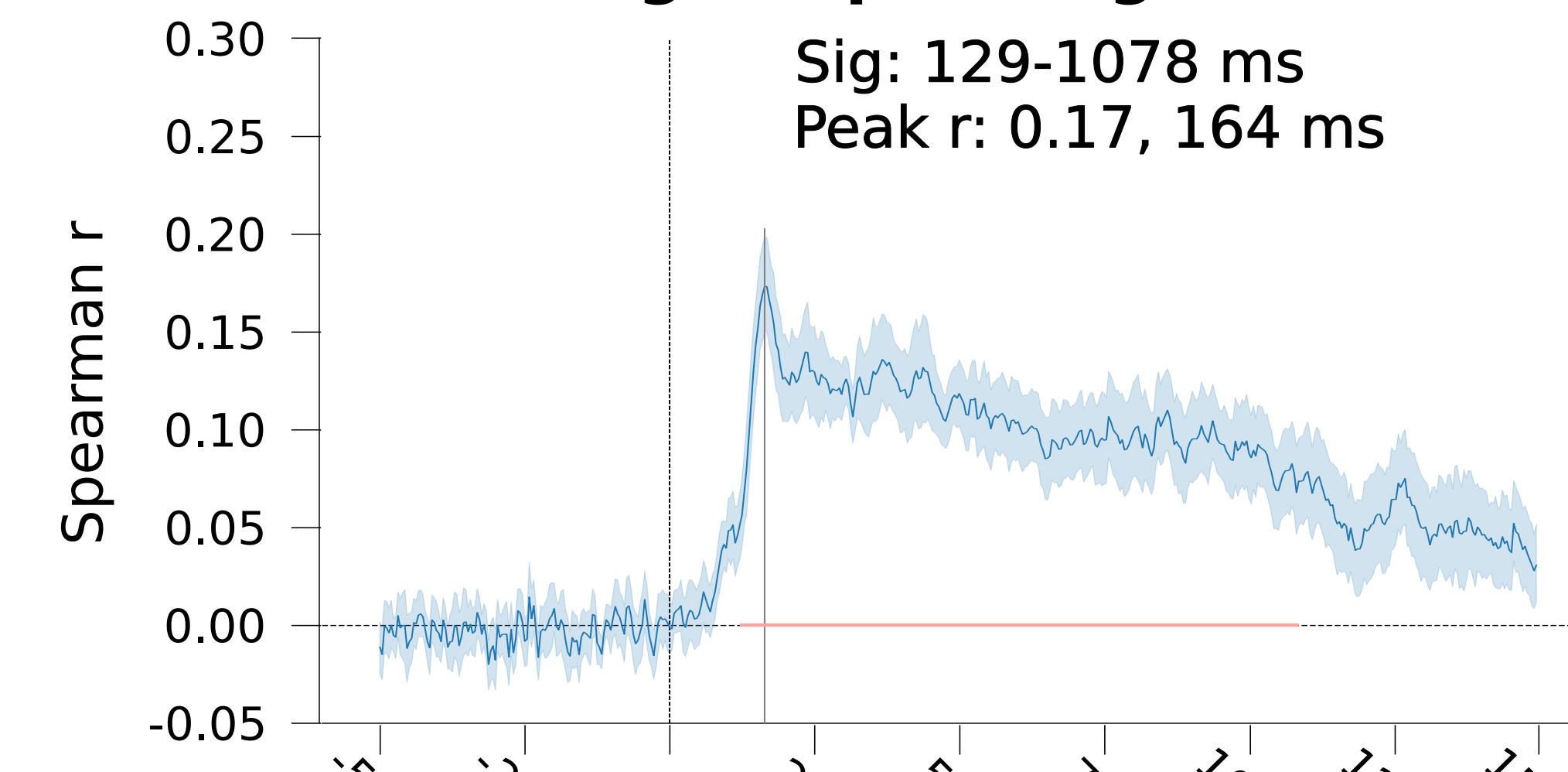


Image Captioning



Discussion

We observed significant correlations between brain activity (measured with fMRI and EEG) and all three behavioural tasks. The discriminability task, in which implicit decisions about similarities are made, showed strong correlations in both fMRI and EEG. Interestingly, these implicit judgments seem to capture representational geometries from the early posterior regions all the way to the late anterior regions of the ventral stream. In contrast, explicit judgements (multiple arrangements or image captioning) were correlated with mostly more anterior parts of the ventral stream. Altogether, these results are suggestive that combining behavioural experiments which capture complementary features underlying similarity judgements can provide a more comprehensive spatiotemporal map of neural representations in the visual cortex.

References

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