Representations of the visual world in the dog brain

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Introduction

The visual system gathers and process information to create representations of the world, these processes occur in different stages, from low-level visual processing, to object recognition. In primates, the occipital lobe performs the first feature detection steps, while computations required for object recognition take place in the inferior-temporal cortex[1,2]. In dogs, there is conflicting evidence[3,4,5] that nevertheless points towards an organization similar to the one found in primates.

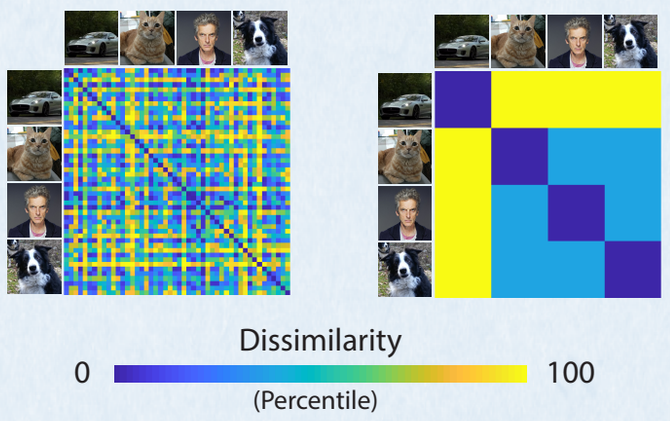
With the use of functional resonance imaging and representational similarity analysis[6], we aimed to describe regions in the dog cortex that process visual stimuli similarly to primate brain regions.

Method

15 family dogs and 13 humans observed natural videos from four different categoriies: humans, dogs, cats and cars. We followed an event related design.

Stimuli: 288 videos (mean length 4.5 s), each run consisted of 12 different videos from each category (ISI = 1.7 s, range 0.7 to 2.5 s).

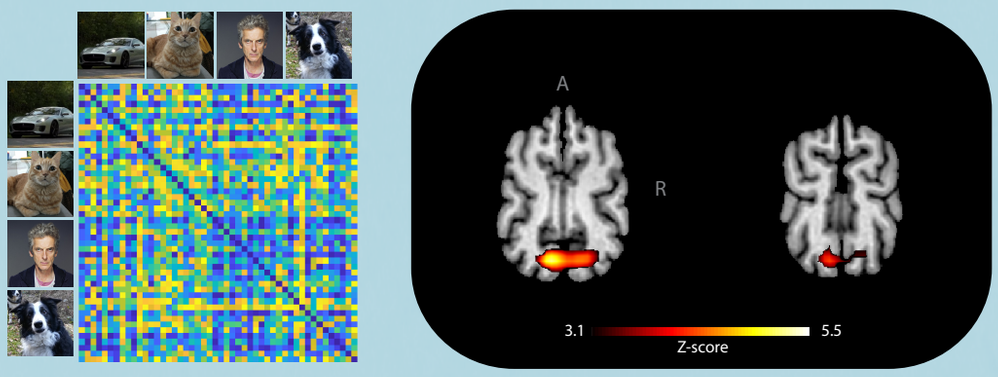
Models tested. A computational model of low-level feature detection (V1 model[7]). And a model of high-level semantic organization (Category model). All results were threshold at Z>3.1 and cluster corrected at p<0.05.



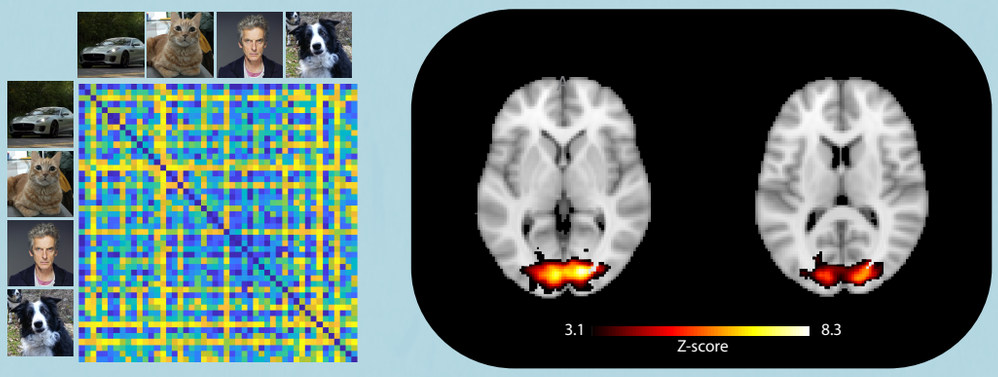
We used a 3 T Philips scanner (8 channels coil for dogs, and 32 channels coil, for humans). We acquired EPI-BOLD images (transverse slices, to dogs 32, to humans 41) with a gradient-echo echo-planar imaging (EPI) sequence (TR =2500 ms; flip angle=90º; with 2.5 x 2.5 x 2.5 mm3 spatial resolution). Each run included 124 volumes.

Results

V1 model

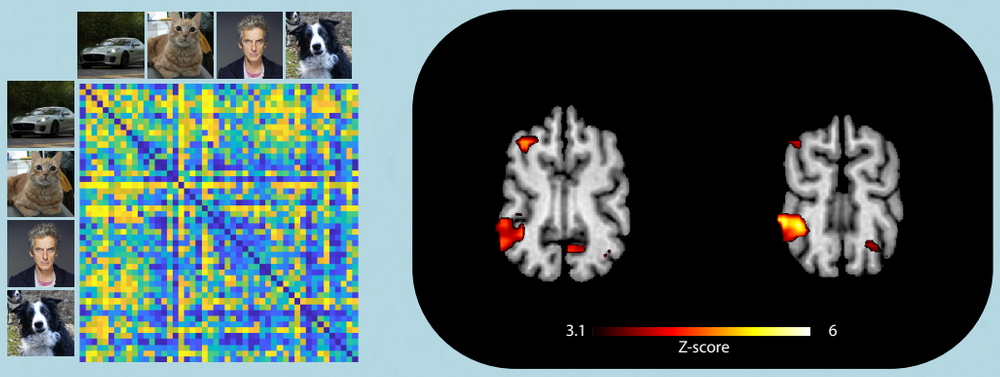


A bilateral cluster (splenial and the occipital gyrus).

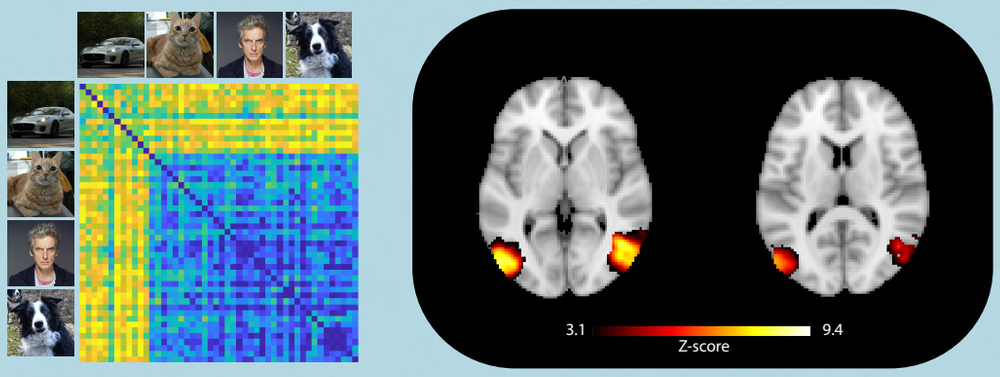


A bilateral cluster (occipital lobe).

Category model



Four clusters (left: mid suprasylvian gyrus, rostral suprasylvian gyrus, caudal ectosylvian gyrus; and in the right ectomarginal gyrus).



Two clusters (right temporal inferior gyrus, and in the left middle occipital gyrus)

Discussion

We found matches for both models in distinct regions in both species, which suggest different encoding patterns along the visual pathway. The similitude between the patterns of activity and the models, suggest similar visual processing in both species, from low-level visual features, to high-level semantic processing, but, the dissimilarity matrix in the dog, revealed an unclear processing pattern, that although matched with the category model, suggest a different semantic arrangement than the one expected. Further studies could introduce a wider variety of stimuli to try to uncover the underlying semantic arrangement in the dog cortex.

We conclude that the similitude between the patterns of activity and the models, suggest similar visual processing in both species but under different organization principles that nevertheless converge in object recognition.

References

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Acknowledgments

Our thanks to our participants and to the caregivers.
This project was funded by the Hungarian Academy of Sciences [via a grant to the MTA-ELTE 'Lendület' Neuroethology of Communication Research Group (grant no. LP2017-13/2017).