

The neural bases of how dogs navigate their social environment

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BACKGROUND

One reason for humans' advanced social abilities is their capacity to continuously make **predictions about the state of mind of others**.

Predictions (or expectations) about one's social environment can be formed based on the perception of others' actions, knowledge, and beliefs¹. **A key brain region involved in this ability is the human temporoparietal junction (TPJ)**².

This brain area has **an evolutionary origin in humans' close primate ancestors**³, with the macaque homologue playing a key role in **forming expectations about their social environment**⁴

Dogs are also sensitive to others' actions or intentions^{5,6}, but the neural mechanisms supporting this complex social ability remain unstudied.

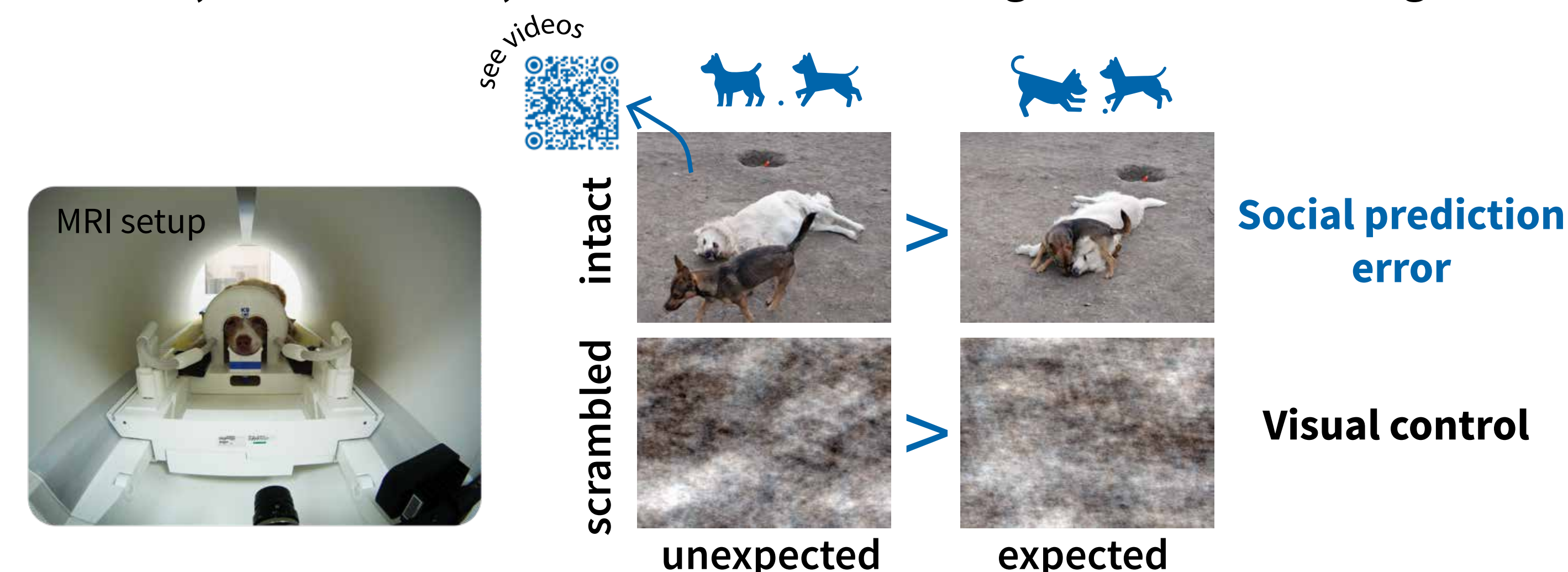
 **How do dogs process social interactions?**

 **Do unexpected turns (e.g., interruption by another event) elicit a social prediction error?**

STUDY DESIGN

Social prediction task

- Currently $N = 23$ pet dogs (10 ♀)
- $M = 6$ yrs (SD: 2)
- Awake, unrestrained, trained⁷
- Adapted from macaque study⁴
- Block design, 4-min task runs
- ~10s blocks (= 2 videos)
- on average 5 task runs / dog

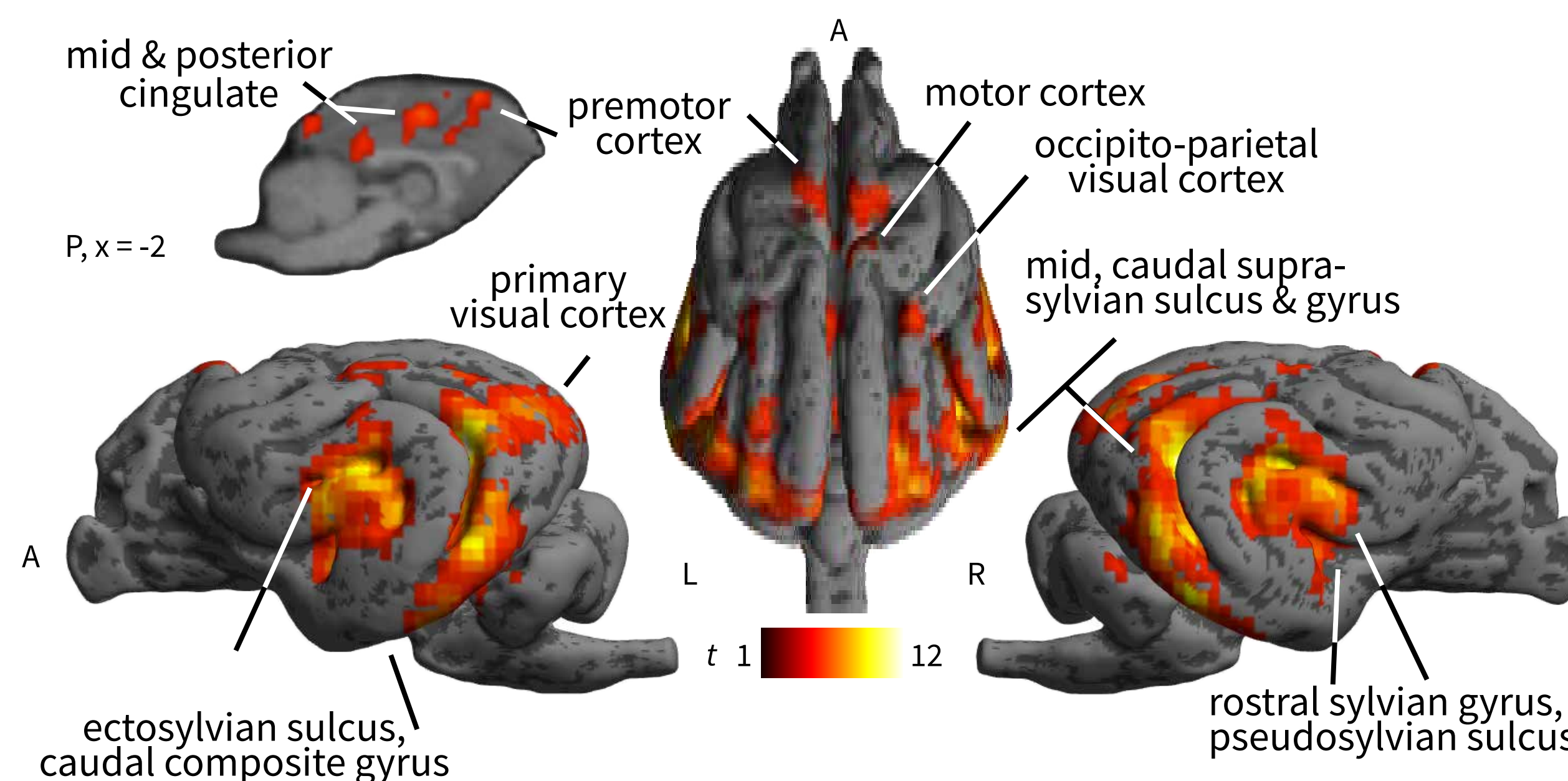


Stimuli validation: $N = 72$ dog experts (64% certified dog trainers)

Neuroimaging data was convolved with a tailored dog HRF⁸. Imaging parameters: multiband accelerated EPI sequence, TR/TE = 1000/38 ms, voxel size = $1.5 \times 1.5 \times 2$ mm³, 24 axial slices, flip angle = 61°, interleaved; structural scan: MP-RAGE, TR/TE = 2100/3.13 ms, voxel size = 0.7 mm isotropic

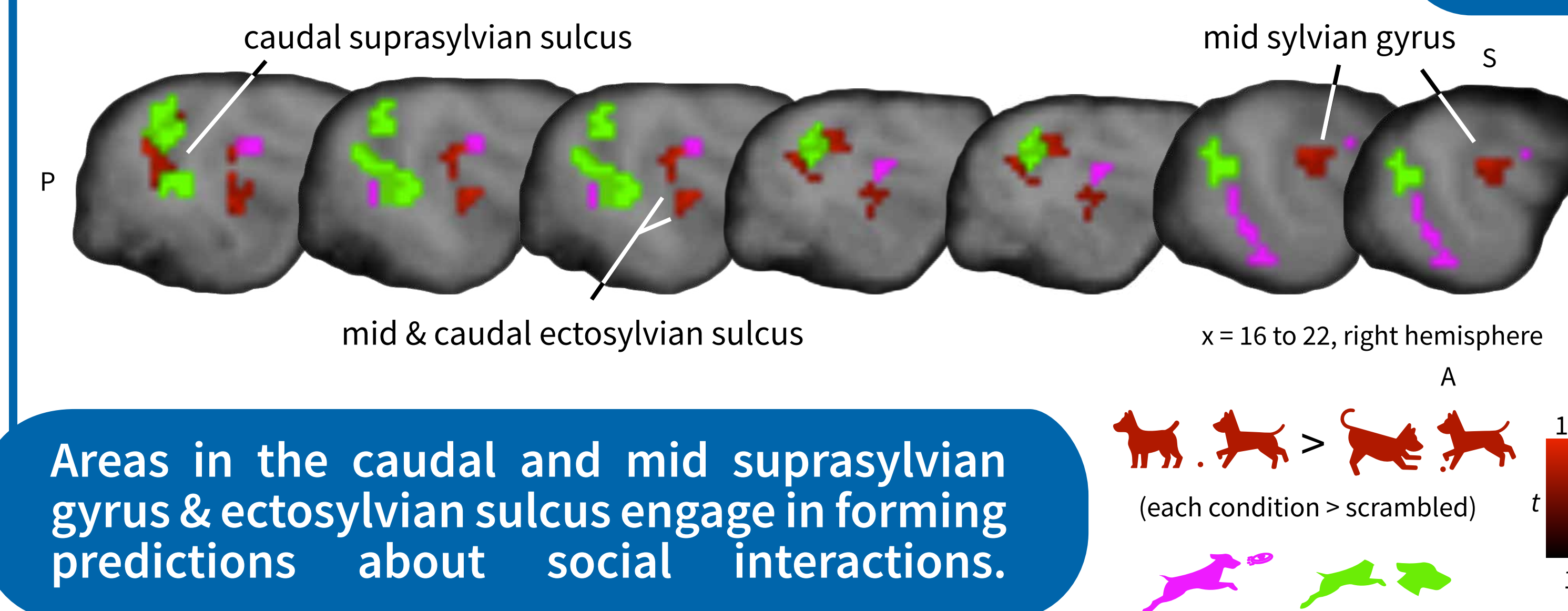
FIRST RESULTS

A Social interaction network (intact > scrambled)



Observing social interactions engages a whole-brain network including occipito-temporal, parietal, (pre-)motor areas, and the cingulate cortex.

D Domain specificity of social prediction areas



FIRST CONCLUSIONS

Social prediction modulates activity in the dog temporal lobe.

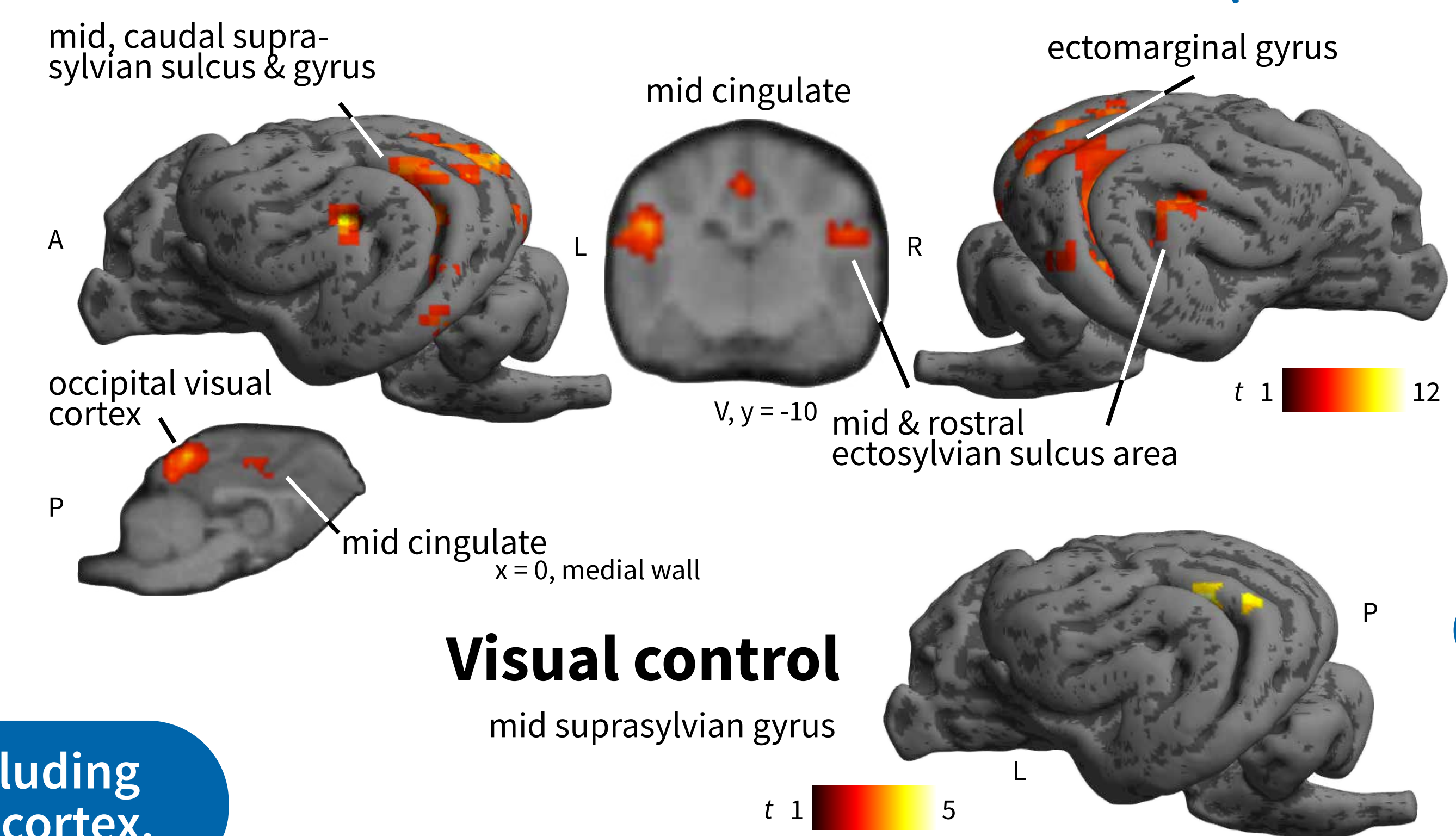
We will further test specificity for social environment with additional task investigating expectation formation in physical domain.

More pronounced involvement of the temporal than parietal lobe indicates a **predominant role of the dog temporal lobe for social perception**.

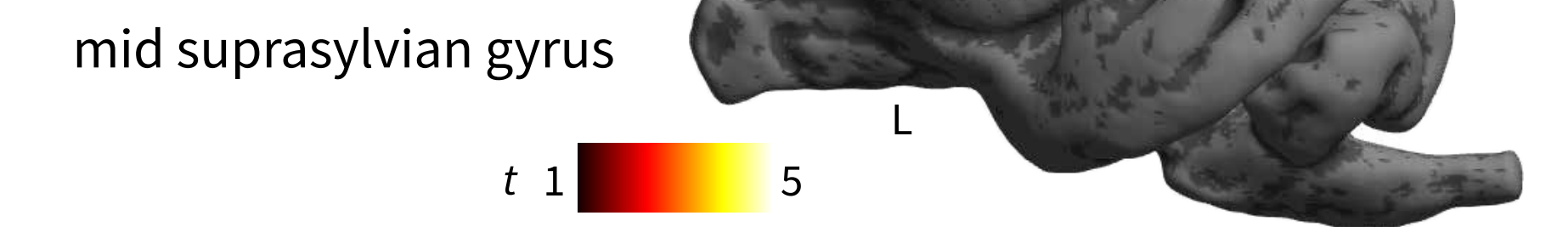
The results indicate functional convergence between dog and primate social brain areas. Next, we will investigate if they are also embedded in analogous networks in these species^{3,4,10} and, therefore, true analogues.

References: ¹Lockwood et al. *TICS* 2020; ²Schurz et al. *Neurosci. Biobehav. Rev.* 2020; ³Mars et al. *PNAS* 2013; ⁴Roumezeilles et al. *Sci. Adv.* 2021; ⁵Londardo et al. *Proc. R. Soc. B* 2021; ⁶Völter et al. *Proc. R. Soc. B* 2023; ⁷Karl et al. *Behav. Res. Methods* 2020; ⁸Boch et al. *Comm. Biol.* 2023; ⁹Boch et al. *bioRxiv* 2023; ¹⁰Mars et al. *eLife* 2018

B Social prediction error



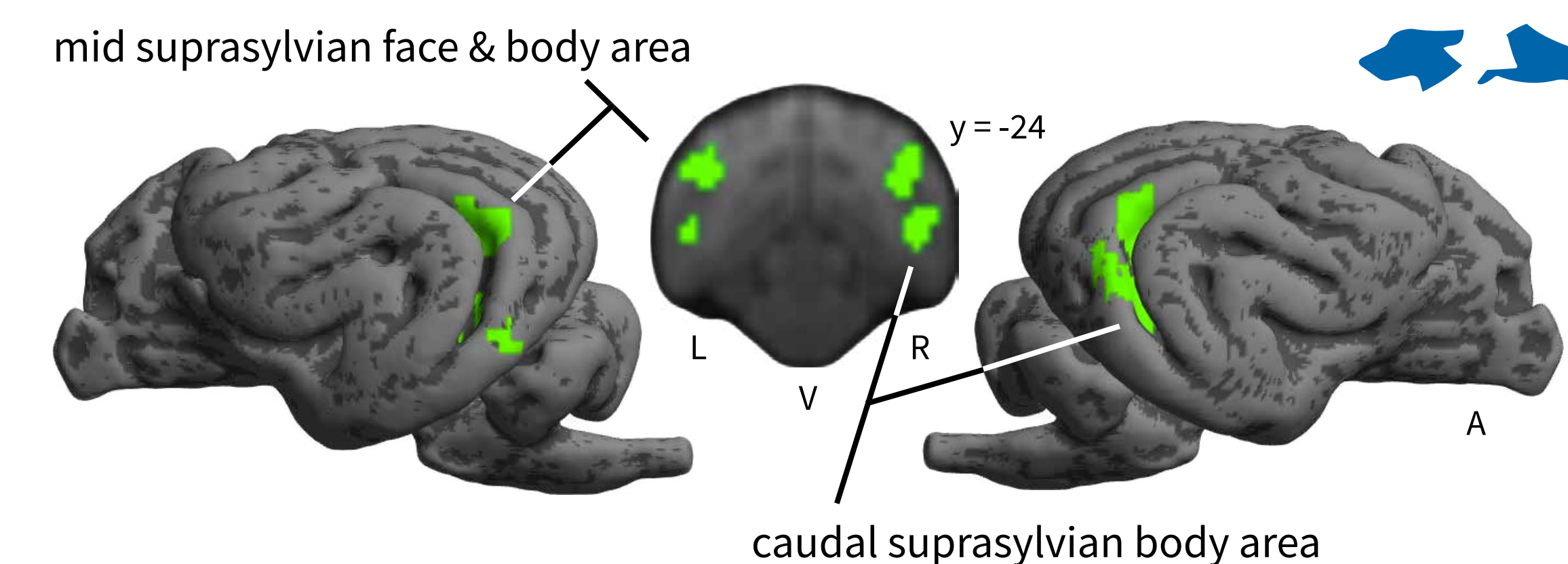
C Visual control



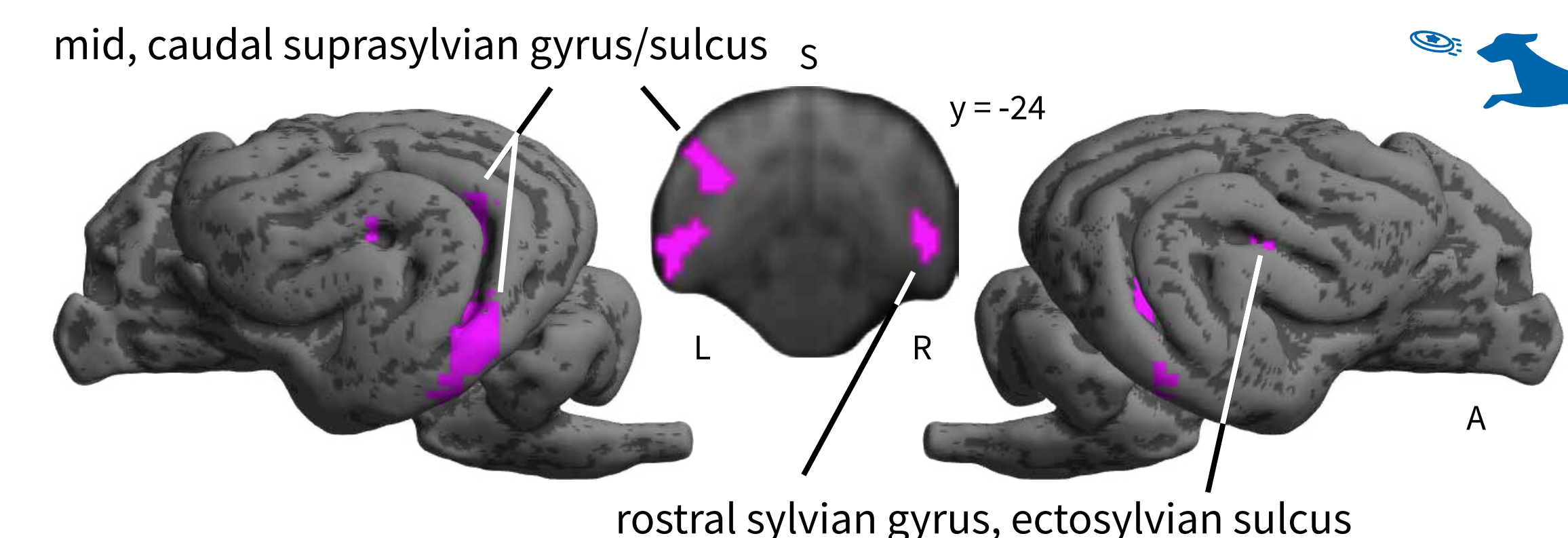
The occipito-temporal regions & mid-cingulate cortex of the social interaction network respond stronger to unexpected turns.

E Functional localizer tasks

Agent perception (faces/bodies > object, visual controls; bodies > faces^{8,9})



Action observation network (action observation > visual, object controls⁹)



Images are accompanied with anatomical locations posterior (P), anterior (A), dorsal (D), ventral (V), superior (S), left (L) and right (R). We used one sample t -tests with a cluster defining threshold of $p < .001$ and probability threshold: $p < .05$ FWE corrected, except for C: clusters did not survive threshold, we then used a more liberal cluster defining threshold of $p < .005$; functional localizer results are summarized as binary masks, due to less power as main task, we set the threshold as for C.

