Modulation of the Action Observation Network by Action, Agent and Observer Factors

Insights from an fMRI Study on Dog-Experts and Non-Experts

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BACKGROUND

We constantly observe the actions of other human and non-human agents

The **Action Observation Network** (AON) may be an important brain network for the processing of actions

It is active both during the **observation** and the **execution** of actions

However, little is known on **factors** that **modulate** this network, especially concerning the observation of **non-human actions**

How do factors of the **action** (transitive/intransitive), **agent** (dog/human), and **observer** (dog-expert/non-expert) modulate the Action Observation Network?

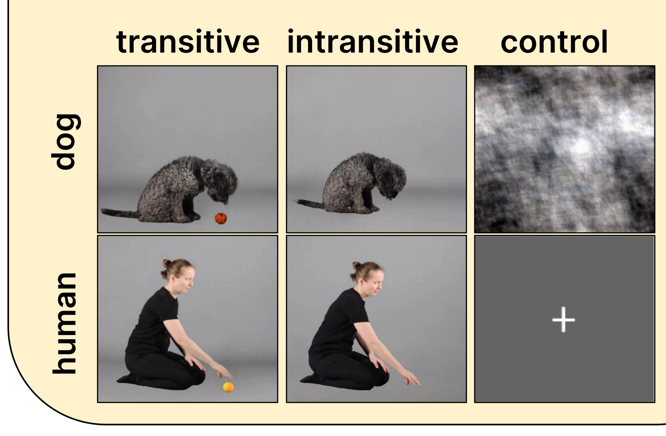
STUDY DESIGN & ANALYSIS

N = 40 participants (55%♀ age: M = 23, SD = 2.61)

n_1 = 17 dog experts n_2 = 23 non-experts

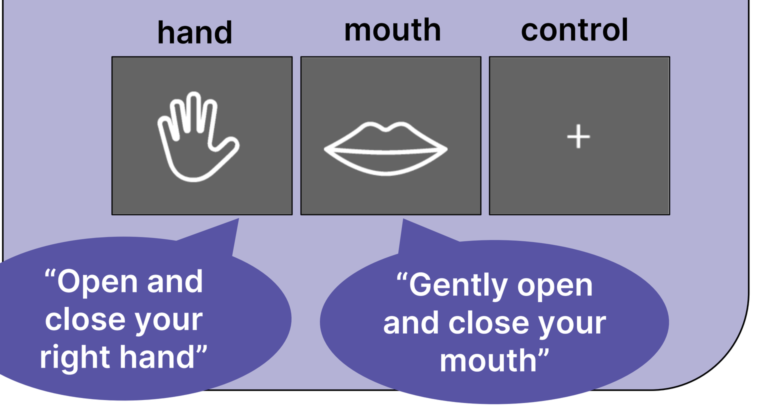
Action Observation Task

- Two five-minute runs
- ~12s blocks



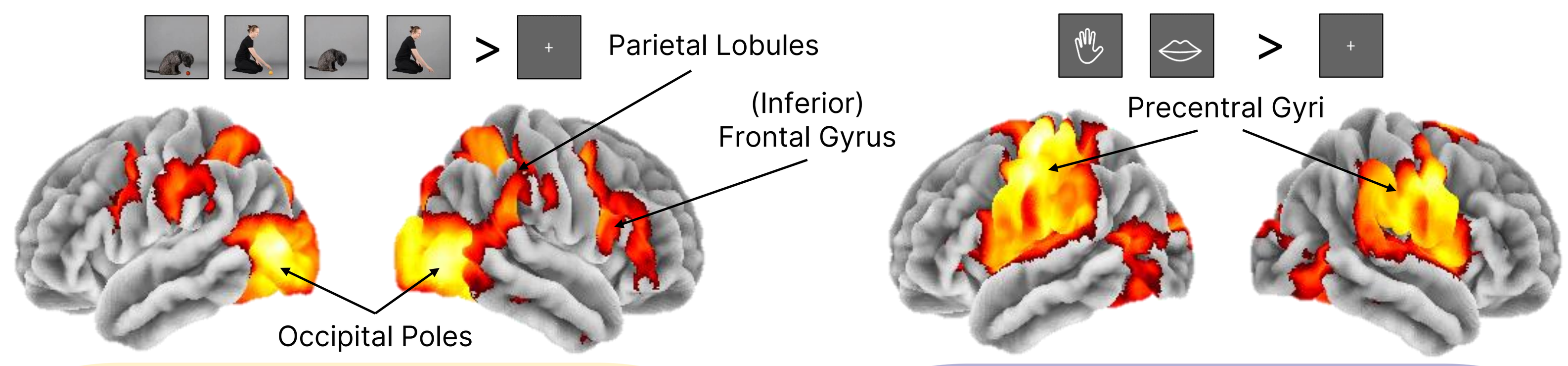
Action Execution Task

- One five-minute run
- ~10s blocks



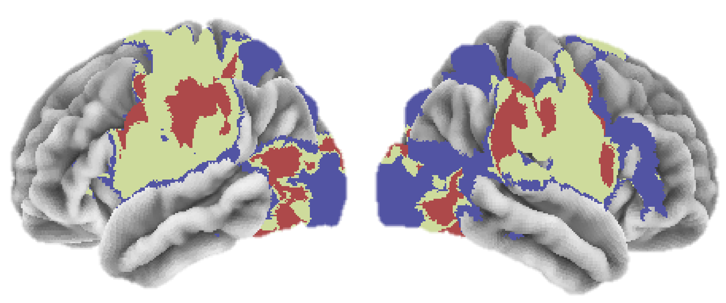
The data were collected using a 32-channel human head coil and a 3T Siemens Skyra MR-system. To acquire functional data, a 4-fold MB accelerated EPI sequence was employed with the following parameters: voxel size = 2 mm isotropic, TR/TE = 1200/34 ms, FoV = 192 × 192 × 124.8 mm3 , flip angle = 66°, 20% gap, and 52 axial slices coplanar to the connecting line between the anterior and posterior commissure, with interleaved acquisition in ascending order. The data were preprocessed using FSL Feat and analysed using Nilearn. See https://github.com/olafborghi/AON_ACTION for analysis code.

ACTION OBSERVATION / EXECUTION



AON activation

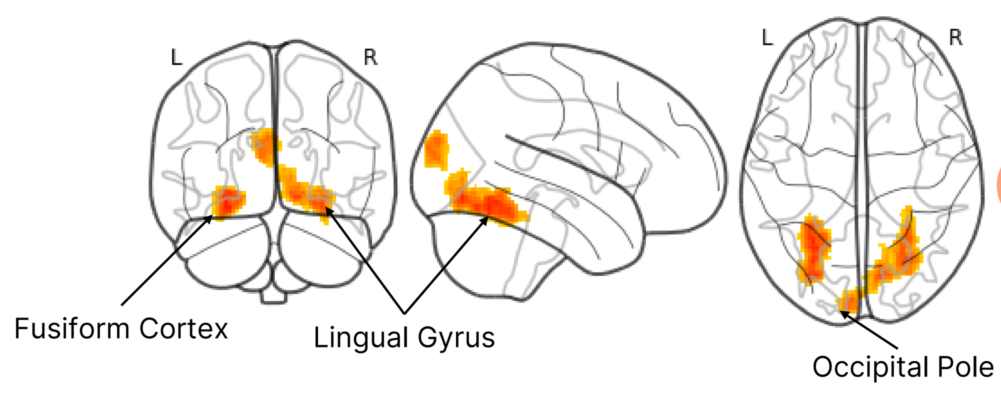
Motor activation



Observation-Execution Overlap[1]

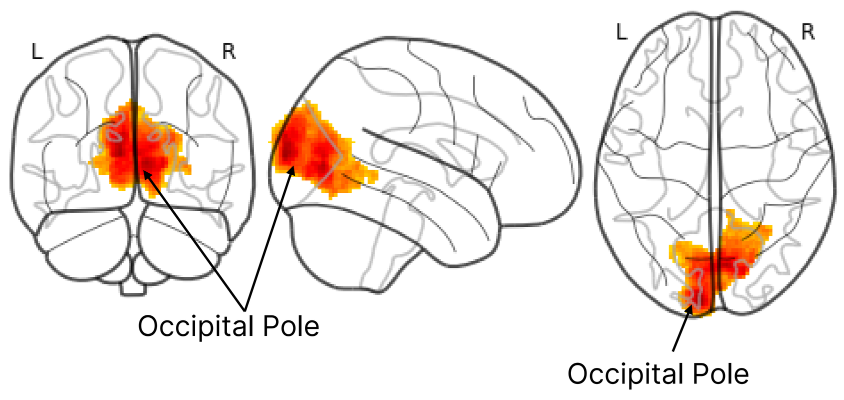
WHOLE-BRAIN FACTOR CONTRASTS

Transitive > Intransitive

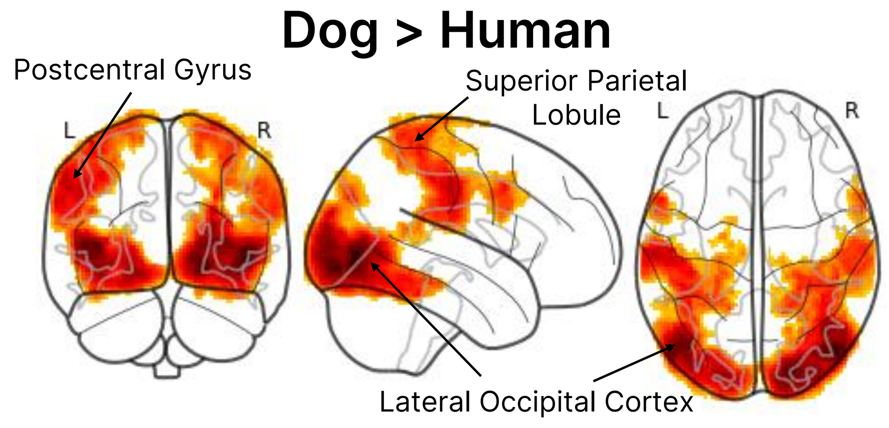


Greater **occipitotemporal** activation for **transitive actions**

Human > Dog



Dog > Human



For all whole-brain contrasts: Voxel level control $p < .001$, cluster level control $p < .05$ (controlled for FWE)

Greater AON activation for **dog actions**

ROI RESULTS

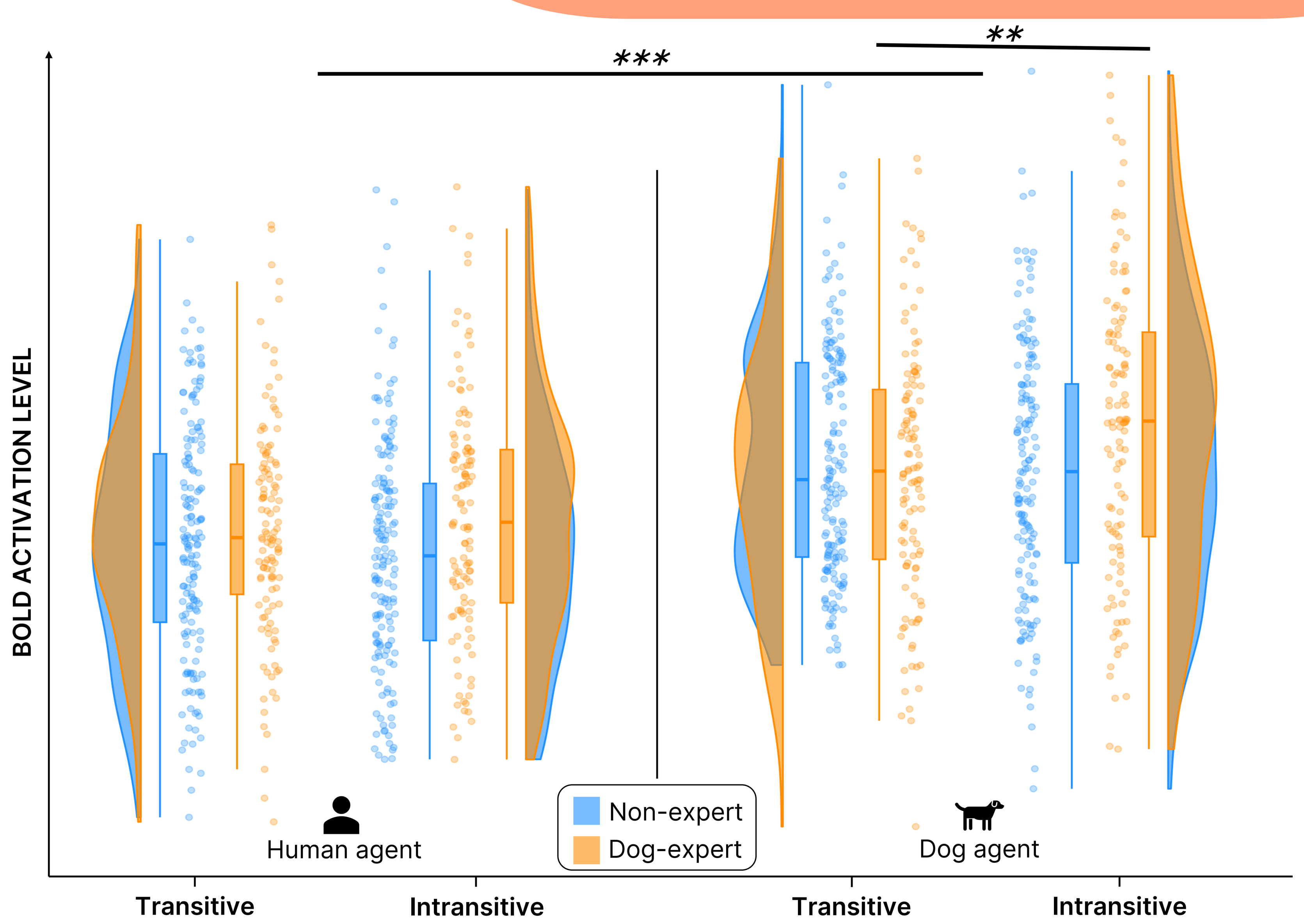
Mean activation levels from areas with observation-execution overlap[1] within anatomical ROIs[2]

Significance determined with a linear mixed effect regression[3]

Higher mean activation levels for **dog** compared to **human** actions (human - dog; $\beta = -.82$, $p < .001$)

Observer * action interaction ($\beta = -.37$, $p = .004$)

- FDR-corrected pairwise post hoc comparisons
  - **Dog-experts: Intransitive dog action > transitive dog action** ($t = 3.49$, $p = .001$, $d = .45$)
  - No effect in non-experts



[2]Anatomical ROIs: Inferior Parietal Lobule, Inferior Frontal Gyrus, Premotor Cortex, Primary Motor Cortex

[3]lme4 formula: activation ~ action * agent * observer + (1 | subject) + (1 | ROI)

CONCLUSION

The human AON is highly reactive to **non-conspecific** (dog) **actions**

Predictive coding model[a]: **Less familiar actions** lead to higher prediction errors → higher activation for dog actions?

Value driven model[b]: Modulation by the subjective **value** / meaning of the action?

- Only **dog experts** may be motivated to infer meaning to the more ambiguous intransitive dog actions → higher prediction error than during the observation of transitive dog actions?

Further research is needed to better understand differences in the neural correlates of experts and non-experts

[a]Kilner, J. M., Friston, K. J., & Frith, C. D. (2007). Predictive coding: An account of the mirror neuron system. *Cognitive Processing*, *8*(3), 159–166. https://doi.org/10.1007/s10339-007-0170-2

[b]Aziz-Zadeh, L., Kilroy, E., & Corcelli, G. (2018). Understanding activation patterns in shared circuits: Toward a value driven model. *Frontiers in Human Neuroscience*, *12*. https://www.frontiersin.org/articles/10.3389/fnhum.2018.00180

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