Decoding representations of actions of other species using multivariate pattern analysis

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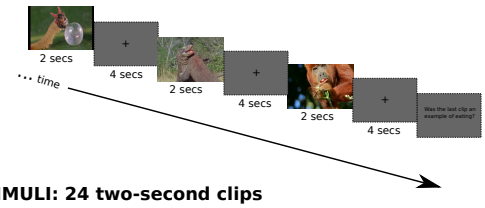
INTRODUCTION

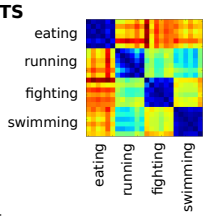
A wide range of stimuli, including point-light animations of human actions[1] and Heider-Simmel animations which depict geometric shapes engaged in social interaction[2], can elicit neural activity in regions of human cortex known to represent actions. The nature of such stimuli suggests that action representations are highly abstract and relatively independent of form. In this study, we probe the generality of action representations using naturalistic stimuli that depict different kinds of animals engaged in a variety of common actions.

fMRI TASK



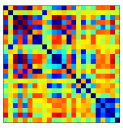
STIMULI: 24 two-second clips

BEHAVIORAL JUDGMENTS

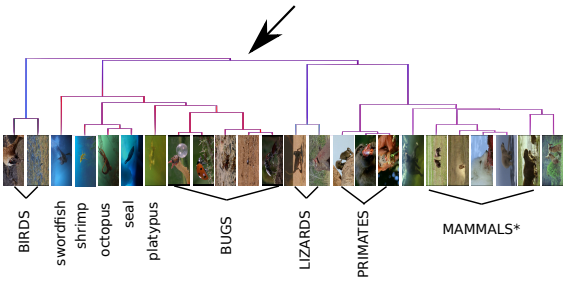


Action judgments dissimilarity matrix

Judgments about the content of the stimulus clips were collected using the "crowd sourcing" resource Amazon's Mechanical Turk.

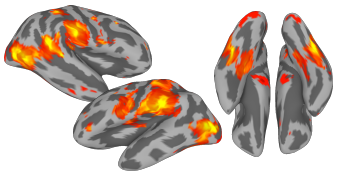


Animal kind judgments dissimilarity matrix

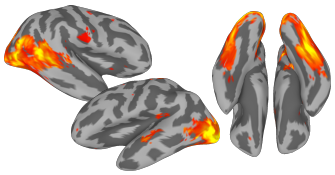


Similarity searchlight for mapping correlations with target behavioral dissimilarity matrices

Action judgments

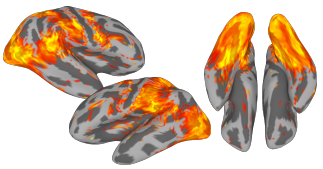


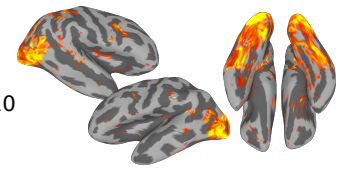
Animal Kind judgments



Support-vector machine pattern classification using surface-based searchlights[3,4]

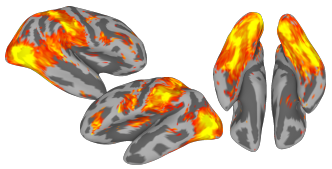
24-way classification shows reproducibility of stimulus-specific patters throughout visual and parietal cortex.





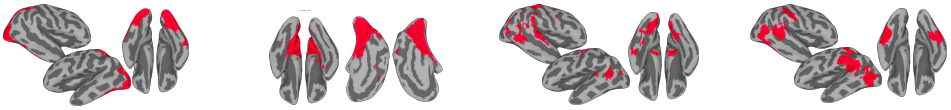
Two-way classification for mammal versus non-mammal

Four-way classification for action class.



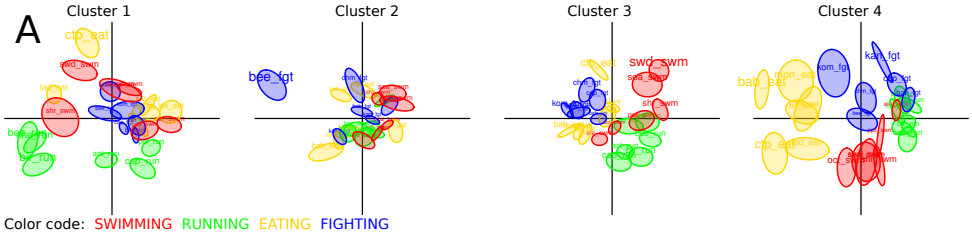
All brain maps use the same scale, showing group T-statstics for results greater than chance, thresholded at p = .01, uncorrected.

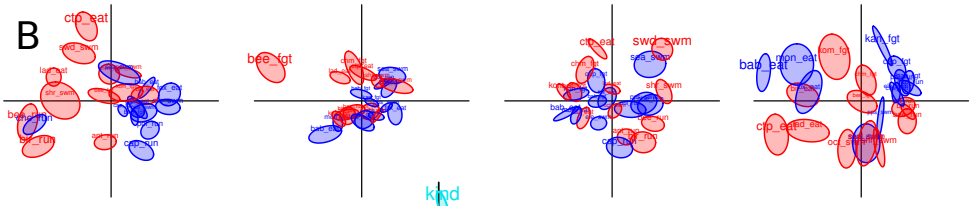
Whole brain clustering based on functional connectivity vectors measured using searchlight dissimilarity matrices. First four clusters are shown.

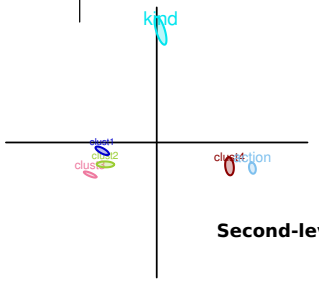


Cluster 1 Cluster 2 Cluster 3 Cluster 4

Three-way (multi-subject) multidimensional scaling (using DISTATIS[5]) for each cluster. First two dimensions are shown for each cluster, color-coded for action (A) and mammal versus non-mammal (B).







Second-level DISTATIS analysis

Conclusions

Convergent evidence across dierent analyses points to action-based semantic organization refected in distributed patterns of BOLD activity spanning a large network of areas including the inferior parietal lobule, pSTS, posterior middle temporal, and lateral inferior temporal cortex.

The sematic organization for action categories appears to be independent of the biological class of the actor. This organization is also differentiaed from the organization of patterns recorded in early visual cortex, suggesting that for this set of relatively uncontrolled naturalistic stimuli, high-level and low-level visual features are experimentally separable.

Surrisingly, we have not observed strong evidence for organization based on biological class. However, separation of mammals versus non-mammals was observed in expected regions including ventral and lateral occipito-temporal cortex.

References

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