Clustering cortical searchlights based on shared representational geometry

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http://www.pymvpa.org

http://NeuroDebian.net

Fork me on GitHub

Aims

Apply clustering to searchlight RSA in order to functionally parcellate the cerebral cortex

Investigate reproducibility for different clustering algorithms [1]

Investigate effects of hyperalignment [2]

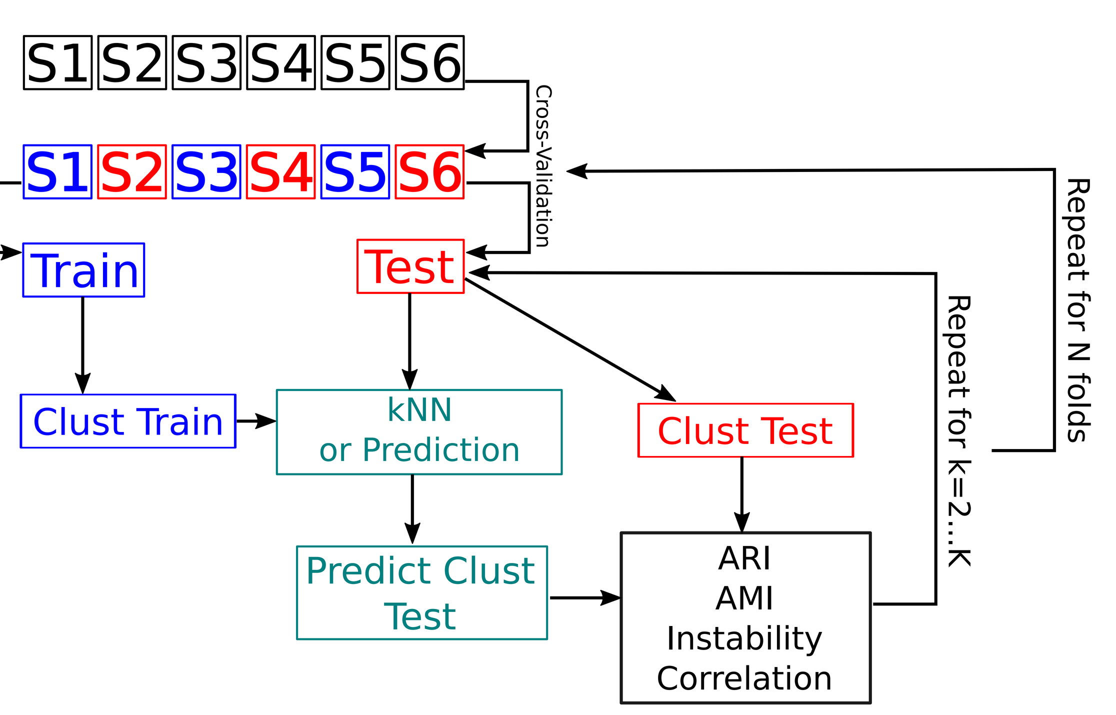
Compare experiment-specific parcellations to publicly available functional and anatomical parcellations

Methods

Clustering algorithms
- k-means
- Ward (with and without structural constraints)
- Gaussian mixture models (with different covariance structures)
- Complete linkage with correlation distance

Metrics
- Reproducibility procedure (inspired by [3] and [4], see below) using adjusted Rand index (ARI), adjusted mutual information (AMI), instability [3], and correlation of average RDMs between corresponding clusters

- Consistency of representational geometry quantified using a measure of homogeneity [5] based on pairwise correlation distance between all searchlight RDMs within a parcel



Cross-validation scheme for parcellation reproducibility estimate

[WIP] Code

www.github.com/mvdoc/reprclust
Fork it and try your favorite methods!

Conclusions

Meaningful parcellations can be obtained by clustering shared representational geometries

None of the methods tested provided "the ultimate solution" for whole brain parcellation with respect to reproducibility

Hyperalignment had drastic effects on reproducibility

Experiment-specific parcellations exhibit higher homogeneity compared to resting-state and anatomical parcellations

Future directions:

Investigate full range of possible values of k

Introduce parcel pruning to remove non-informative parcels

References

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[2] Haxby, J. V., Guntupalli, J. S., Connolly, A. C., Halchenko, Y. O., Conroy, B. R., Gobbini, M. I., Hanke, M., & Ramadge, P. J. (2011). A common, high-dimensional model of the representational space in human ventral temporal cortex. Neuron.
[3] Lange, T., Roth, V., Braun, M. L., & Buhmann, J. M. (2004). Stability-based validation of clustering solutions. Neural Computation.
[4] Yeo, B. T., Krienen, F. M., Sepulcre, J., Sabuncu, M. R., Lashkari, D., Hollinshead, M., Roffman, J. L., Smoller, J. W., Zöllei, L., Polimeni, J. R., Fischl, B., Liu, H., & Buckner, R. L. (2011). The organization of the human cerebral cortex estimated by intrinsic functional connectivity. Journal of Neurophysiology.
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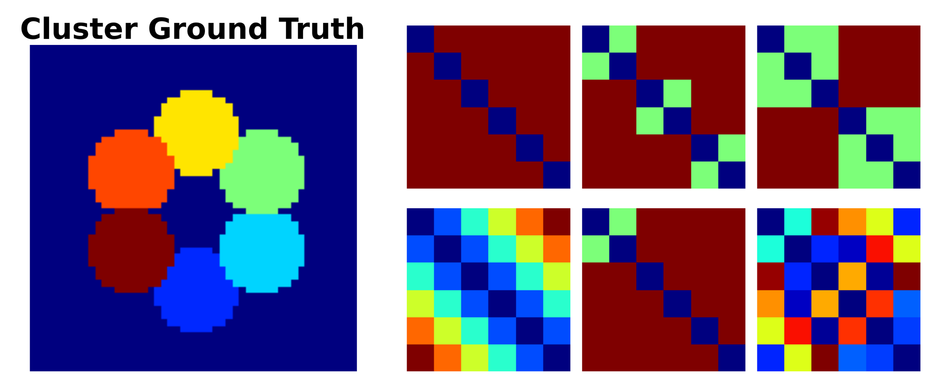
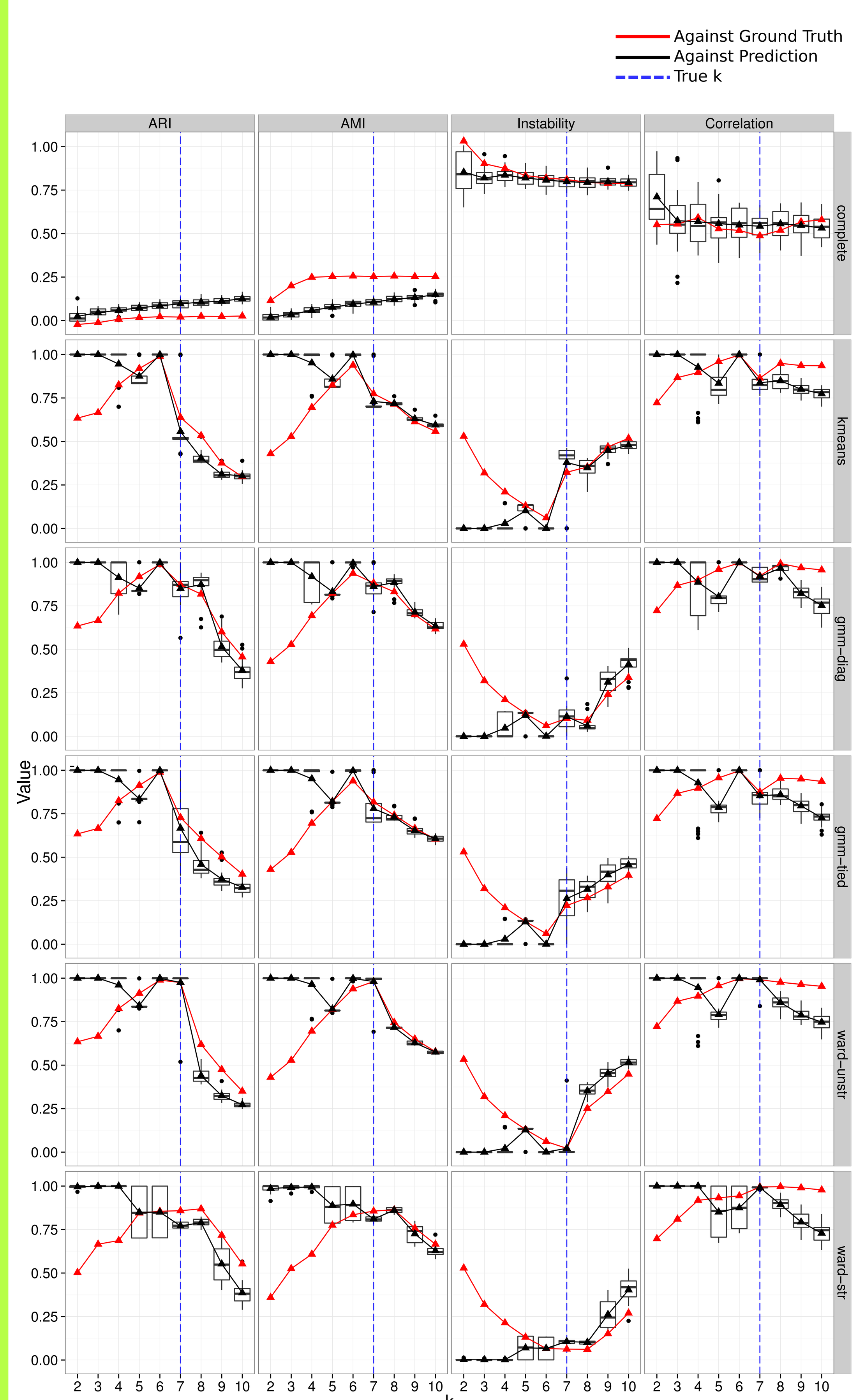
Simulated data



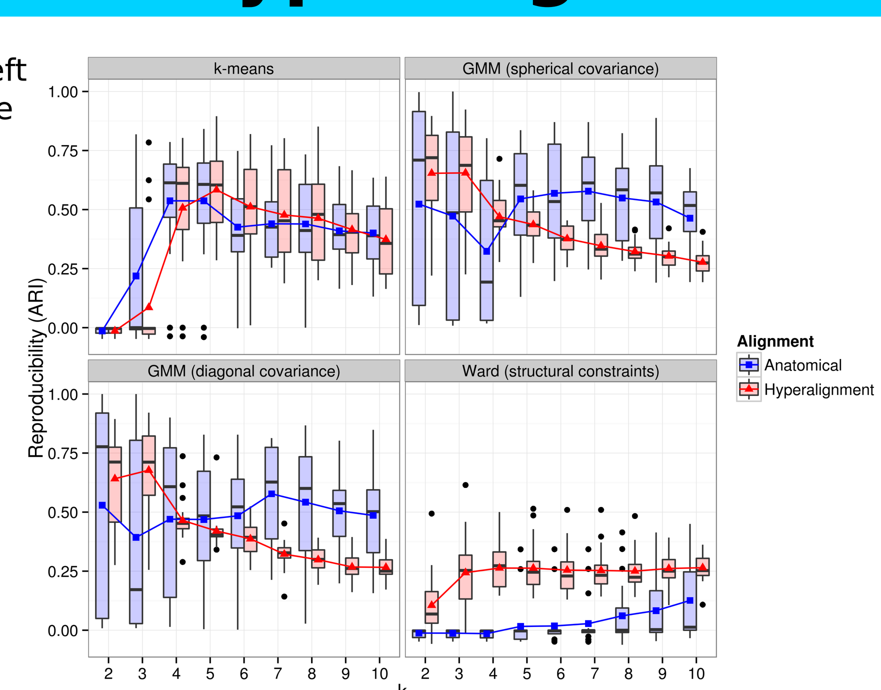
- 10 simulated subjects
- 6 contiguous clusters with pattern information
- Different RDM in each cluster
- Random subject-specific and common noise

Simulation results

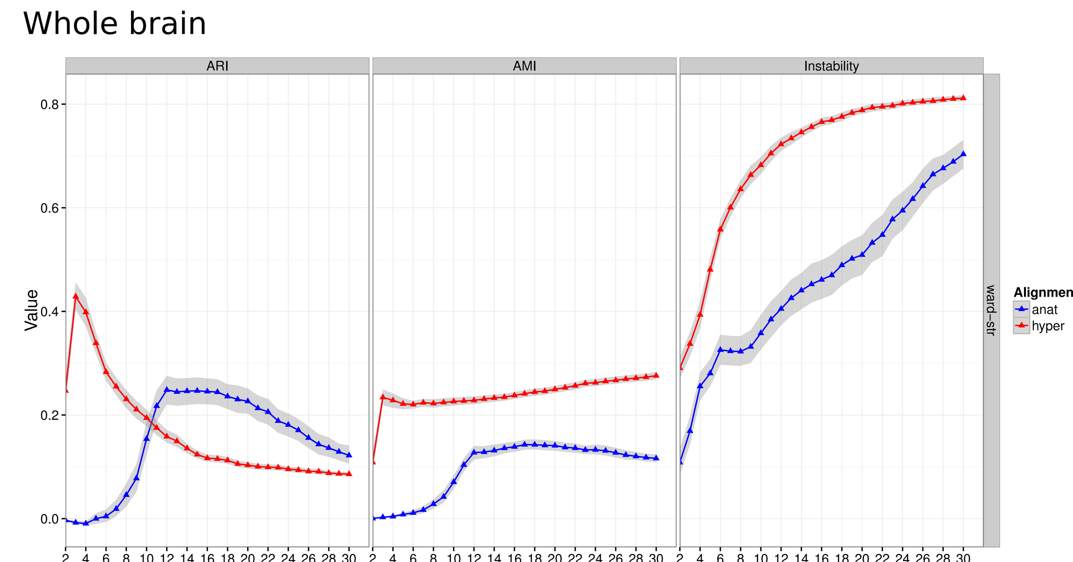


Effect of hyperalignment

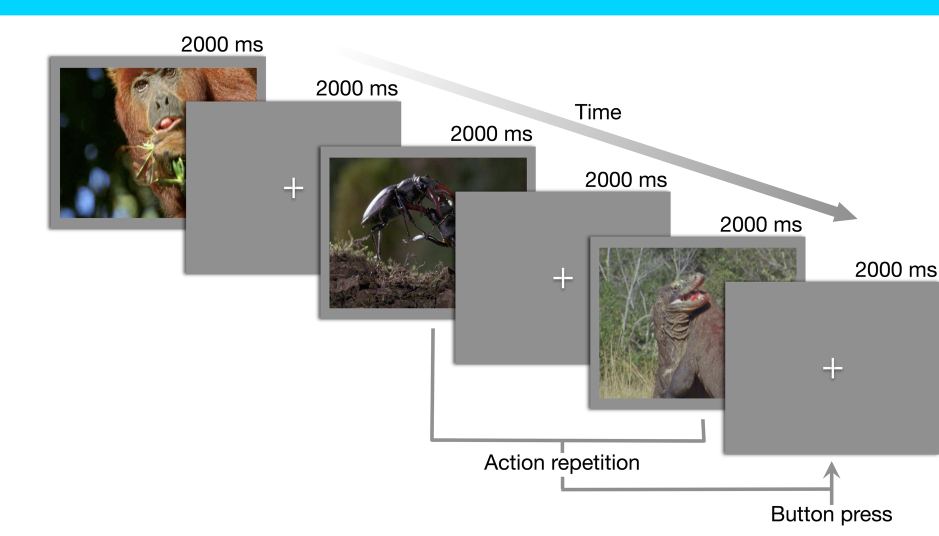
Posterior left hemisphere



Whole brain

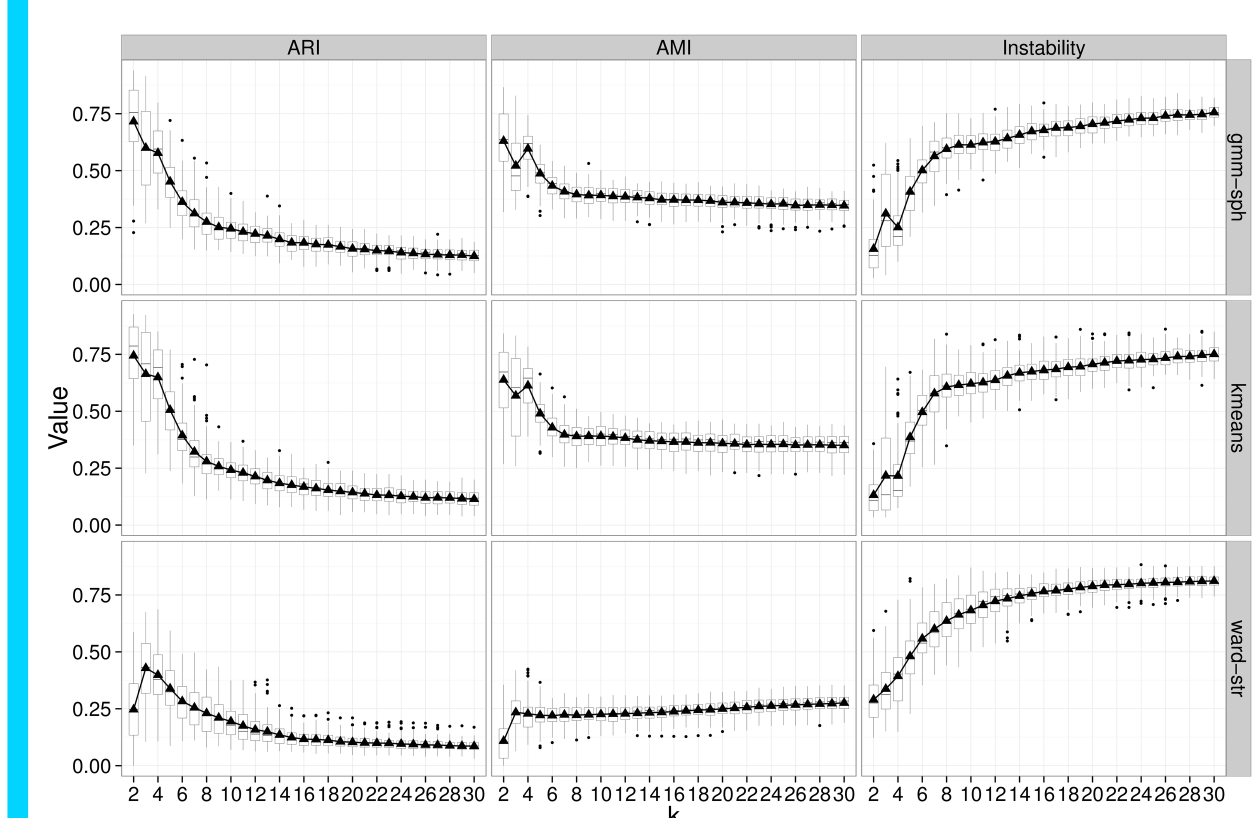


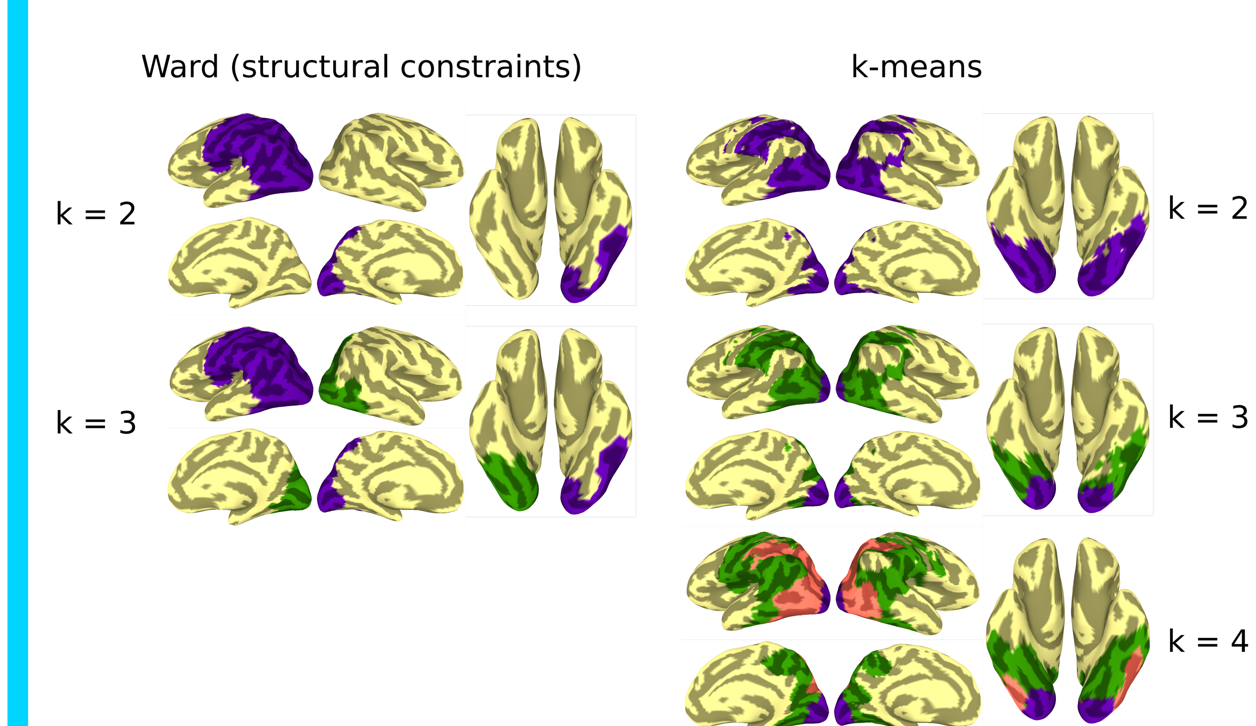
Real fMRI data



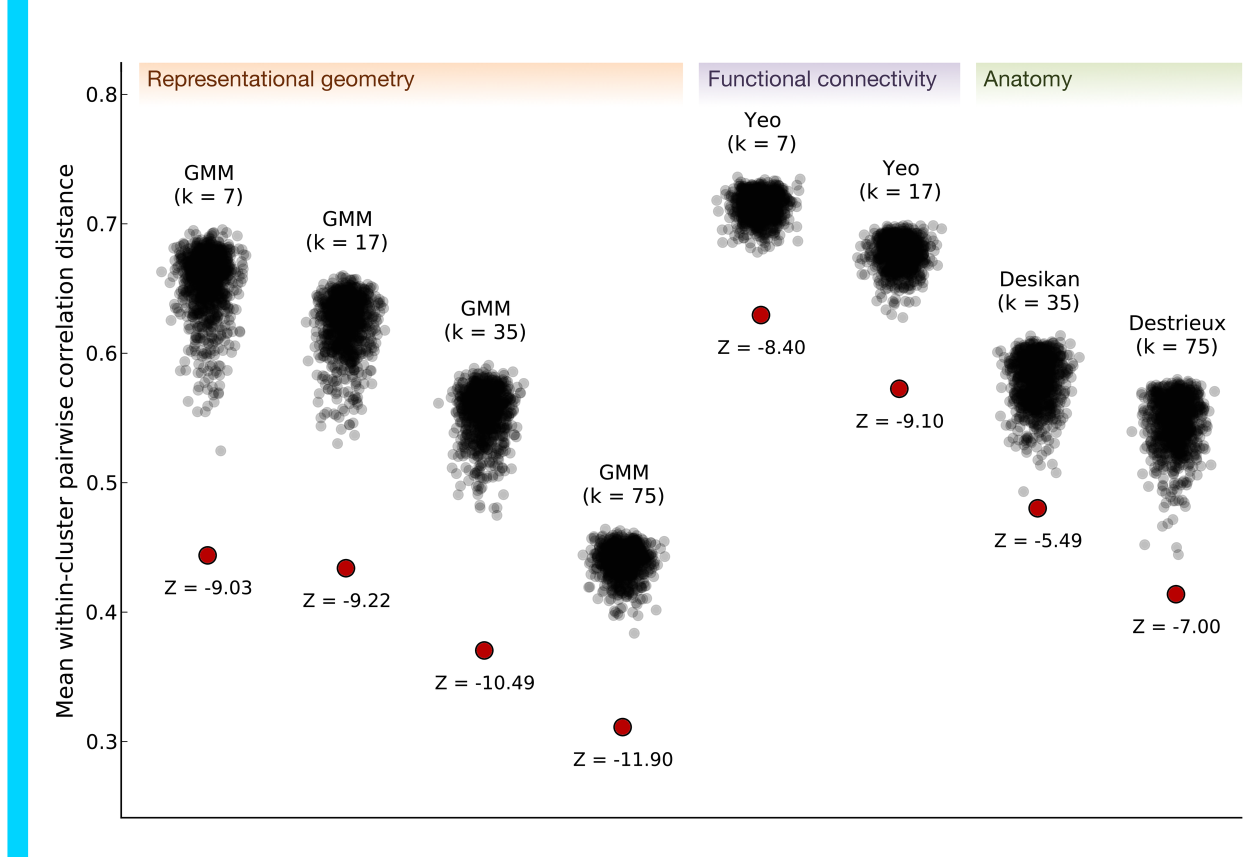
- 12 participants watching 2 s naturalistic video clips of behaving animals [6]
- 5 animal taxa, 4 actions (20 total conditions)
- 1-back task requiring attention to action categories
- 20 x 20 RDM computed with surface-based searchlights (100 voxels) using correlation distance
- Anatomical alignment and whole-brain hyperalignment [2]

fMRI results





Homogeneity analysis



Within each parcel, average pairwise correlation distance between all searchlight RDMs

Null distribution of homogeneities estimated by randomly rotating the spherical projection of the cortical surface

Comparison with parcellations derived from anatomy (FreeSurfer) and resting-state functional connectivity [4]