Complementary Information in Lateralized Brain Function

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Lateralization in Brain Function

The brain is lateralized for some percepts, including faces [1] , while not lateralized for others.

Are representations in lateralized regions less redundant (different and informative representations in both hemispheres) than those in not-lateralized regions?

Organizational inconsistencies between hemispheres make homologous ROI selection difficult.

This project develops a coordinate system that builds off inter-hemispheric anatomical consistencies, and applies standard MVPA techniques to corresponding ROIs to determine lateralized information redundancy.

Visual Task

The data [2] for this project was collected from subjects that viewed 4 different types of stimulus (faces, words, numbers, tools/objects), followed by a task of deciding if the two stimuli examples shown were different, or just a rotation of the same stimulus.

MVPA Searchlights

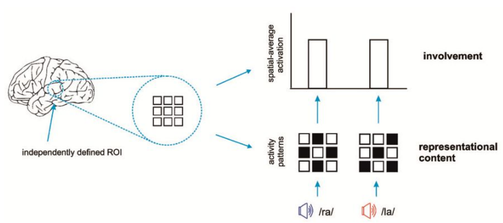

Fig.1 Multiple voxel ROIs can form a representational pattern of a stimulus or brain function [3]

To analyze the redundancy in representations between corresponding ROIs, standard Multi-Voxel Pattern Analysis (MVPA) searchlight techniques are applied to each hemisphere's ROI data separately, and to the combination of the corresponding ROI data.

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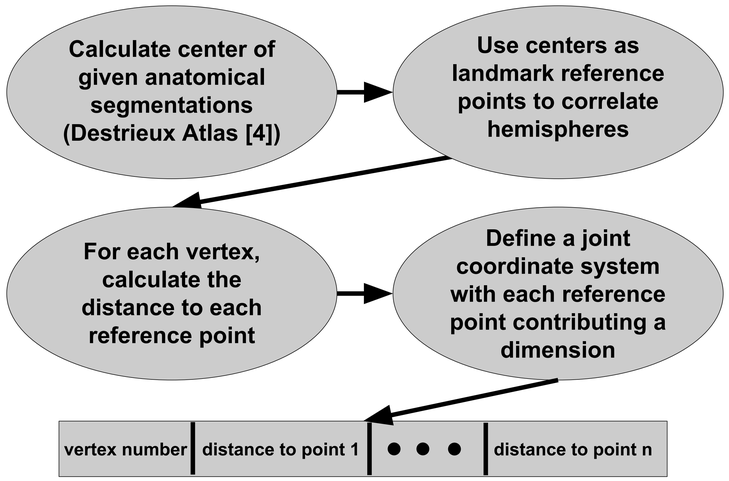
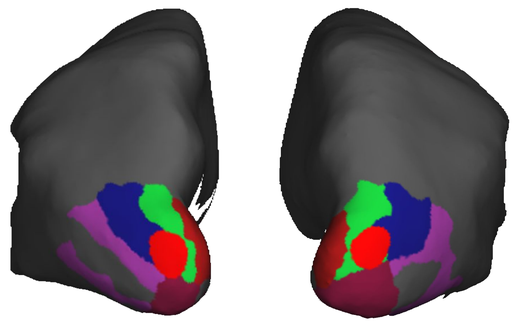
Anatomically Based Coordinate System





Corresponding ROI Color

Fig.2 Locating corresponding ROIs through anatomically based coordinate system, shown in relation to surrounding segmentations.

Analysis of Corresponding ROIs

This new coordinate system is used to located corresponding ROIs from one hemisphere to the other, iterating over the whole cortical surface with a Naive Bayes Classifier.

If joint data analysis provides a higher classification rate than in any single hemisphere ROI (a high non-redundancy score) that would provide evidence that non-redundant task relevant information (different and informative representations) is present in both ROIs.

Selected Regions of Study

Fusiform Face Area (lateralized for percept of interest)
Fusiform Gyrus (larger area containing the FFA)
Somatosensory Cortex (control region)

Classification Accuracy for Face Percept

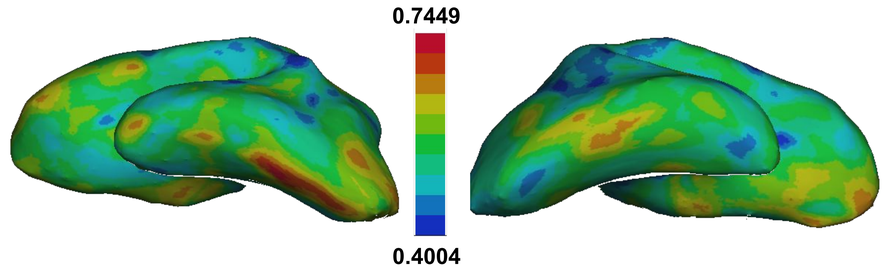


Fig.3 Classification accuracy heat maps for the left hemisphere and right hemisphere, with the color scale remaining the same between hemispheres. Chance accuracy is .5.

Information Non-Redundancy for Face Percept

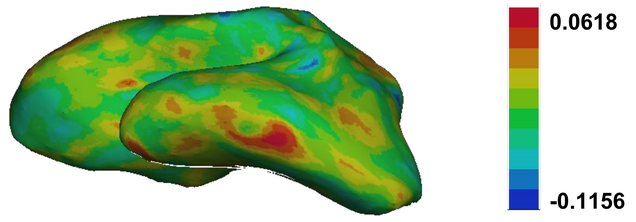


Fig.4 Classification non-redundancy heat map, shown on the left hemisphere.

Accuracy and Non-Redundancy for Selected Regions

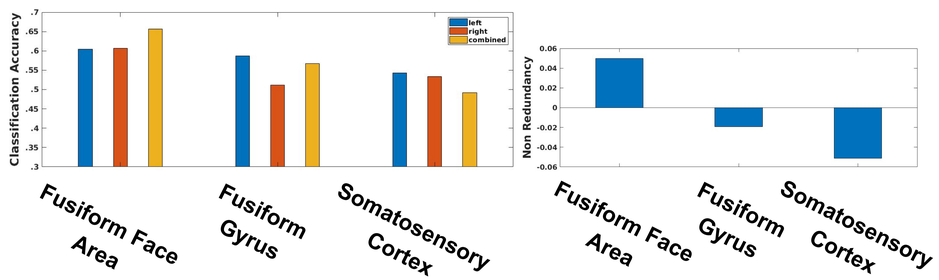


Fig.5 A. Classification accuracy in select regions broken down by left hemisphere, right hemisphere. B. Classification accuracy difference (non-redundancy) with combined corresponding ROI data.

Top Non-Redundant Regions

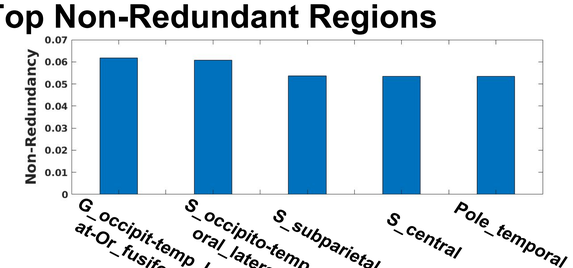


Fig.6 Classification Accuracy difference (non-redundancy) for least redundant segmentations.

References: [1] Meng, M., Cherian, T., Singal, G., & Sinha, P. (2012). Lateralization of face processing in the human brain. Proceedings of the Royal Society B: Biological Sciences, 279(1735), 2052–2061. http://doi.org/10.1098/rspb.2011.1784 [2] Emerson, R. W., & Cantlon, J. F. (2015). Continuity and change in children's longitudinal neural response to numbers. Developmental Science, 18(2), 314–326. http://doi.org/10.1111/desc.12215 [3] Mur, M., Bandettini, P. A., & Kriegeskorte, N. (2009). Revealing representational content with pattern-information fMRI—an introductory guide. Social Cognitive and Affective Neuroscience, 4(1), 101–109. http://doi.org/10.1093/scan/nsn044 [4] Fischl, B., Salat, D.H., Busa, E., Albert, M., Dieterich, M., Haselgrove, C., van der Kouwe, A., Killiany, R., Kennedy, D., Klaveness, S., Montillo, A., Makris, N., Rosen, B., Dale, A.M., 2002. Whole brain segmentation: automated labeling of neuroanatomical structures in the human brain. Neuron 33, 341-355.