Supervoxel parcellation of visual cortex connectivity

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**Summary**

- How is the cortex functionally and structurally organized?
- New tool: High-resolution connectivity matrices
  - Functional measure: Resting-state connectivity
  - Anatomical measure: Diffusion tractography
- How similar are functional and anatomical connectivity?
  - Result: Similar at voxel-scale, but depends on cortical location
- What is the spatial structure of these connectivity matrices?
  - Explore using spatially-informed clustering
  - Result: Reveals retinotopic and functional organization

**Previous Work**

- Whole-brain comparisons of functional and anatomical connectivity are coarse, atlas-dependent\textsuperscript{1,2,3,4}
- Greedy clustering algorithms give only approximate solutions\textsuperscript{5,6,7}

**Data: Human Connectome Project**

- Resting-state fMRI - 40 subjects (2mm isotropic)
  - Connectivity = correlation between timecourses
- Diffusion Tractography - 10 subjects (1.25mm isotropic)
  - Sampled 33 billion tracts using FSL
  - Connectivity = log number of fibers between voxels

**Voxel-level Multimodal Comparison**

- No anatomical connectivity
- Strong anatomical connectivity

- Anatomical connectivity is consistently predictive of functional connectivity for individual voxel pairs ($r=0.25$)

**Multimodal Comparisons Across Cortex**

- Regions of both high and low consistency between functional and anatomical connectivity
- Functional and anatomical connectivity maps are very similar in LO ($r=0.57$), possibly corresponding to the Vertical Occipital Fasciculus
- Foveal V1 has similar functional and anatomical connectivity maps in occipital cortex, but tractography reveals additional connections to anterior regions ($r=0.42$)

**Generative Clustering Model**

- Produces spatially-contiguous “supervoxels”
- Refines clustering with multiple passes
- Uses data statistics to help set number of clusters

  1. Each voxel selects a neighbor to cluster with
  2. Latent connectivity between supervoxels
  3. Observed connectivity is noisy estimate of supervoxel connectivity

**Supervoxel Clustering**

- Functional clusters divide early visual areas into eccentricity rings, and separate dorsal regions V3A/B from lateral regions LO1/2 and ventral V3/V4
- The Parahippocampal Place Area (white outline) overlaps multiple functional and anatomical clusters, connected to different regions (posterior=red, anterior=blue)

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