Co-activation mapping and Parcellation

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Meta-Analyses

• **Topic based meta-analyses:**
  derive brain regions consistently found across studies investigating a specific function

• **Meta-analytical connectivity modeling:**
  derive brain regions consistently found to co-activate with a specific seed region across studies investigating different functions
Meta-analytical connectivity modeling

• Key idea:
  
  regions showing concurrent activation consistently across studies are functionally connected

→ Meta-analysis as a tool to derive functional connectivity
MACM - Workflow

- Identify all experiments activating the seed region
- Exclude clinical studies, group comparisons, ROI analyses
- Extract all coordinates reported in identified experiments
- Perform a meta-analyses across identified experiments
Co-activation of left M1

Which brain regions are functionally connected to left M1?
Co-activation of left M1

- Identify all experiments activating the seed region

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155 experiments activating left M1
Co-activation of left M1

- Extract all coordinates reported in identified experiments

~2200 activation foci of those 155 experiments activating left M1
Co-activation of left M1

- Perform a meta-analyses across identified experiments

Network significantly co-activating with M1 across 155 task-activation studies
Co-activation of left M1

Meta-Analysis on finger tapping

fMRI study on finger tapping
Comparison to resting state functional connectivity

MACM

Resting-State
Connectivity based parcellation

• Identify functional heterogeneous subclusters within a region of interest
• Based on connectivity pattern of each voxel of the region of interest
• Connectivity profiles: DTI, resting-state, MACM
CBP - Workflow

- Perform a MACM analysis for every individual voxel of the seed
  - Connectivity matrix: Connection strength for every voxel of the seed with all voxels of the brain
- Calculation of differences in connectivity between each voxel pair of the seed
- Distance matrix: similarity between all seed voxels
- Clustering: identify a stable clustering solution, using hierarchical or K-mean clustering
CBP of posterior medial frontal Cortex

Are there functionally distinct subregions within the posterior medial frontal cortex seed?
CBP of posterior medial frontal Cortex (pMFC)

- Perform a MACM analysis for every individual voxel of the pMFC seed

  For each voxel:
  - Identification of all experiments activating that voxel
  - Computation of across-experiment convergence of co-activations
CBP of posterior medial frontal Cortex

- Calculation of difference in connectivity between each voxel pair of the seed
CBP of posterior medial frontal Cortex

- Clustering
  voxels of the same cluster show similar co-activation patterns

voxels of different clusters show more different co-activation patterns
CBP of posterior medial frontal Cortex

What are the connectivity differences driving this parcellation?
Summary

• Coordinate-based meta-analyses provide a statistical tool for the objective integration of findings

• Meta-analytic connectivity modelling offers an approach to task-based functional connectivity

• Co-activation based parcellation enables to identify cortical modules in a data-driven fashion
Thank you!