Introduction to brain parcellation
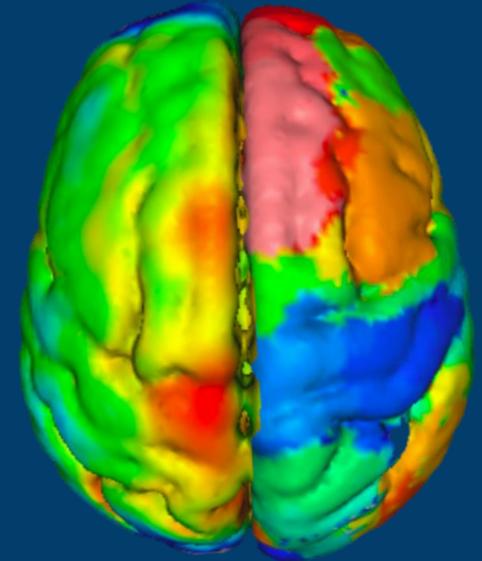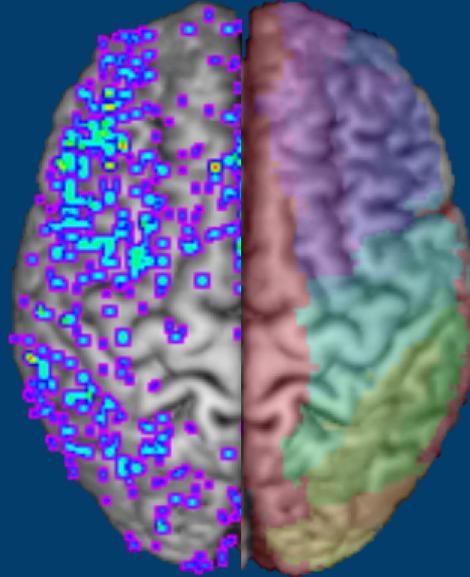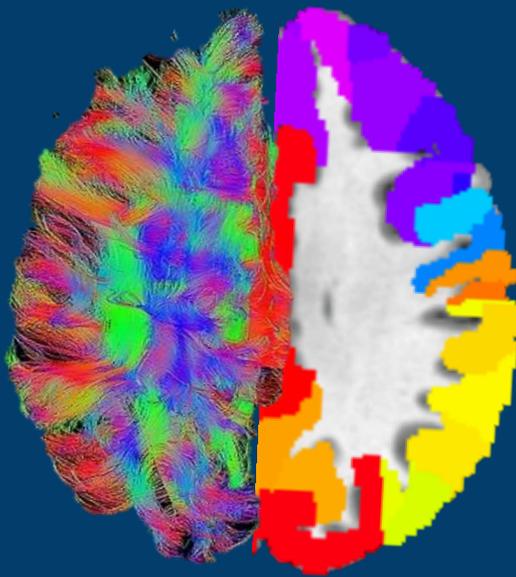
Sarah Genon
Cognitive Neuroinformatics Lab

Brain parcellation

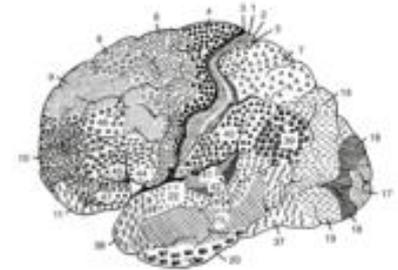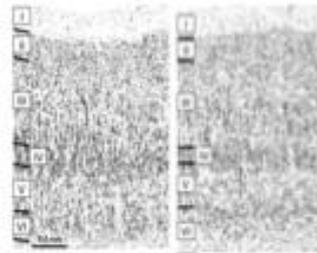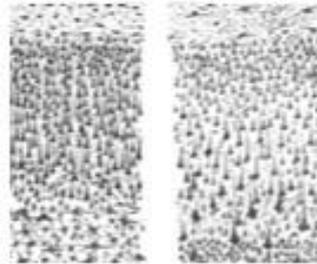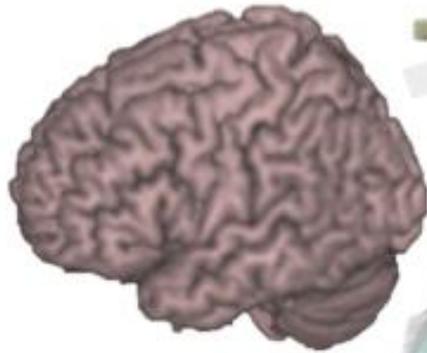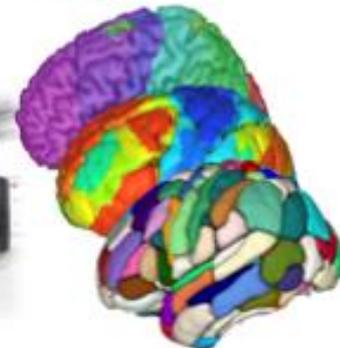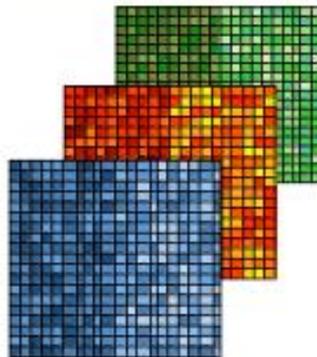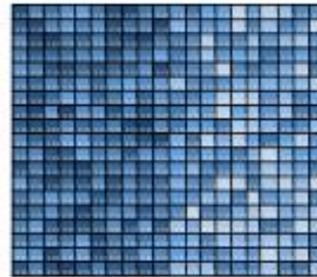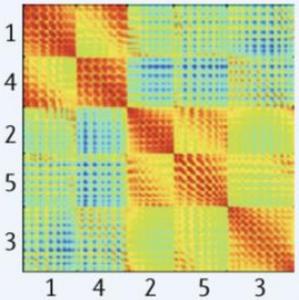**From histology**

To multimodal MRI

#BrainBFT

Algorithm	Boundary mapping	Clustering or factorization
Markers		
Local **Histology-based:** • Cytoarchitecture • Receptors • Myelin **MRI-based:** • Myelin • Meta-analytic activation modelling	Border detection in cortex based on cytoarchitecture	Clustering of amygdala voxels based on their activation in behavioural paradigms
Global **MRI-based:** • Resting-state functional connectivity • Meta-analytic connectivity modelling • Diffusion tractography • Structural covariance	Boundary mapping of resting-state functional connectivity of cerebral cortex	Clustering of cerebral cortex based on resting-state functional connectivity
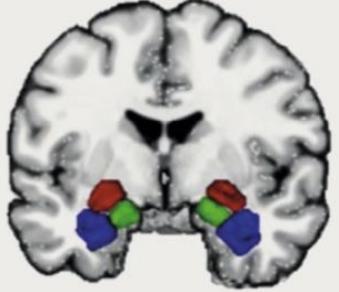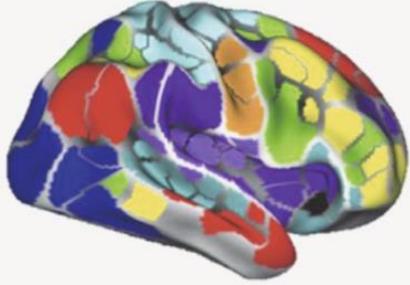
Eickhoff, Yeo & Genon, 2018, Nat. Rev. Neurosci.
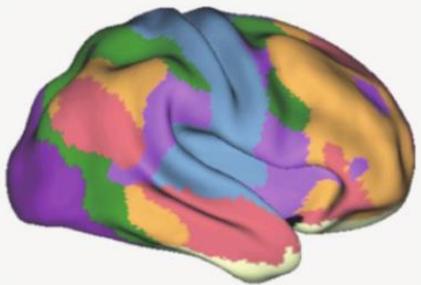
Connectivity-based parcellation (CBP)

Neuroimaging scanner

Connectivity
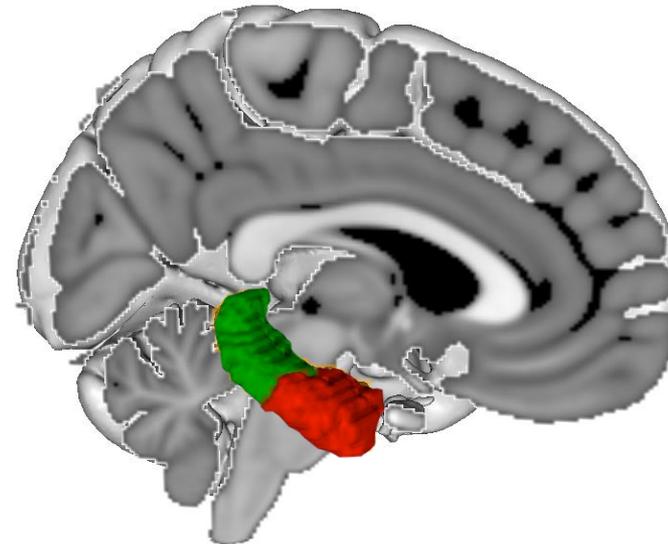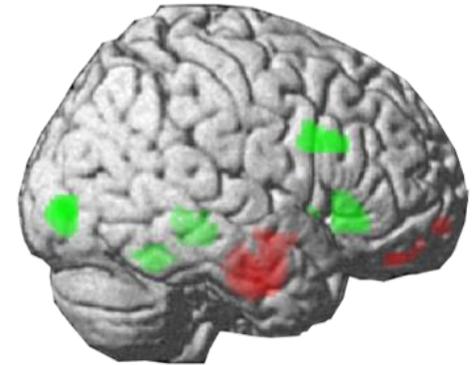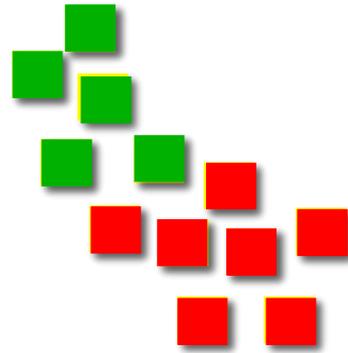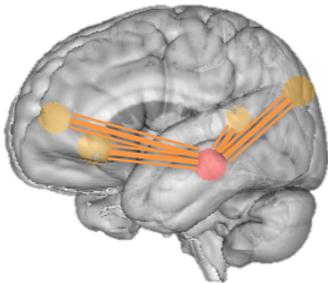
How to estimate connectivity ?

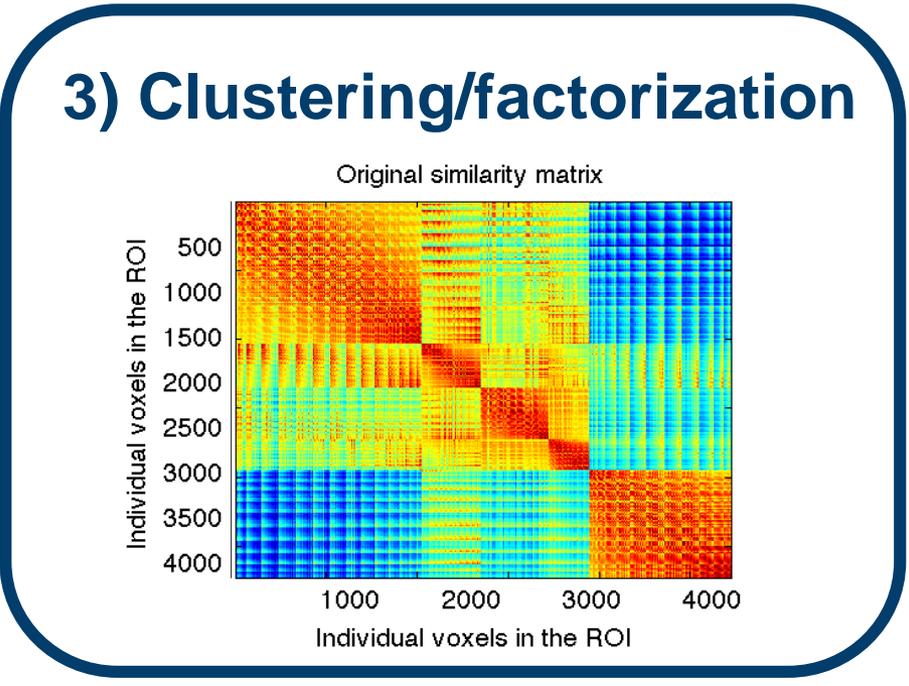| Type of connectivity	Functional		Co-plasticity	Structural (white matter)
Data	Task-based fMRI	Resting state fMRI	Anatomical MRI	Diffusion MRI
Approach	Task-based: Activation during task	Resting-state: Signal fluctuations at rest	Morphometry-based: Structural co-variation in the population	Diffusion-based: Estimation of fiber direction
Main method	Meta-Analytic Connectivity Modeling (**MACM**)	Cross-timepoint correlation in signal fluctuations (**RSFC**)	Correlation of local GM across subjects (**SC**)	Probabilistic diffusion tractography (**PDT**)

Eickhoff, Yeo & Genon, 2018, Nat. Rev. Neurosci.
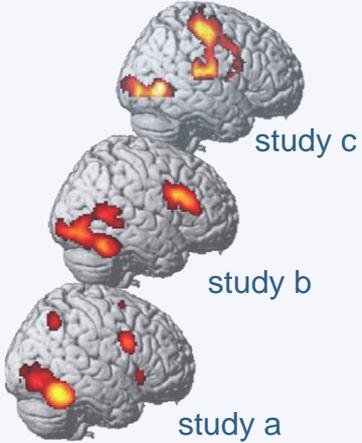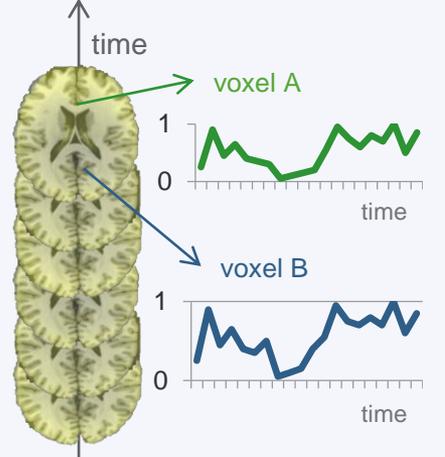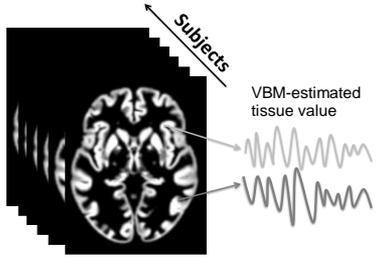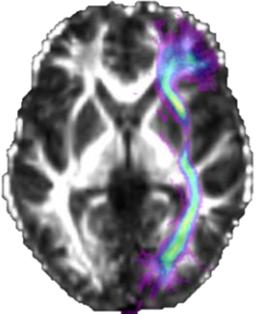
CBP: how ?
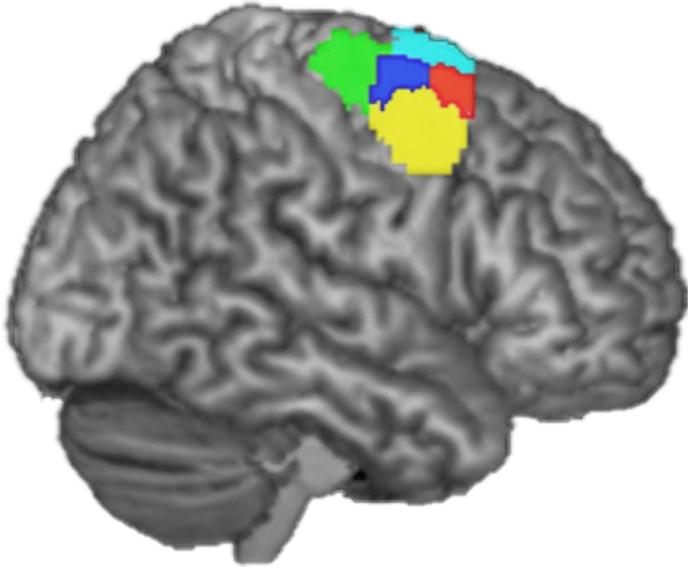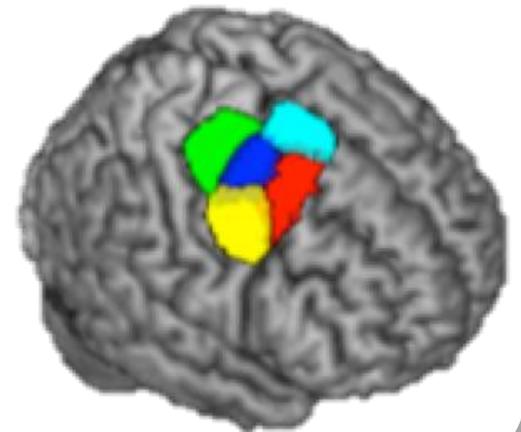

> 1) **Region of Interest:**
>
> **Dorsal Premotor Cortex:**
>
> *Interface between prefrontal and primary motor*

2) Connectivity matrix

3) Clustering/factorization

Original similarity matrix

Genon et al., 2017, Cerebral Cortex
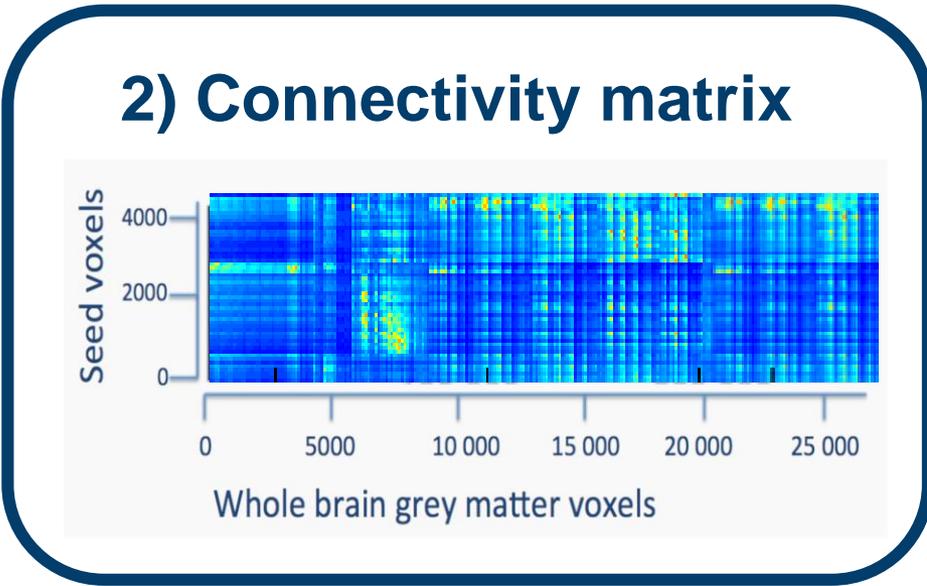
Convergence between connectivity modalities
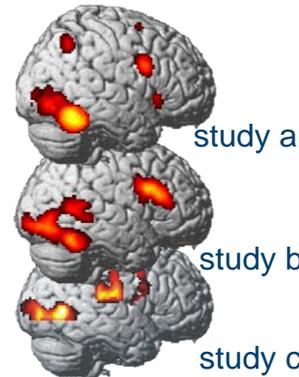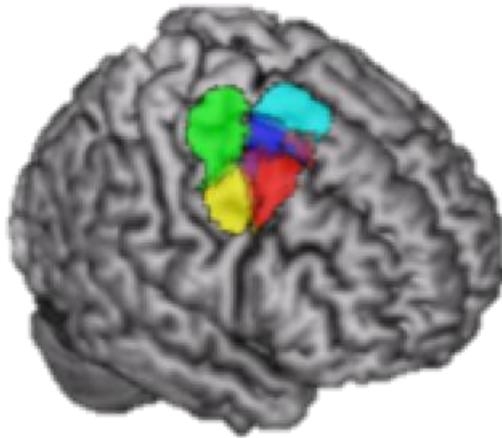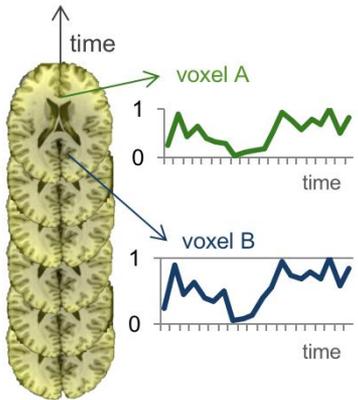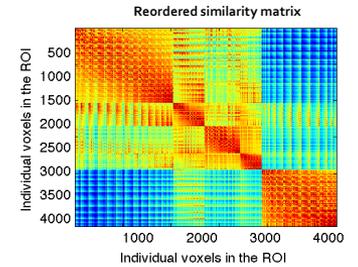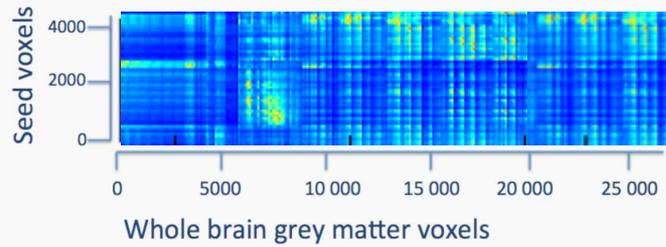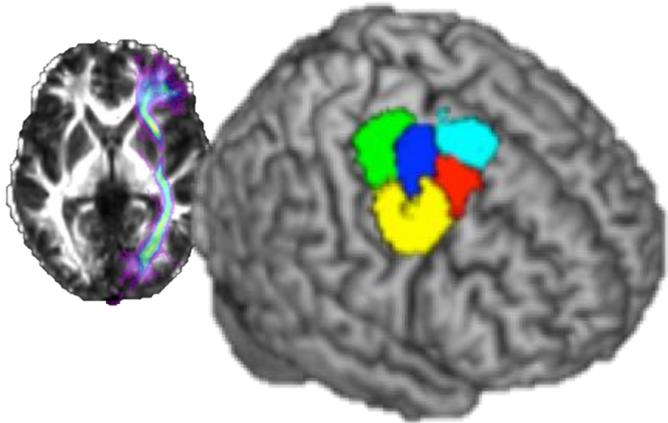
CBPtools for different connectivity modalities:

CBPtools for different connectivity modalities:

CBPtools for different connectivity modalities:

Reuter et al., submitted

Local microstructure VS large-scale functional integration

Local microstructure

Connectivity markers

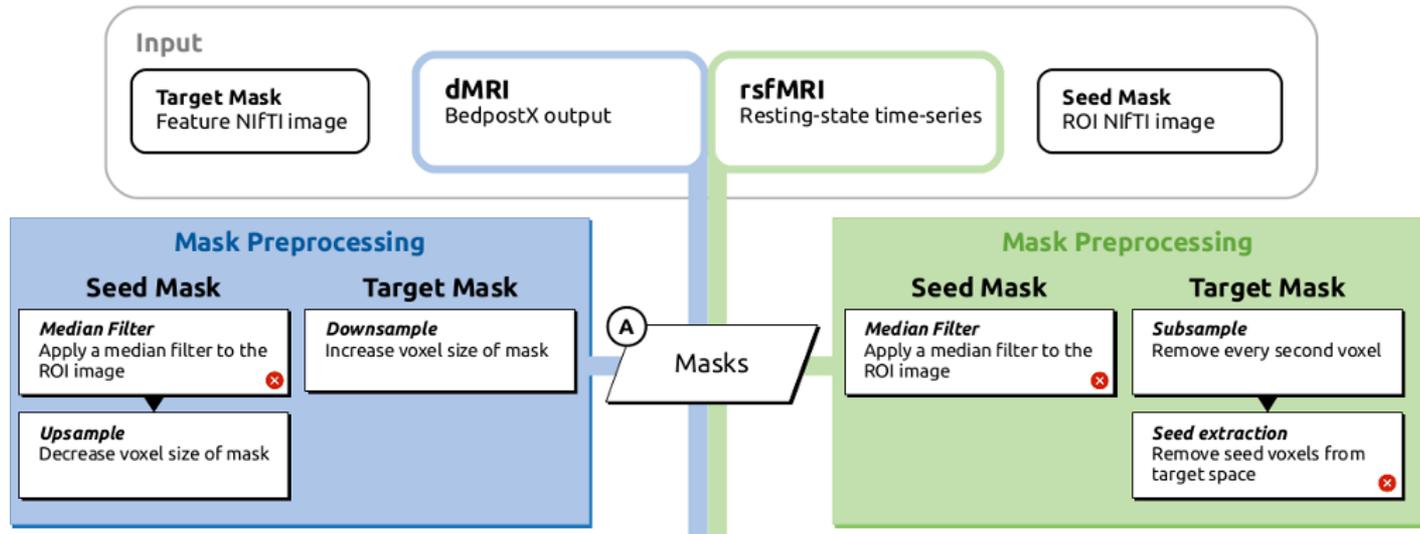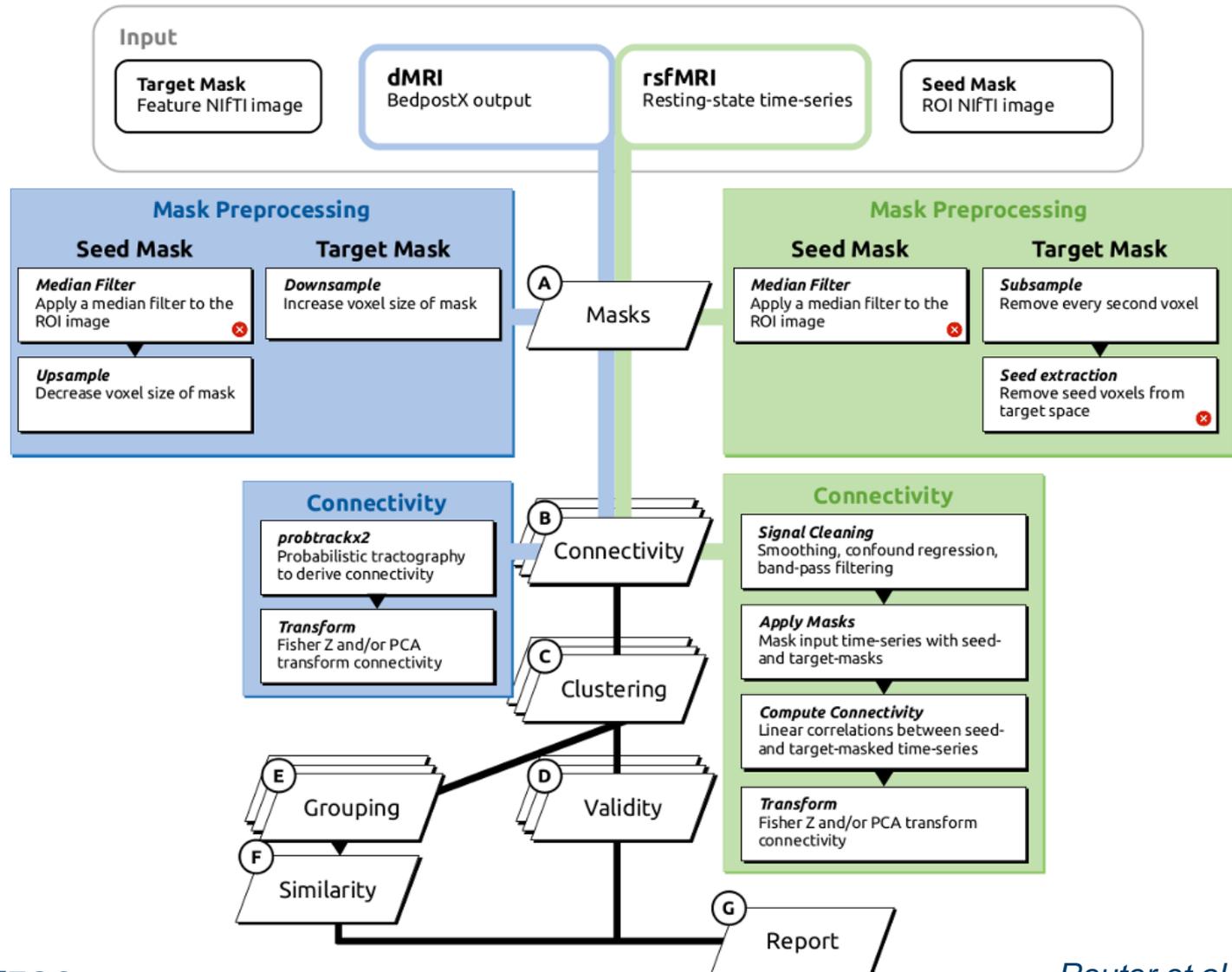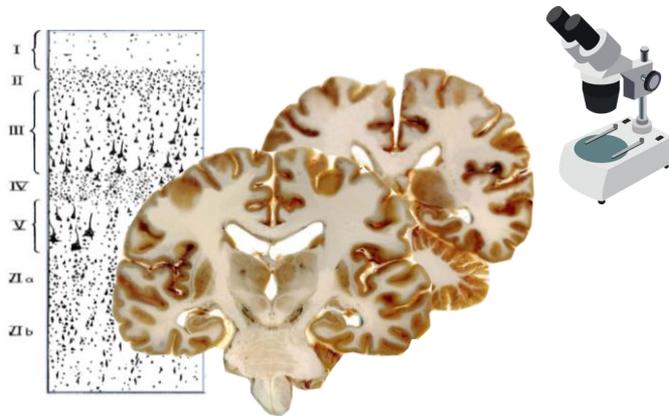# Local microstructure VS large-scale functional integration

Local microstructure
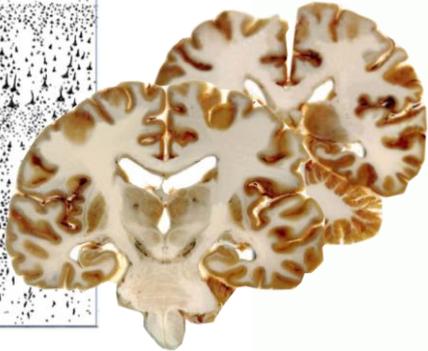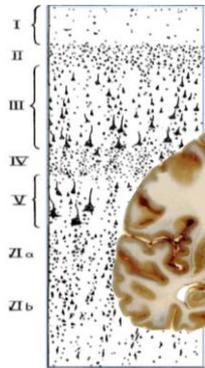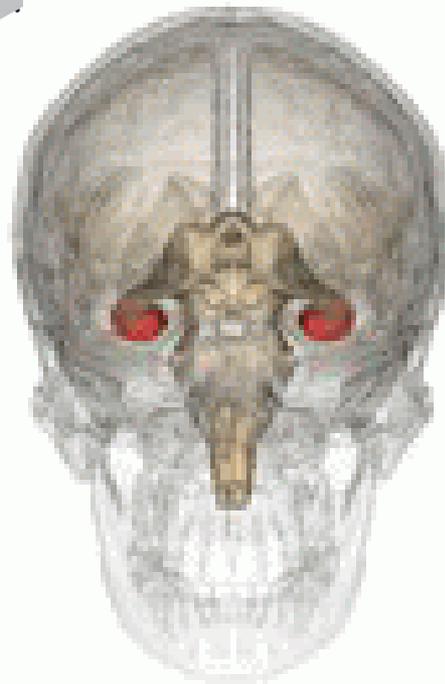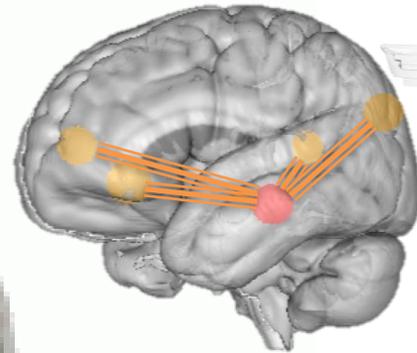
Connectivity markers

Local microstructure VS large-scale functional integration

Local microstructure

Connectivity markers

Ding & Van Hoesen, 2015

Lateral   medial

Local microstructure VS large-scale functional integration

study a study b study c

time
voxel A
voxel B
time

2k

3k

Local microstructure VS large-scale functional integration

Local microstructure

lateral ↔ medial

anterior

posterior

Amunts et al., 2006

Plachti et al., in press

Connectivity markers
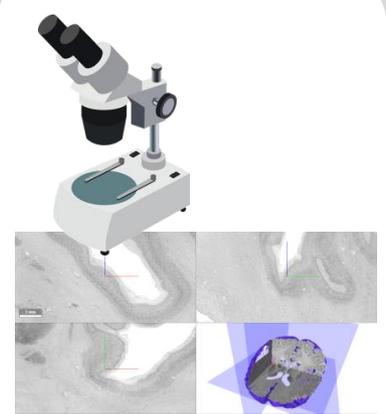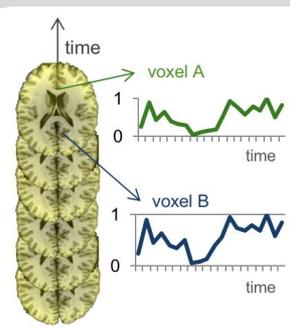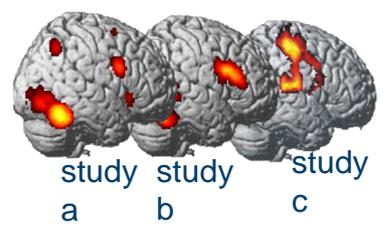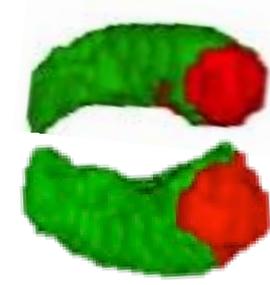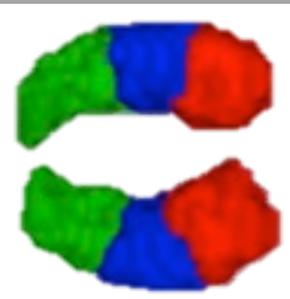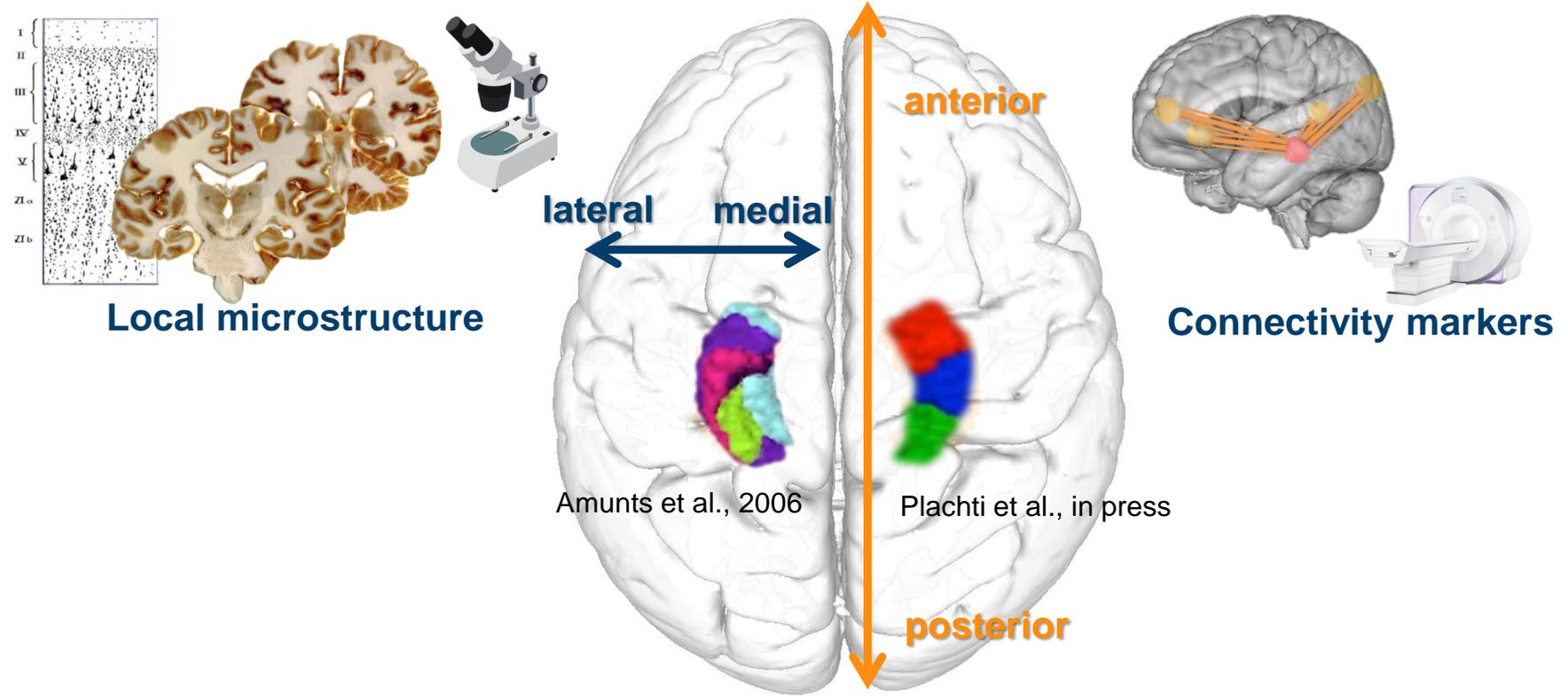
Local microstructure and large-scale functional integration

#BrainBFT

study a study b study c

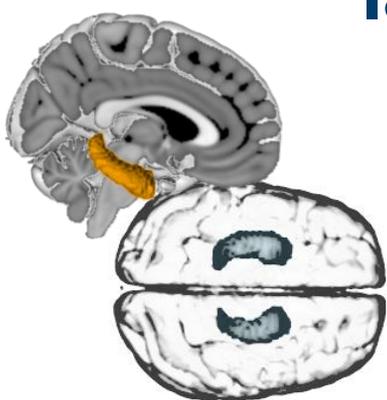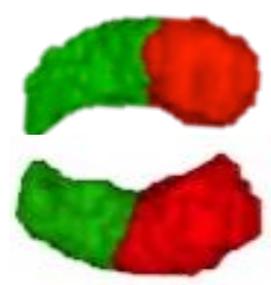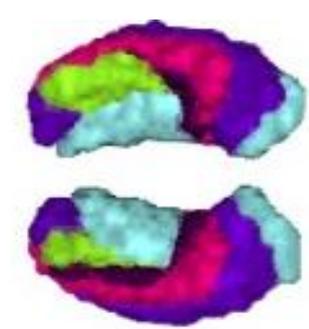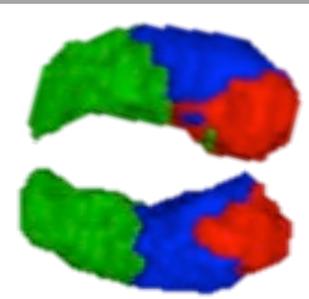2k

3k

Plachti et al., in press, Cerebral Cortex
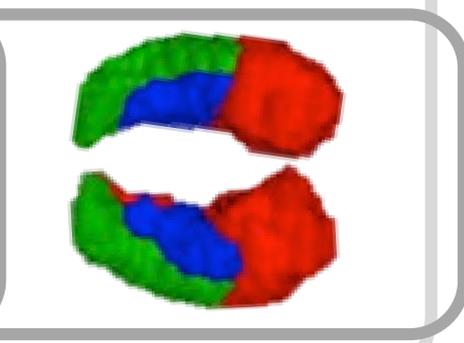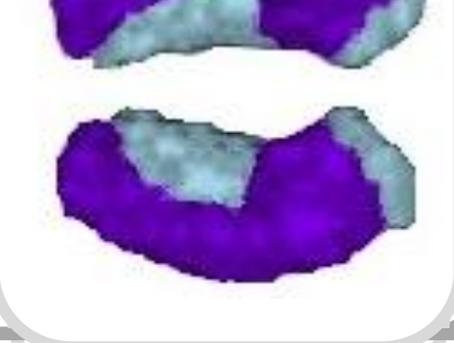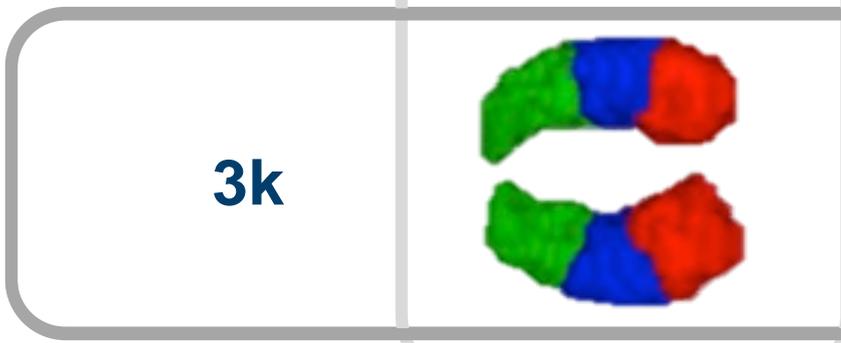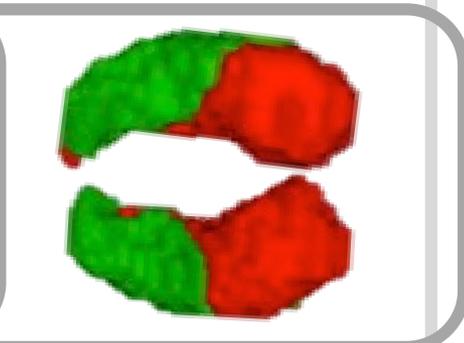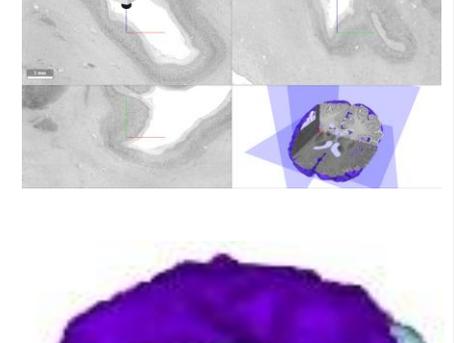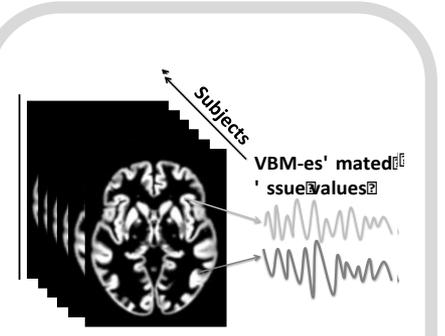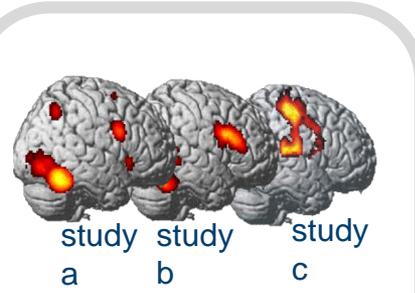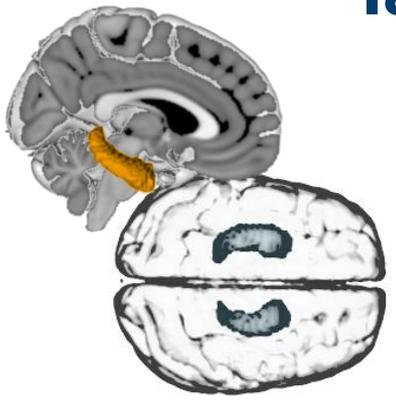
Take home messages

<u>Brain parcellation</u>

= a very wide **set of methods** to identify brain regions and/or networks

From histology to MRI-based connectivity

To **understand** or to **represent** brain organization and data

Convergence and divergence between mapping features

CBPtool as a user-friendly tool for connectivity-based parcellation to

- Examine **replicability** across samples

- Examine **convergence** across connectivity features

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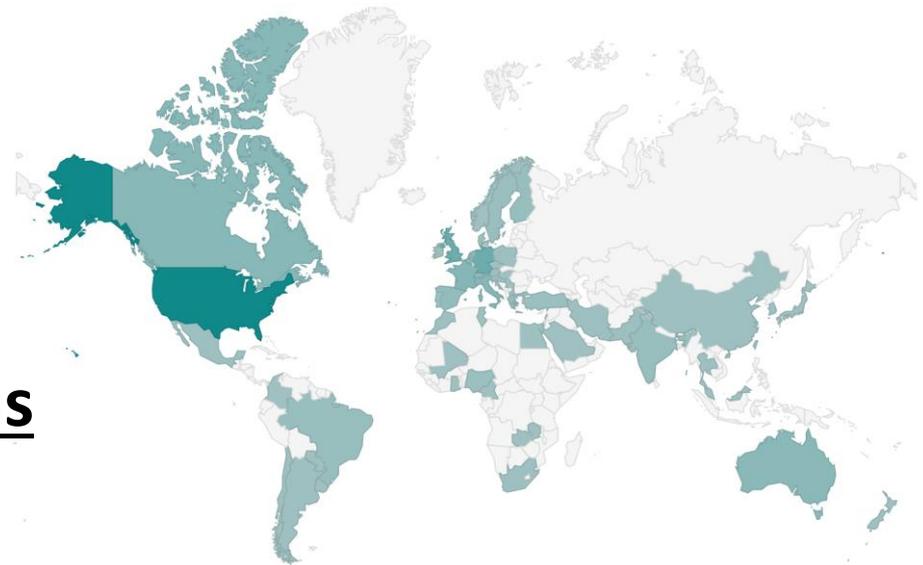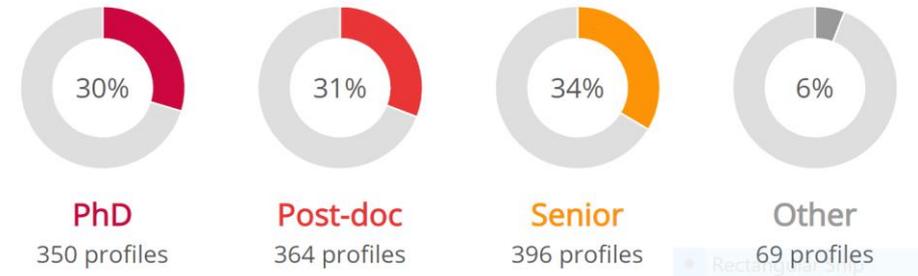
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THANK YOU

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Holger Schwender

WashU
Aris Sotiras

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Poll: Shahrzad has generated a parcellation map of the brain based on resting-state functional connectivity but she is afraid that the pattern could has been partially driven by noise in the resting-state signal, what other parcellation modality can she us

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Poll: After computing a parcellation of the insula based on resting-state data with CBPtool, Shahrzad has chosen a 3-cluster solution as the optimal model because this solution was supported by all validity metrics, can she conclude that her parcellation i

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Poll: Shahrzad wants to develop an age prediction framework based on grey matter volume data (i.e. to predict age of a participant based on his/her grey matter volume image). However, voxel-wise data as high dimensional data (hundreds of thousands of voxel

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