

Reliable in-vivo detection of claustrum connections into the forebrain by tractography of two large human samples

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1 Introduction and Aims

What is the claustrum? a thin layer of grey matter located between the external and extreme capsule and below the insular cortex

Why are we interested in it?

- There have been findings of claustrum changes in many pathologies such as **epilepsy, schizophrenia, and prematurity.**
- It is suggested to be the **most densely connected structure in the brain by metric volume**, with connections going to nearly every brain region.

What is our aim? Describe the presence and morphology of connections between the claustrum and cortical and subcortical regions in healthy adults and investigate their relative strengths

2 Study Sample

	BEST cohort (n = 81)	HCP young adult cohort (n = 81)
Sex (male/female)	52/29	45/36
Age (years, mean)	26,8	28,5
Age range	25-27	22-35
Scanner type	3T	3T
DW directions	32 + 1 b0	90 + 6 b0
DW resolution	2 mm	1.25 mm

3 Methods

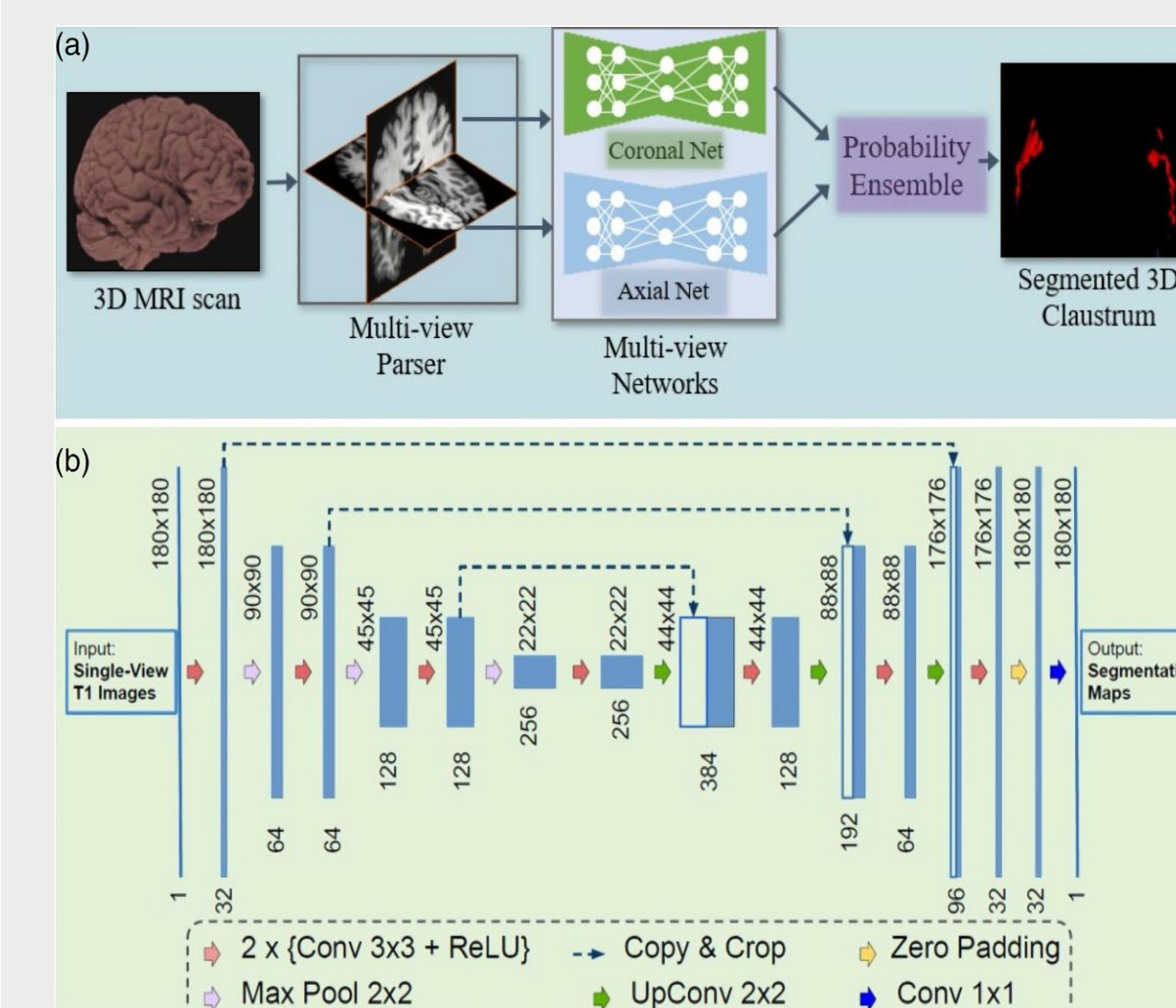
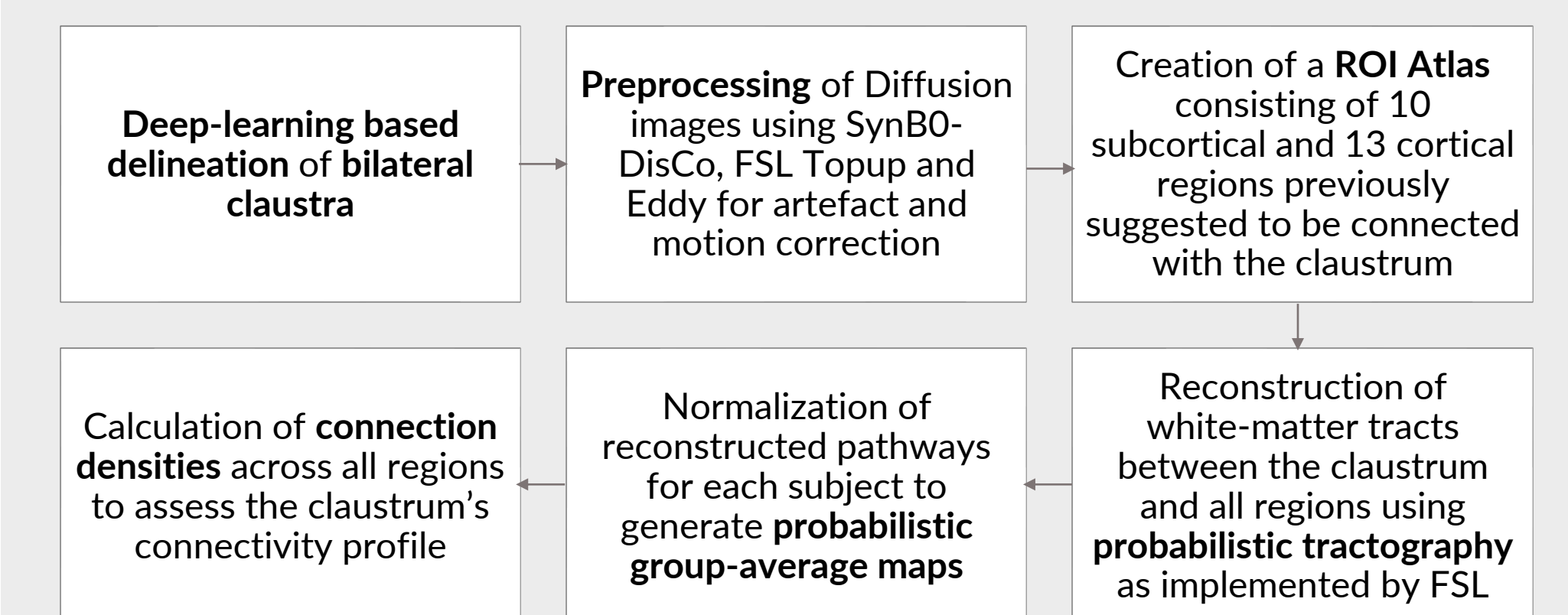


Figure 1:
Claustrum Segmentation Algorithm (Li et al. 2021)

a) Multi-view fully convolutional networks were used to segment the 3D bilateral claustra

b) 2D convolutional network architecture for axial and coronal view

4 Results

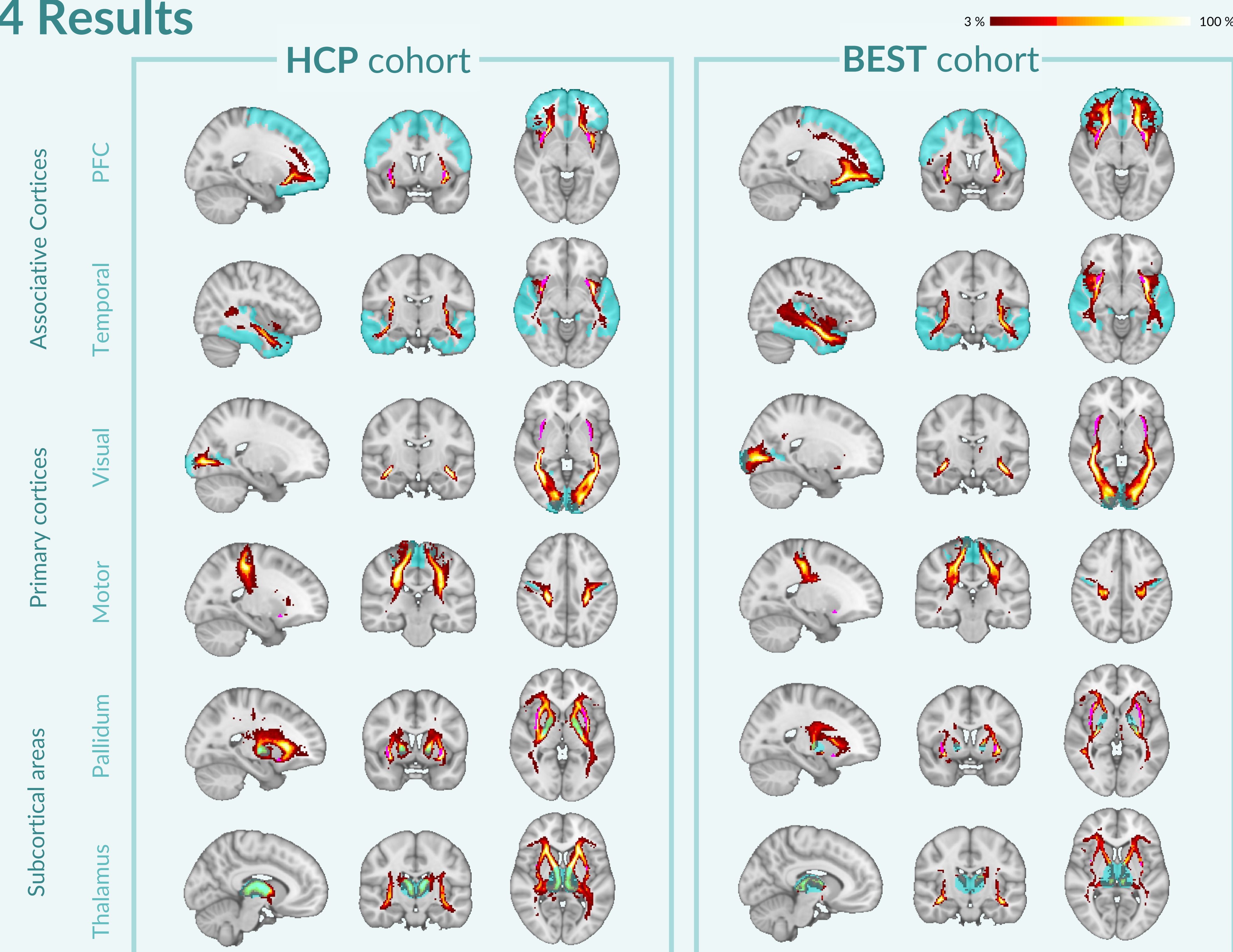


Figure 2: Probabilistic group-average maps for reconstructed streamlines to a selection of analysed regions for both cohorts

1 → **Robust streamline reconstruction** across subjects is possible for a large part of the regions and provides further evidence for widespread ipsilateral as well as contralateral connectivity of the claustrum.

- Robust, plausible reconstruction of ipsi- and contralateral streamlines to **all associative and primary cortices** as well as some subcortical structures, notably **most neuromodulatory nuclei, the thalamus and the pallidum.**

- Reconstruction of streamlines between the left and right claustra were also possible and suggest interconnectivity of the two structures.

- Reconstructions to cingulate cortices, hippocampus, and many contralateral subcortical structures were not as robust.

- Connections to certain areas located in very close proximity to the Claustrum, such as the striatum, the insula or the cholinergic basal forebrain, are not well analysable using our method due to the nature of the tracking algorithm and relatively low resolution of diffusion weighted imaging.

2 → Results are **reproducible between the two independent cohorts** despite strong heterogeneity in imaging protocols (such as resolution and number of diffusion weighted directions). For some visual examples see Figure 2 (to the left).

5 Conclusion, outlook

Our results demonstrate the reliable reconstruction of claustrum connectivity in humans and provide a base for further examinations of claustrum connectivity in health and in the context of different pathologies. Further possible uses include:

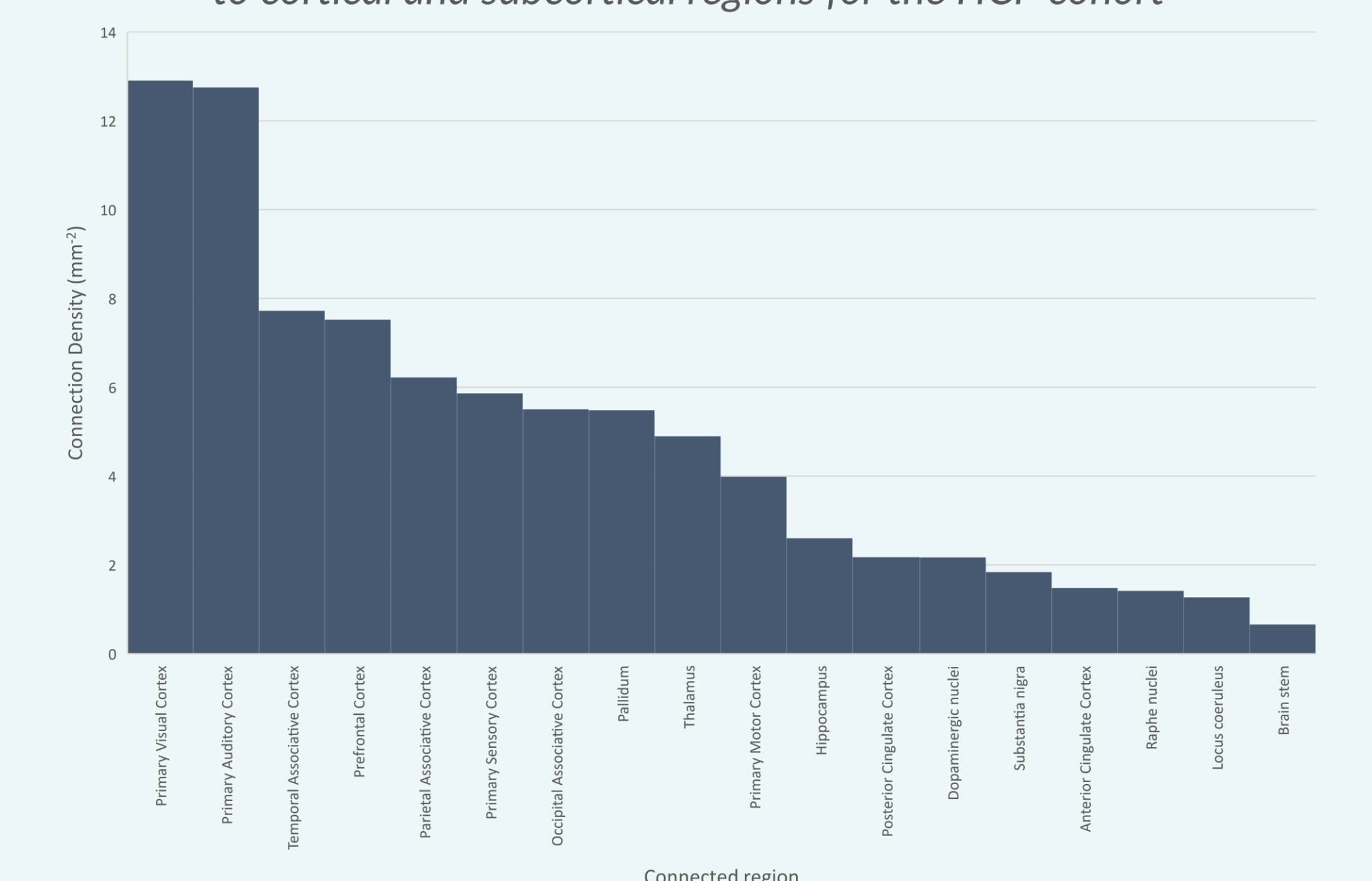
- Examining tract morphology and microstructure in disease
- Examining links between CD and neuropsychological function

Preliminary results indicate that some scores measuring **attention** (Short Penn CPT), significantly correlate with CD between the **claustrum** and the **prefrontal cortices** of both hemispheres.

3 → **Connection density (CD) measure** allows to quantify our results and indicate which regions are relatively most densely connected to the claustrum by metric volume.

$$\text{connection density (CD)} = \frac{\text{number of reconstructed streamlines}}{\text{volume of connected regions}}$$

Figure 3: Left and right side averaged connection densities (CD) to cortical and subcortical regions for the HCP cohort



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