Poster 1823

Relations between local cortical geometry and functional homogeneity: a replication study

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Introduction

In parallel to brain connectivity studies, rs-fMRI scans are increasingly processed for measuring local functional homogeneity (FH) of the cortex with the aim of understanding local brain organization. Several studies have been conducted for estimating the reliability of FH measures, such as regional homogeneity (reHo) [6]. The influence of scan duration and in-scanner motion has for instance been investigated in [8]. Because multimodal datasets are difficult to assemble, the relation between FH and structural MRI was less studied.
In this work, we conducted a replication study with two large multimodal datasets for investigating the relations between FH measures and local cortical geometry. The contributions of local cortical regions to the most significant and robust relation were examined in detail and compared with myelination levels.

Methods

- local functional homogeneity and local cortical geometry were measured for the subjects of two large benchmark neuroimaging databases
- the correlations between these maps were measured for each subject independently and we report the median correlation at the population level
- significant associations were further investigated by measuring local correlations between the maps (and reporting the median of the individual maps obtained).

Philadelphia Neurodevelopmental Cohort

- 650 healthy participants [3]
- age 8 to 23
- motion correction via a dedicated pipeline [4]
- Freesurfer used for registration (no T2 MRI)

Human Connectome Project

- 100 unrelated HCP subjects [1]
- age 22 to 35 (one 36+)
- minimal processing based on MsMall registration [2] (multimodal registration)
- ICA+FIX denoising [2]

Functional Homogeneity (FH)

measured by comparing the rs-fMRI time serie of a voxel with the time series of the neighboring nodes. We compared three measures of similarity:

- the average of the correlations between all pairs of times series
- their Kendall's coefficient of concordance, also known as regional homogeneity (reHo) [6]
- the multivariate joint entropy [7]

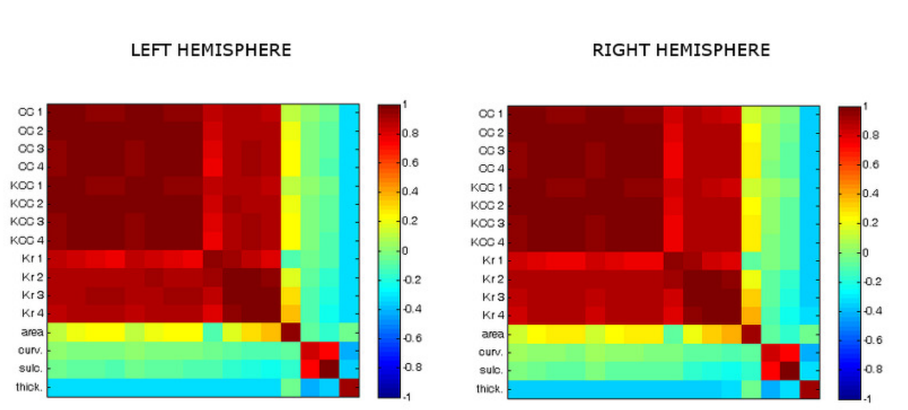
Neighborhoods

four radii were considered:

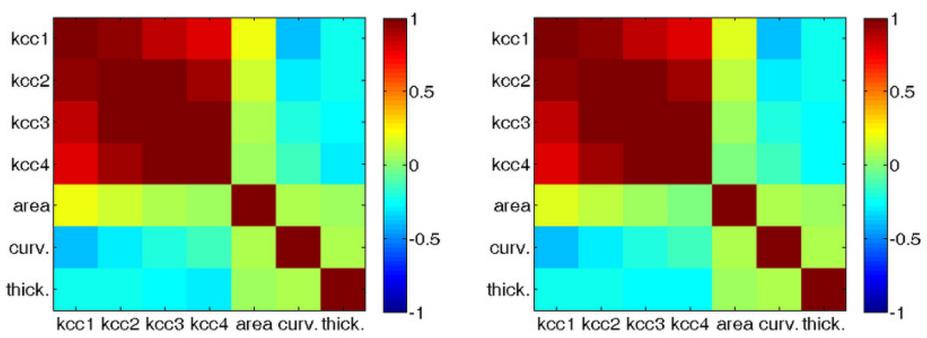
- a cortical node and its cortical mesh neighbors
- a node, its neighbors and their direct neighbors
- etc ...

Local Cortical Geometry

- maps generated by Freesurfer after registration [5]
- **PNC** : areal distortion, cortical curvature, sulcal depth and cortical thickness [4].
- **HCP** : areal distortion, cortical curvature, and cortical thickness.
- myelin maps derived from T2 MRI were also available for the HCP (we registered them to PNC Freesurfer atlas)

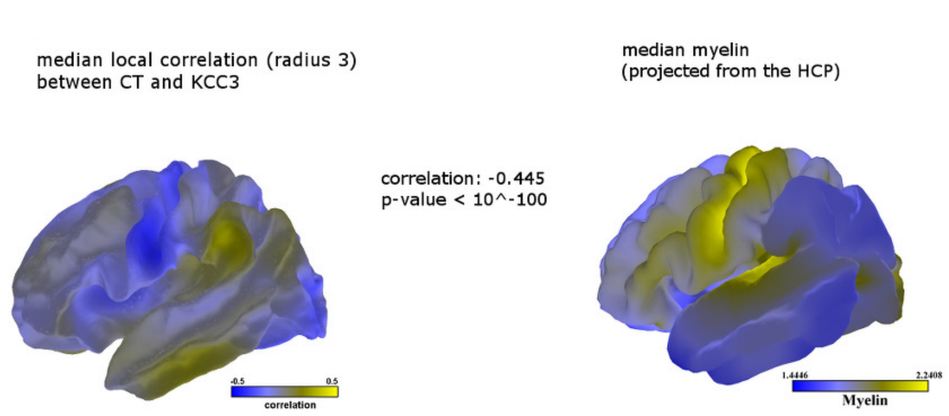


Philadelphia Neurodevelopmental Cohort

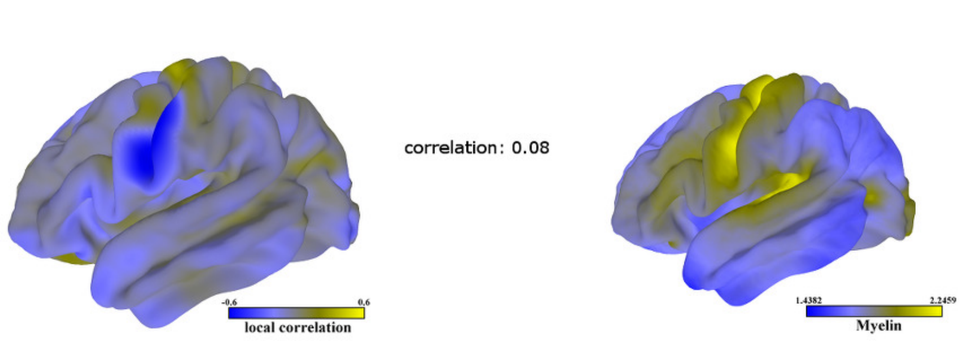


Human Connectome Project

Figure 1. Median of the correlation between local cortical maps[5](area: areal distortion, curv.: cortical curvature, sulc.: sulcal depth, thick.: cortical thickness) and FH measures (CC: average correlation, KCC: regional homogeneity[6], Kr: entropy[7]), for both datasets and both hemispheres.



Philadelphia Neurodevelopmental cohort



Human Connectome Project

Figure 2. Comparison between the local correlations between an FH measure (kcc3) and cortical thickness (CT) and the median myelin map, for the left hemisphere of both datasets. Local correlations were computed for a neighborhood of radius 3.

Results

- FH measures very similar
- strong and reproducible anti-correlation between CT and FH
- slightly different local contributions to this anti-correlation

Conclusion

- very similar results for the two hemispheres
- strong correlation between functional homogeneity measures
- the size of the neighborhood has a very small impact on results
- robust anti-correlation between functional homogeneity and cortical thickness
- contribution to this anti-correlation aligned with myelin when T2 is not used for registration

functional homogeneity should always be corrected for cortical thickness
(in addition to the factors reported in [8])

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