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Topo-pathological re-wiring in brain structural connectomes of de novo Parkinson's Disease patients

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Although several studies in the last decades have challenged our understanding of Parkinson's Disease (PD) pathophysiology, an important gap at a network and system level still remains to be filled in order to understand the fundamental changes in high-order motor and non-motor circuits underlying PD symptoms. The wide spectrum of both motor and non-motor symptoms suggests that Parkinson's Disease may reflect extended alterations of the global brain network, thus justifying the onset of this heterogeneous symptomatology. Such hypothesis would be suitable with the idea of an "associationist" brain, which goes beyond the classic cortical "localizationist" theory. According to the former, the brain might consist of several, segregated and parallel distributed networks around critical and participating cortical epicenters. To the best of our knowledge, only few studies attempted to improve our understanding on structural MRI networks in PD. With the aim of detecting altered topological rewiring of brain networks in early stage de novo PD patients, we reconstructed tractography-based brain structural connectomes [1] in a pilot population of 10 PD patients and 13 controls. Topological features of structural connectomes were computed and compared between the healthy controls group and the group with PD at different level of cut-off. Significant group differences were showed at certain cut-off in the structural connectivity from the measurement of the Local Community Paradigm-correlation (LCPcorr), Characteristic Path Length, Betweenness Centrality and Edge Betweenness Centrality. Increased value of LCPcorr in the pathological group reflects a topological (and not spatial) network local community re-organization of structural interactions between common neighbors nodes [2]. As a result, the PD group has an increased correlation between the number of common neighbors and the number of their internal-interactions across all the structural local communities in the networks. On the other hand, decreased values in Characteristic Path Length, Betweenness Centrality and Edge Betweenness Centrality suggest also a global topological network re-wiring. Taken together these findings strongly indicate altered topological rewiring in de novo PD brain connectome and could shed new light on the pathophysiology of the disease and in the definition of network-based markers for a more quantitative and precise diagnosis.

References

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Keywords
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