Hubs of brain functional networks are radically reorganized in comatose patients*

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Abstract

In this talk, I will present a method to analyse functional magnetic resonance imaging (fMRI) or magnetoencephalographic (MEG) data, in order to characterize the network of connections in the brain. I will show how to measure the network connections in the brain at different frequency bands, using a wavelet correlation measure. Then, significant correlations are marked as effective connections, this allows us to construct a graph. Finally, topological parameters of these graphs, such as efficiency, are extracted, and comparisons between populations are conducted. This suggests that correlated, low-frequency oscillations in human fMRI data have a small-world architecture that probably reflects underlying anatomical connectivity of the cortex. Because the major hubs of this network are critical for cognition, its slow dynamics could provide a physiological substrate for segregated and distributed information processing. I will also illustrate this method on a recent fMRI data set with resting state functional MRI data acquired from 17 patients with severely impaired consciousness and 20 healthy volunteers (Achard et al. PNAS 2012). We found that many global network properties were conserved in comatose patients. Specifically, there was no significant abnormality of global efficiency, clustering, small-worldness, modularity, or degree distribution in the patient group. However, in every patient we found evidence for a radical reorganization of high degree or highly efficient "hub" nodes. Cortical regions that were hubs of healthy brain networks had typically become non-hubs of comatose brain networks and vice versa. These results indicate that global topological properties of complex brain networks may be homeostatically conserved under extremely different clinical conditions and that consciousness likely depends on the anatomical location of hub nodes in human brain networks.

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