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Dynamics of the human effective connectome at rest revealed by functional neuroimaging

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Studies of brain connectivity alterations using resting-state functional Magnetic Resonance Imaging (rsfMRI), Diffusion Tensor Imaging (DTI) and more recently Diffusion Spectroscopic Imaging (DSI) data have advanced and enlarged our knowledge on the organization of large-scale structural and functional brain networks, which consist of spatially distributed, but functionally linked regions that continuously share information.

Brain's energy is largely consumed at rest during spontaneous neuronal activity (~20%), while task-related increases in metabolism energy are minor (<5%). Spontaneous ultralow-frequency fluctuations in BOLD-based rsfMRI signals (<0.01Hz) at the level of large-scale neural systems are not noise, but orderly and organized in a series of functional networks that permanently maintain a high level of temporal coherence among brain areas that are structurally segregated and functionally linked in Resting State Networks (RSNs). Some RSNs are functionally organized as dynamically competing systems both at rest and while performing various tasks.

The Default Mode Network (DMN), the most important RSN, is even more active during rest and involved in realization of tasks like memory retrieval, emotional process, and social cognition.

Cortical connectivity at rest is reportedly altered in several neurological and psychiatric disorders. Most recently, human brain function has been imaged in fMRI and thereby accessing both sides of the mind-brain interface (subjective experience and objective observations) has simultaneously been performed. As such, functional neuroimaging moves onto new potential applications like reading the brain states, discriminate neurological dysfunctions (if any), brain- computer interfaces, lie detection and alike.

The contribution aims to review and evaluate the most current approaches for early detection and classification of cognitive impairments and dementia, particularly among syndromes with relatively similar behavioral effects, based on alterations in brain connectivity at rest explored by rsfMRI, DTI and DSI.

Biography

Radu Mutihac is Chair of Medical Physics Section, University of Bucharest, and works in Neuroscience, Signal Processing, Microelectronics and Artificial Intelligence. As postdoc/research associate/visiting professor/full professor he has run his research at the University of Bucharest, International Centre for Theoretical Physics (Italy), Ecole Polytechnique (France), Institut Henri Poincaré (France), KU Leuven (Belgium). Data mining and exploratory analysis of neuroimaging time series were addressed during two Fulbright Grants in Neuroscience (Yale University, CT, and University of New Mexico, NM, USA). His research in fused biomedical imaging modalities was carried out at the Johns Hopkins University, National Institutes of Health, and Walter Reed Army Institute of Research, MD, USA.

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