Network analysis of EEG and MEG in dementia: novel approaches

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The aim of this dissertation was two-fold: firstly, to develop new measures including an effective connectivity measure (HVG-TE) to estimate direction of information flow between pairs of time series, and to develop a tree clustering method (TAHC) to detect the hierarchical clustering structure in MSTs; secondly, to apply HVG-TE (or PTE), MST measures and TAHC, and multiplex network metrics to EEG and/or MEG data in AD and/or bvFTD in order to gain insights into the pathophysiological mechanisms of the two types of dementia. TAHC, one of the first tree-clustering methods, provides a definition and an algorithm for the detection of clusters in trees, and reveals important underlying hierarchical MST clustering structure contained in weighted networks. The EEG study showed different functional connectivity and network topology in bvFTD and AD, indicating different pathophysiological mechanisms in the two types of dementia. The MEG multiplex network study demonstrated that the hippocampus and posterior hub regions were preferentially affected in AD. The hub vulnerability of these regions correlated positively with cognitive deterioration and abnormal accumulation levels of amyloid-beta plaques in cerebrospinal fluid, which may augment the underlying neuropathological cascade in Alzheimer’s disease. The application of PTE to source-space MEG data unbiasedly characterises the disrupted information flow pattern between posterior hub brain regions and frontal and subcortical brain areas, which could potentially explain the underlying pathophysiological mechanism in AD. HVG-TE is a novel effective connectivity measure, which can be used to estimate the direction of information flow in simulated and experimental functional brain networks without the biases of aforementioned methodological factors.