Diagnosis of Alzheimers Disease Using Dynamic High-Order Brain Networks

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Principal Investigators

SHEN, DINGGANG

Institution

UNIV OF NORTH CAROLINA CHAPEL HILL

Contact information of lead PI
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USA

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Diagnosis of Alzheimers Disease Using Dynamic High-Order Brain Networks

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30/09/2016

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5

The project/programme is most relevant to:

Alzheimer's disease & other dementias

Keywords

Alzheimer's Disease, mild cognitive impairment, symptomatology, personalized diagnostics, disease diagnosis

Research Abstract

Diagnosis of Alzheimer’s Disease Using Dynamic High- Order Brain Networks Abstract

Alzheimer’s disease (AD) is the most common form of dementia with no known disease-modifying treatment. Current clinical diagnosis and monitoring of the disease are primarily based on subjective neuropsychological and neurobehavioral assessments, which are generally susceptible to large variability. Objective biomarkers that are sufficiently sensitive and specific for diagnosis and monitoring purposes are hence critically in need. Neuroimaging fits this need and provides objective measures and markers of preclinical disease states for aiding researchers and clinicians in developing new treatments and monitoring their effectiveness. Since AD- related neurological degeneration occurs long before the appearance of clinical symptomatology, additional diagnostic information during the prodromal phase of AD, i.e., mild cognitive impairment (MCI), is of paramount importance for the success of treatment. The goal of this project is to develop a machine-learning diagnostic framework based on resting-state functional MRI (R-fMRI) for accurate AD diagnosis at the individual level, so as to promote early detection for possible treatment and prophylaxis. Achieving this goal requires significant technical innovations to empower researchers the ability to detect sophisticated yet subtle alteration patterns in brain function. In this project, we will dedicate our efforts in accomplishing the following specific aims. In Aim 1, we will harness the temporal dynamics of functional connectivity to provide additional information for accurate identification of individuals who are at risk for AD. This is significantly different from most existing methods that assume temporal stationarity and are therefore unable to take advantage of temporally-evolving connectivity information for more fine-grained characterization of rapidly changing brain states. In Aim 2, we will extract high-order information from functional networks, beyond the commonly used region-pair correlation, for characterizing functional synchronization of the interactions of multiple pairs of regions. This overcomes the over-simplistic pairwise-interaction assumptions of existing methods, and thus allows greater capacity to model complex brain circuitry. In Aim 3, we will fuse information across imaging modalities to complement functional networks with both the white-matter structural networks (generated using diffusion MRI) and the morphological networks (generated using cortical thickness information from anatomical T1-weighted imaging). This will allow complementary information from different modalities to reinforce each other in improving diagnostic accuracy. Upon successful completion of this project, we expect that the resulting comprehensive, integrated, and effective diagnosis framework will be conducive to improving the success of early detection of MCI/AD, as well as other neurological disorders including schizophrenia, autism, and multiple sclerosis.

Lay Summary
Narrative Description of Project AD-related neurological degeneration occurs long before the appearance of clinical symptomatology. Information provided by neuroimaging data, which is sensitive to pathology during the prodromal phase of AD, i.e., mild cognitive impairment (MCI), is of paramount importance for the success of diagnosis and treatment. The goal of this project is to develop a machine-learning diagnostic framework based on resting-state functional MRI (R-fMRI) for accurate AD diagnosis at the individual level, so as to promote early detection for possible treatment and prophylaxis.

Further information available at:

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