Longitudinal brain imaging and modelling of ageing and disease processes

Background: The structure and shape of the brain changes through development, ageing, and in disease. Cross-sectionally, changes in cortical shape and structure correlate with age, cognitive function, and disease severity or progression. However, it is less clear if brain structure derived from neuroimaging can also reliably track disease progression in individuals and longitudinal research is required to establish causal relationships between brain structure and disease processes.
Question/hypothesis/aim: We aim to track brain structure of individual subjects longitudinally, alongside clinical and cognitive outcome variables to develop individualised neuroimaging markers of ageing and degenerative processes.
Methods: Using large-scale open-access structural neuroimaging datasets, structural changes across different processes will be established and related to clinical and cognitive outcome measures. We will establish a baseline with healthy ageing as an initial process, with age and neuropsychological data as primary outcome measures. We will then investigate dementia and epilepsy as application domains, given the significance of brain structural changes in these disorders, and supervisory expertise.
Timeliness: This interdisciplinary project fills a crucial knowledge gap in medical neuroimaging and provides a unique opportunity to combine novel computational/AI methods with huge datasets to gain a mechanistic understanding of how and why brain structure and shape change in different processes, and how this relates to clinical and cognitive outcomes. We aim to address urgent societal needs to advance knowledge of neurodegenerative disorders.
Potential impact: Leveraging longitudinal data, the project will improve our understanding of how ageing and diseases progress and how reorganisation occurs. It will inform on potential neurobiological causes of neurodegenerative and neurological diseases. Predicting disease progression of individuals based on the interaction of outcome measures, morphological and connectivity measures offers a huge leap forward in research and, crucially, could be translated into clinical tools to aid prognosis and inform medical decisions.
Supervisory team: We offer a rich research environment in both clinical and computational labs. Dr Yujiang Wang is a UKRI Future Leaders Fellow and co-PI of the Computational Neuroscience, Neurology, and Psychiatry (CNNP) lab in the School of Computing. Key expertise: the development of computational biomarkers based on mechanistic understanding of the processes driving brain shape. Prof. John-Paul Taylor is Clinical Professor of Translational Dementia Research and PI of the Lewy Body Lab in the Faculty of Medical Sciences. Key expertise: application of neurophysiology and neuroimaging to dementia populations.

References:
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