Project Details	
Project Code	MRCNMH24Ca McNabb
Title	A multimodal investigation of brain structure and function in schizophrenia
Research Theme	Neuroscience & Mental Health
Summary	Aberrant brain structure and function are implicated in the pathophysiology of schizophrenia, but the mechanisms by which these alterations cause psychotic experiences are unclear. This project utilises advanced neuroimaging and analytic techniques to investigate how brain structure and function contribute to the complex neurophysiological processes underlying psychosis, using a state-of-the-art multiscale multimodal imaging dataset unique to Cardiff University.
Description	Strong evidence implicates aberrant brain structure and function in the pathophysiology of schizophrenia. Researchers have identified disturbances in short and long-range functional connections, white matter microstructure and synaptic processes that, together, suggest a diffuse and complex pathology. It is unclear, however, how brain structure and function drive the specific psychological disturbances present in schizophrenia and how these eventually lead to symptoms like delusions, hallucinations, anhedonia and cognitive impairment. This project will use pre-existing data from a multi-modal, multi-scale study of brain structure and function in schizophrenia (the Welsh Advanced Neuroimaging Database in Psychosis), which used advanced neuroimaging techniques designed to probe brain tissue microstructure (quantitative and diffusion magnetic resonance imaging; MRI), neurochemical signalling (magnetic resonance spectroscopy; MRS), and functional coupling (magnetoencephalography; MEG). The dataset also includes genetic, environmental and cognitive data that can be incorporated into analyses to investigate a wide range of research questions, tailored to the scientific interests of the student. The primary focus of this work will be on furthering our understanding of functional coupling in schizophrenia and investigating how functional coupling is dictated by neurochemical signalling and tissue microstructure. The PhD student will be trained to analyse brain imaging data from multiple modalities (including MRI and MEG), model complex dynamical systems using computational modelling, and gain a broad understanding of clinical neuroscience, genetics, and pharmacology. The project will involve several, overlapping phases: Preparation phase: Project design The dataset employed in this project allows for a high degree of flexibility. During this phase, the student will work with the supervisors to develop the project in line with their academic interests and desired skills training. Phase 1: Literature review The student will review recent literature in the fields of tissue microstructure, functional connectivity and dynamic causal modelling and suggest novel approaches for combining these techniques to improve understanding of neurophysiological and psychological processing in schizophrenia. Phase 2: Brain structure and function They will first investigate how brain tissue microstructure, measured using quantitative and diffusion MRI techniques, is affected in schizophrenia, and how tissue microstructure affects brain function, measured using MEG. Phase 3: Dynamic causal modelling Using task

	data from MEG and sophisticated computational modelling techniques, the student will develop models to describe key psychological theories of schizophrenia, including excitation-inhibition imbalance and hierarchical predictive coding. They will have the opportunity to incorporate data from other modalities (e.g., genetics, MRS, microstructure) into their model, to investigate how these features influence the model and its interpretation. Work from this project will contribute to our understanding of structure-function relationships in schizophrenia and how these impact psychological processes underlying the disorder. This project is based at Cardiff University Brain Research Imaging Centre (CUBRIC), in collaboration with researchers at the University of Exeter and University of Bath. The supervisory team will include experts in neuroimaging, computational modelling, statistical analysis, genetics and psychiatry. As part of the student's training, they will be expected to present their work at national and international conferences (e.g., BIC-ISMRM, MEG UK, SIRS) and publish high-impact peer reviewed papers. In addition, they will participate in research meetings focused on microstructural MRI and MEG, giving them the opportunity to learn from experts in the field and build lasting relationships with their peers.
Supervisory Team	
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