Project Details	
Project Code	MRCNMH25Ca McNabb
Title	Using MRI, MEG, and machine learning to better classify severe mental illness
Research Theme	Neuroscience & Mental Health
Summary	Clinical diagnoses of severe mental illnesses currently rely solely on symptom report and poorly predict long-term outcomes. This PhD project aims to integrate information from brain imaging, cognitive testing, blood biomarkers and genomics to improve mechanistic understanding. In this PhD, you will develop and refine machine learning algorithms to try and recategorise severe mental illnesses based on mechanistically-informed biological markers. You will also learn about the processes and challenges associated with bringing neuroimaging biomarkers to real-world clinical settings through hands-on experience at Bioxydyn, a leading start-up in this field. Suitable candidates will have a love of programming, neuroscience and neuroimaging.
Description	Schizophrenia and bipolar disorder are severe mental health disorders affecting more than 64 million people worldwide. Despite their prevalence, their aetiology is poorly understood and diagnoses still rely on clinical categorisation of symptoms rather than biological markers. This lack of pathophysiological understanding hinders therapeutic progress, with almost no mechanistically novel therapies developed since the introduction of antipsychotics and lithium in the mid-20th century. This inter-disciplinary PhD project will contribute to the South Wales and South-West England (SW2) Brain and Genomics Hub of the National UKRI Mental Health Platform. The Brain and Genomics Hub will employ deep phenotyping strategies, including advanced magnetic resonance imaging (MRI), magnetoencephalography (MEG), clinical, cognitive, genetic, epigenomic, and immunometabolic evaluations, in 600 people with schizophrenia, bipolar disorder and schizoaffective disorder. As the PhD student on this project, you will develop advanced machine learning algorithms to meaningfully categorise people with severe mental health disorders, using brain imaging data (e.g. functional and microstructural) that capture features linked to disorders like schizophrenia and bipolar disorder. These categories should be biologically interpretable, repeatable, and generalisable, and provide mechanistic insights to aid future development of personalised treatments and targeted therapies. You will also work to interpret and understand the biological significance of these categories by exploring additional data from imaging and non-imaging sources as part of the larger Brain and Genomics Hub project. Lastly, you will learn about the processes and challenges associated with bringing neuroimaging biomarkers to real-world clinical settings through hands-on experience at Bioxydyn, a leading start-up in this field. The project will involve several overlapping phases: Preparation phase (Development of project plan and literature review): The dataset you will employ in this project allows for a high degree of flexibility. During this phase, you will work with the supervisors to develop the project in line with your academic interests and desired skills training. As part of this preparation phase, you will review recent

	literature in advanced clustering algorithms, clinical neuroimaging, psychiatric genetics and psychiatric disorders (specifically, schizophrenia, bipolar disorder and schizoaffective disorder) and suggest novel approaches for improving stratification and classification in psychiatric disorders. Phase 1: UK Biobank In this phase, you will develop a clustering algorithm capable of meaningfully categorising people with severe mental health disorders using image-derived phenotypes from the UK Biobank. The UK Biobank includes 157 people with schizophrenia, 602 people with psychotic disorders, and 836 people with bipolar and related disorders, and provides an excellent resource for developing the initial clustering algorithm. Phase 2: SW2 Brain and Genomics Hub During this phase, you will determine whether clusters derived from UK Biobank are applicable to the Brain and Genomics Hub project, to identify a robust set of image-derived phenotypes for classification. You will then work to derive biological meaning from clusters through exploration of other imaging (MEG) and non-imaging (genetic, clinical) data collected as part of the Brain and Genomics Hub project. Phase 3: Broadening Horizons Placement During the Broadening Horizons Placement, you will develop a comprehensive understanding of the complexities associated with translating research-derived biomarkers into clinical practice, in partnership with Bioxydyn, a leading UK-based imaging start-up pioneering the use of microstructural imaging biomarkers in drug development and clinical trials https://bioxydyn.com. This project is based at Cardiff University Brain Research Imaging Centre (CUBRIC), in collaboration with researchers at the University of Bath. The project also includes researchers from the University of Bristol, University of Exeter, and Swansea University, as well as experts from Bipolar UK and Adferiad Recovery. Your supervisory team will include experts in neuroimaging, computational modelling, statistical analysis, genetics and psychiatry. As part of your training, you will be expected to present your work at national and international conferences (e.g., BIC-ISMRM, MICCAI) and publish high-impact peer reviewed papers. In addition, you will participate in research meetings focused on MRI, computer science, genetics and mental health, giving you the opportunity to learn from experts in the field and build lasting relationships with your peers. This project would be well suited to prospective students with a strong background in coding, computer science and/or neuroimaging who are interested in developing novel algorithms for personalising mental healthcare.
Supervisory Team	
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