Project Details	
Project Code	MRC18NMHCa Teufel
Project Title	Exploring the emergence of psychotic experiences using multimodal neuroimaging and mathematical modelling
Research Theme	Neuroscience & Mental Health
Summary of Project	Psychotic disorders such as schizophrenia are among the most devastating mental health conditions. Combining mathematical modelling and multimodal neuroimaging, the aim of this PhD project is to understand the computational and neurocognitive processes underlying the emergence of psychotic experience such as hallucinations and delusions.
Project Description	This project cuts across applied mathematics, cognitive neuroscience, and psychiatry. The overall aim is to understand the computational and neurocognitive processes underlying the emergence of psychosis, and neurocognitive contributions to psychopathological risk. Psychotic disorders such as schizophrenia are among the most devastating mental health conditions and leading contributors to the global burden of disease. Psychotic symptoms involve a loss of contact with reality in the form delusions (false beliefs) and hallucinations (perceptual experiences in the absence of stimuli). Given the complexity of the processes underlying these symptoms, recent advances have often been driven by integrated, cross-disciplinary approaches using mathematical models, behavioural testing, and neuroimaging (1). Theoretical models emerging from this new field of 'computational psychiatry' highlight abnormalities in predictive processes in the brain of psychotic individuals. Specifically, current models of brain function view the generation of representations of the external world as an inference process, in which existing (prior) beliefs are combined with new sensory input. Recent evidence suggests that psychotic symptoms may arise from undue weighting of predictive prior beliefs (2). To gain mechanistic understanding of the pathophysiology of psychosis, this project will examine the integration of sensory input and prior beliefs via multimodal neuroimaging and mathematical modelling. Using tasks developed by C.T. (2), which allow teasing apart sensory input and prior beliefs, the project will work with psychotic patients recruited through existing clinical infrastructure provided by J.W. The project will also adopt an individual-differences approach, studying a sample of healthy individuals characterised along dimensions of schizotypy. Whilst the incidence of psychotic illnesses is too low to study in longitudinal/cohort designs, psychotic experiences that exist on a continuum with clinical disorders occur frequently within the general population. The current project exploits this fact to identify neurocognitive biomarkers of distinct psychopathological phenotypes, which may be associated with differential risk of psychosis. The neuroimaging facilities at CUBRIC provide unique opportunities to collect both magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI) data in the same individuals (3). These modalities are highly complementary, yielding high-definition temporal and spatial information, respectively. Neuroimaging data will be analysed using the Dynamic Causal Modelling (DCM) approach, which provides the tools to characterise directional connectivity between and within brain regions associated with sensory input and prior beliefs (4). Incorporation of information from MEG and fMRI modalities within a single DCM framework will allow characterisation of neural mechanisms underlying psychotic experiences in unprecedented detail, e.g., with models of receptor level activations (5). The work will further our understanding of the computational and neurobiological processes underlying psychosis and will inform the development of neurocognitive biomarkers for psychopathological risk. 1.Teufel (2016)_Brain_139(10):2600–2608. 2.Teufel (2015)_PNAS_112:13401-13406 3.Carhart-Harris,[…],Singh,[…] (2012)_PNAS_113(17): 4853–4858 4.Moran (2008)_NeuroImage_2(1):272-284 5.Gilbert,[…]&Moran (2015)_NeuroImage_124:43-53

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