Project Details	
Project Code	MRCNMH24Br Mellor
Title	Linking neuronal function to mental health: How genetic risk factors impair cognitive flexibility and neural plasticity in psychiatric disorders.
Research Theme	Neuroscience & Mental Health
Summary	Genetic risk factors for psychiatric disorders are clustered around genes that regulate synaptic function and adaptation, indicating common disrupted biological processes. We have revealed how one of these genes (Dlg2) perturbs a core feature of synaptic signalling. In this project, we will uncover how this leads to abnormal cognition by directly measuring neuronal adaptations during tasks demanding cognitive flexibility, and test mechanisms to rescue cognition.
Description	Genetic risk factors are highly significant in determining susceptibility to a range of psychiatric disorders including anxiety, depression and psychosis. Many of these psychiatric risk factors cluster around genes involved in synaptic function and plasticity but we know relatively little about the core features of synapses that are disrupted and how these lead to cognitive impairments common to many of these conditions. Emerging evidence indicates that many key psychological processes such as perception, memory and adaptability rely on dendritic signalling events generated by the interaction of multiple synapses on single neurons. These dendritic signals are extremely sensitive to neural network perturbations caused by genetic mutations to synaptic proteins or changes in brain state mediated by neuromodulators such as acetylcholine or serotonin. We have discovered that the genetic risk factor Dlg2, which is associated with schizophrenia, autism and intellectual disability, disrupts dendritic signalling and synaptic plasticity (PMID: 35115661). In this project we aim to determine how these disrupted neuronal processes lead to impairments in flexible neuronal representations of behaviour and whether they may be rescued by targeting these specific processes. In this way we will directly link biological processes to cognitive impairments observed in psychiatric disorders and develop practical strategies for treatment. The project will test these hypotheses using transgenic animals bearing mutations in the synaptic protein Dlg2 (Hall, Wilkinson). The project will first determine how dendritic calcium signalling is impaired in these animals using electrophysiology coupled with imaging of synaptic and dendritic calcium signals, techniques routinely used in the Mellor and Ashby groups (PMID: 26758963, 30242046). The project will then determine how hippocampal representations of spatial features adapt during changing environmental conditions by measuring hippocampal place cell activity using 2-photon imaging during animal exploration of a virtual reality environment, using early career researcher Witton's expertise. We will test whether reduction in Dlg2 expression impairs the flexible representation of changing environments at neuronal and behavioural levels. Finally, the project will test whether impairments in neuronal representations and behaviour may be rescued by application of clinically relevant drugs such as muscarinic receptor agonists or psychedelics that target serotonin receptors. The ultimate goal will be to find out if manipulating dendritic signalling using pharmacological tools is capable of changing behavioural outcomes in adult animals. This will

	form the basis of future therapeutic strategies for the treatment of psychiatric disorders The student will be trained in Bristol in dual electrophysiology and 2-photon imaging performed in ex vivo brain slices. Subsequently, training will transition to 2-photon imaging in vivo and animal behaviour paradigms developed in Cardiff, Exeter and Bristol. Aligned with this the student will be trained in complex data analysis and manipulation of virtual reality environments. Our collaboration with Dan Dombeck's group (www.dombecklab.org) offers the opportunity to learn from world leaders in virtual reality behaviour in rodents. In addition, the project can also be extended to use computational models to predict the likely outcome of dendritic signalling perturbations on behaviour through our collaborations with Cian O'Donnell (Ulster and Bristol). Through our collaborations with pharmaceutical companies including Compass pathways, SoseiHeptares, Lilly and Takeda we have access to novel drug pipelines that we can test. For example, Compass have shown psilocybin is effective in depression and SoseiHeptares have a suite of muscarinic receptor ligands in development for clinical trials in schizophrenia (PMID: 34822784).
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