Cholinergic modulation of spatial memory in cortical brain circuits

Supervisory team:
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Project description:

Learning and memory are amongst the most fundamental mental processes, as they allow us to use experience to solve problems and adapt our behaviour. Acetylcholine (ACh) is a neuromodulator that is known to be an important regulator of learning and memory. This project will bring together a variety of in vivo and ex vivo techniques and computational analysis to decipher how ACh regulates the processing of learning and memory in the brain's neocortex.

The retrosplenial cortex (RSC) is a region of neocortex that is a key node in brain circuit that is essential for learning and memory. In particular, the RSC is important for discriminating between memories of different places, which are called spatial memories. The RSC is richly supplied by cholinergic (i.e. ACh releasing) synapses, which indicates that ACh plays an important role in the processing of spatial memories in RSC. We have good evidence that ACh can reconfigure neural activity in RSC, but almost nothing is currently known about how or when ACh is acting to regulate the processing of spatial memories in RSC.

The specific aims of this project are (i) to determine the cellular and synaptic mechanisms by which ACh regulates communication between neurons in RSC, and (ii) to determine how ACh regulates the processing of spatial memories in RSC. To tackle these aims, you will join a vibrant research community spanning two of the UK's leading research universities, Exeter and Bristol, working alongside a team of 6 postdocs and 10 PhD students across the labs of Dr Jon Witton (Exeter), Prof Jack Mellor (Bristol), and Dr Jon Brown (Exeter). You will be trained in cutting-edge ex vivo and in vivo techniques, using a combination of mouse genetics, patch clamp electrophysiology, optogenetics and pharmacology to address aim (i) and in vivo brain imaging and behavioural analysis to tackle aim (ii). You will also develop skills in computer programming by writing novel analytical algorithms.

This project will establish a new foundation for understanding how ACh regulates the processing of learning and memory in cortical brain circuits. This will help to us better understand how disrupted ACh signalling causes learning and memory loss in neurological diseases such as Alzheimer's, and how current ACh boosting drugs (e.g. Donepezil) actually work to enhance cognitive abilities in patients. In summary, this is a highly interdisciplinary project that offers an exceptional training opportunity in an exciting and important field of neuroscience research.