Plasticity of visual information processing and the consequences of neurodevelopmental disorders

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Project description:
The ultimate goal of much neuroscience research is to link the responses of individual neurons or populations of neurons with perceptual capabilities and behavioural outcomes. Recent advances in functional brain imaging at the cellular and subcellular levels are now allowing us to approach this goal in an unprecedented manner. In this project we will apply two-photon imaging of calcium signals to examine fundamental questions of how higher cortical areas are wired during development and how this process goes awry in neurodevelopmental and neuropsychiatric disorders.

First we will examine how an early defect of vision in one eye affects higher visual function in the long term. In humans, such an early developmental disadvantage of one eye relative to the other causes a condition known as “lazy eye”. Most of the research into the underlying mechanisms has focused on the primary visual cortex (V1), despite the well-recognised fact that the extent of abnormalities in V1 cannot account for the much greater deficits in visual performance. The cutting-edge techniques in use in our lab will enable the student to investigate visual stimulus-evoked activity in higher visual areas of mice while these are carrying out visual discrimination tasks.

We will extend this work to examine more broadly how developmental deficits in neuronal connectivity formation might result in abnormal propagation of information through cortical circuits. Specifically we will use similar techniques to examine the flow of information through cortical circuits in a genetic model of autism spectrum disorders and of schizophrenia. Although these mouse models are well understood at the electrophysiological level little is known about how the mutations translate into sensory abnormalities. In this project two-photon imaging will be complemented with in vivo electrophysiological recordings in order to analyse synaptic connectivity. The aim of this project is to identify specific cellular mechanisms by which developmental or genetic defects translate into visual or neurological condition.