Targeted Project / AY 2023 -2024

Circuit-dissection of sensory-guided decision-making in freely behaving mice using automated operant conditioning

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Research area: Neuroscience of sensory processing

Project outline:

A fundamental challenge in Neuroscience is to understand how neuronal circuits learn to optimize decision-making in complex and dynamic sensory environments. This capacity is impaired in multiple neuropsychiatric disorders including autism and schizophrenia, but the mechanisms are poorly understood.

This project focuses on the circuits that allow mice to learn to integrate and selectively respond to olfactory and visual stimuli to maximize rewards. Traditionally, sensory-guided decision-making is tested in head-restrained rodents, with simplified tasks with small stimulus sets that pertain to one sensory modality. This limits generalizability of results to natural decision-making, where unrestrained animals sample and integrate multiple sensory inputs. This project therefore takes advantage of an innovative automated behavioural apparatus called the AutonoMouse to study sensory-guided decision-making in freely moving rodents, with self-initiated training sessions from the animal's home cage.

The studentship will capitalize on the expertise in the Galliano and Poort lab to study neuronal olfactory and visual representations during learning. Chronic 2-photon calcium imaging and electrophysiology will reveal how learning modifies responses of different neuronal cell types, using advanced computational methods to characterize behaviour and neural circuit function. This approach will enable testing the hypothesis that long-term changes in inhibitory cell types are critical for learning and expert task performance. Optogenetic and pharmacological manipulations of brain areas and cell types will help establish the causal mechanisms.

Comparative experiments in healthy mice and genetic and pharmacological mouse models with learning and decision-making impairments will give additional insights into these mechanisms and inform strategies to rescue behavioural deficits.

BBSRC DTP main strategic theme: Understanding the rules of life