Master Thesis Project: Developing an Automated Visual-Motor Learning Paradigm

Keywords: Behavioural neuroscience • Visual-motor learning • Home-cage training • Curriculum learning • Experimental neuroscience

Project overview

Our perception of the world is not passive but strongly influenced by our actions, expectations and goals. When we interact with our environment, our movements change the sensory information we receive. The brain must continuously integrate these sensory signals with ongoing actions to guide behaviour and learn from experience. Higher-order cortical areas are thought to influence how sensory information is processed. However, it remains unclear whether these top-down signals are necessary for learning new relationships between actions and sensory feedback, for performing already learned behaviours, or both.

This Master's thesis is part of our research on top-down modulation of sensorimotor decision-making. The student will focus on developing and establishing a new automated visual-motor learning task in mice, combining experimental task development, behavioural training and quantitative data analysis.

Project objectives

The main objective of this Master's thesis is to establish and validate a new automated visual-motor learning paradigm in mice. This involves developing a reliable home-cage training system in which animals can voluntarily participate in a visual-motor task. Based on that the student will be implementing a curriculum-based training paradigm, for which task difficulty and learning progression is gradually increased according to each animal's progress. The student will contribute to integrating sensors, developing automated visual stimulus and reward control, and establishing reliable methods for monitoring and recording behavioural performance. Once the system is established, the student will run a first cohort of mice to evaluate the training procedure, investigate learning dynamics and identify potential improvements to the experimental setup.

Thesis structure and scope

The primary goal of this Master's thesis is to gain hands-on experience in experimental neuroscience by developing, implementing and validating a new automated behavioural setup.

The project will consist of three stages:

1. **System development:** Familiarise yourself with the existing experimental setup and integrate the required sensors, visual stimulus control, reward delivery and automated data acquisition into the home-cage training system.
2. **Behavioural paradigm development:** Establish a curriculum-based training procedure that gradually introduces animals to increasingly complex visual-motor tasks. Test and optimise the system to ensure reliable operation and data collection.
3. **Experimental validation:** Run a first cohort of mice, monitor their training progress and analyse learning behaviour to evaluate and improve the experimental paradigm.

The exact scope will depend on the progress of system development and the time available.

What we expect

We are looking for a motivated Master's student with a strong interest in behavioural neuroscience and experimental system development. The project combines hands-on experimental work with programming, automated behavioural control and quantitative data analysis. Experience with programming (MATLAB or Python), electronics or automated experimental setups is an advantage but not required. Patience, precision and an independent, systematic approach to problem-solving are important.

In this project, you will be working with laboratory mice. This includes animal handling, behavioural training, monitoring of experimental animals and potentially, short surgical interventions.

Contact

If you are interested in the project or have any questions, please contact Roman at romaboeh@ethz.ch.