University of Basel

DBM Basel
Department of Biomedicine

MASTER THESIS PROJECT: IN NEUROBIOLOGY

Sensation of time in the auditory system

The sensation of time on a scale from milliseconds to seconds is necessary for adaptive behaviors, such as communication, sensory-motor processing etc. But how can the brain create the feeling of elapsed time given that there are no dedicated sensory organs?

Earlier studies suggest that the duration of a given event is perceived through the respective sensory system. In human behavioral experiments it was shown that more intense stimuli are felt to last longer. When brought to the lab, the same phenomenon was observed, and optogenetic stimulation of primary somatosensory cortex was altering perceived duration of a tactile stimulus (Reinartz et al., The sensory code within sense of time | bioRxiv). These experiments suggested that the sensory cortices do not just relay the beginning and end of the event to a higher-order internal clock-like circuitry, but that their neuronal activity itself acts as a substrate of the feeling of elapsed time. In other words, a direct non-linear read-out of primary sensory cortices drives time perception. But what are the neuronal activation dynamics underlying such read-out of primary sensory areas with coupled stimulus representation (intensity and duration) to generate biased perceptual decisions?

To that aim, I designed a single-stimulus auditory categorization task, where mice are trained to classify naturalistic sound textures according to their duration. As proof of concept, I identified the intensity bias in perceived duration – louder sound textures are perceived as longer - in the auditory system of these mice. Applying multi-channel electrophysiology and 2-photon calcium imaging, I am recording neuronal activity of identified neuron types (PV, SST, PYR) in primary auditory cortices and probe their behavioral relevance.

In psychophysical studies with schizophrenic patients, behavioral measures suggest an overestimation of perceived durations (Stevenson et al., 2017) related to the severity of positive symptoms (Ueda et al, 2018 and references therein). Given these findings, can the psychotic overestimation be explained by an alternated representation of the sensory world (e.g., hallucinations), or by a change in its integration mechanism?

I believe that studying the mechanisms and circuit dynamics of time perception in mice will open a window to map low-level signal processing mechanisms that might be disturbed under specific psychiatric conditions. On the long term ty mice findings on the activation dynamics of specific inhibitory neuron types will allow me to set up models on time perception to shape well-defined human psychophysical experiments to compare possible sensory processing phenomena between rodent and human perception.

Methods applied and experience obtained during the internship

Mouse behavioral training in a highly controlled psychophysical setup, learning and application of psychometric analysis, introduction to electrophysiological & 2-photon calcium imaging methodology, potentially insights to optogenetic technology.

Specific Requirements

Strong interest in understanding the brain and its relation to behavior. Motivation and patience to train mice in a behavioral task. Experience with MATLAB analysis is desirable, motivation to learn it is necessary.

Supervision & Contact

Dr. Sebastian Reinartz, sebastian.reinartz@unibas.ch
Prof. Tania Rinaldi Barkat, tania.barkat@unibas.ch, Brain & Sound Lab (www.brainsoundlab.com)

Location

The project will take place in the Brain and Sound Lab directed by Prof. Tania Rinaldi Barkat at Basel University, Switzerland. The aim of the lab is to understand the role of neuronal circuits in making sense of sounds. We use a systems neuroscience approach and combine optogenetics, in vivo electrophysiology, functional imaging, behavioral assays, cochlear implants and computer modeling to explore the functions of neuronal circuits in the mouse central auditory system.