REGIONAL CENTRE FOR BIOTECHNOLOGY

Seminar series

Sniffing to decide: temporal aspects of olfactory information processing.

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Abstract

A cardinal question in neuroscience is how the brain perceives the ever-changing external world and subsequently makes the appropriate decisions to adapt the behavior. Of critical importance is how fast the brain can extract information, and what factors control the speed of information processing and decision-making? Olfaction was generally thought as a ‘slow’ sense compared to other senses. We investigated the speed of olfaction using the mouse model system. Mice discriminated simple odors in ≈200 ms and complex binary mixtures with additional tens of milliseconds. Such olfactory representation can be maintained in the OB plausibly by the inhibitory network. We tested this hypothesis by altering the function of inhibitory interneurons, granule cells (GCs), in the OB. A bidirectional shift in the synaptic inhibition caused a similar effect in the discrimination speed for complex odorants. In the next step, we investigated how the GC inhibition controls firing properties of output neurons (mitral/tufted cells, M/Ts) by directly correlating the behavior outputs with physiological changes. A specific stimulation of GCs using Channelrhodopsin (ChR2) caused enhancement of pattern separation by M/Ts, which helped the animals to learn complex discrimination tasks faster than control subjects. We have also investigated the factors controlling odor discrimination efficiency at the sensory input level. Studying the evoked glomerular patterns for different chemical classes showed that similarity and strength of glomerular activation define the extent of neuronal processing as reflected in the discrimination speed. Therefore the similarity of glomerular representations can be used as a neural metric to predict olfactory discrimination speed. Strikingly, olfactory associative learning caused a long-lasting potentiation at the sensory input level that may help improving odor detection thresholds. The future goal is to focus on synaptic and molecular mechanisms of sensory perception and decision-making by giving special attention to different inhibitory circuits of mouse OB.