UNIVERSITÄT ZU LÜBECK
INSTITUT FÜR ROBOTIK
UND KOGNITIVE SYSTEME

Neural Coding in the Olfactory System

Abstract

by

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Due to its simple organization the olfactory system is an ideal model system for sensory processing. In this talk I will address two main questions: 1) 'Is piriform cortex an auto-associative memory?' and 2) 'What are the coding strategies used for representations of odours?'

Due to its anatomical layout, closely resembling abstract networks such as the Hopfield net and a seemingly random connectivity, piriform cortex has long been described as a perfect example of an auto-associative network. The general idea was that associations between input and output patterns in piriform cortex are formed through plastic synapses between principal neurons. While there is no doubt that neural plasticity plays a major role in forming input representations, computational modelling studies have put the auto-associative network hypothesis into question. It has been shown that random connectivity from olfactory bulb to piriform cortex and within piriform cortex, an essential part of the auto-associative network hypothesis, cannot reproduce experimental current-source density (CSD) profiles in weak electric shock paradigms in a detailed network model of piriform cortex. This modelling effort suggests that several subgroups within piriform cortex exist which have a high density of within-group connections but which are only sparsely inter-connected. While these subgroups are very likely to function in an auto-associative manner, their existence and layout is likely to be 'hard-coded' in the anatomical structure of the olfactory system. One might speculate that these subgroups correspond to 'metabolic pathways', that represent metabolically important groups of odours/chemical compounds.

In the second part of the talk, I will talk about coding strategies of single neurons in the olfactory system. Piriform cortex contains two major classes of principal cells: superficial pyramidal (SP) cells and semilunar (SL) cells. These two cell types show strikingly different electrophysiological response properties: While SP cells tend to start their firing with short bursts of activity before settling to a more regular pattern, SL cells fire extremely regular. Furthermore, there are marked differences in terms of short-term synaptic plasticity of afferent fibres onto both cell types. These differences lead to a dispersion of output firing patterns (firing rate and latency, but not jitter) across a broad range, which has important implications for olfactory coding.

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