

Dynamics of Odor Encoding: Neural Circuit Modeling

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The understanding of the nonlinear dynamics of olfactory bulb (OB) is essential to the modeling of brain and nervous system. We analyze the conditions governing neural oscillations and the nature of odor-receptor interactions and propose a biologically plausible four-layer model of the OB with three nonlinearities.

We view the layered architecture of the bulb as a composition of different processing stages performing different computational tasks. The model contains sensory, glomerular, external plexiform and granule layers with excitatory and inhibitory neurons and dendrodendritic interactions. It has different number of mitral and granule cells which improves the cognitive ability of the model. In a noisy background our model functions as an associative memory, although it operates in an oscillatory mode.

We derive the requirements under which a state is stable and test whether a given equilibrium state is stable against noise. The presented model demonstrates its capability to discriminate odors by using nonlinear dendrodendritic interactions between neurons.