Robust and sensitive representation of odors in the dynamic competitive model of the antennal lobe

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Abstract

Recent studies of the locust olfactory system show that odors are represented by stimulus-specific spatio-temporal patterns of neural activity in the antennal lobe. These patterns are stable from trial to trial for the same odor, but change significantly when another odor is presented. A theoretical framework of "winnerless competition" (WLC) was developed recently to study possible mechanisms of such identity-temporal coding. The main feature of WLC networks is non-symmetric lateral inhibition between neurons that leads to spatio-temporal switching activity in the network. In this work a model network of Hodgkin-Huxley type projection neurons with lateral inhibition is studied. By calculating the 'distance' between multineuron spike trains we demonstrate that such network exhibits robustness of the dynamics against noise, reproducibility of same-stimulus responses and sensitivity to the small changes in the stimuli. Hence it is able to encode spatial input information into spatio-temporal patterns of neural activity in a very sensitive but at the same time robust manner.