

## **Constructing phase models of biological neural networks from experimentally estimated phase-response curves**

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Under fairly general conditions the complex dynamics of neural networks can be reduced to simple models of coupled phase oscillators. To do so, the phase-response (or phase-resetting) curve (PRC) of the neurons must be determined. The PRC quantifies how much the period of the oscillator changes in response to a perturbation occurring at any phase. In mathematical neural models, like the Hodgkin-Huxley equations, the PRC can be calculated from the dynamical equations. However, a reliable estimation of the PRC in real neurons presents difficulties that have impaired neuroscientists from systematically taking advantage of the information PRC provides. Combining theory, computer simulations and electrophysiological recordings (whole-cell patch-clamp) we have developed a successful approach for efficient estimation of PRCs in real neurons (Phys. Rev. Lett. 94, 158101). This has permitted us to construct a phase model of a biological neural network, in particular of the olfactory bulb, and to study its dynamics. In our analysis we found that i) the estimated PRC of the principal cells in the olfactory bulb, the mitral cells, have partially positive and partially negative domains (n=3 neurons) suggesting that they behave as resonators or type II neurons; ii) these PRCs possess higher order harmonics, a necessary condition for the formation of more than one oscillator clusters (synchronized neural assemblies); iii) inhibitory interactions between mitral cells, as in the olfactory bulb through granule-cell-mediated inhibition, lead to the formation of a dominant synchronized assembly; iv) addition of fluctuating inputs (or noise) into oscillator networks induce transitions between assemblies in a way that is reminiscent of a “winnerless competition” dynamics.

This work has been supported by a grant NIDCD (R01DC005798).