

Predicting synchronized neural assemblies from experimentally estimated phase-resetting curves

Roberto F. Galán^{a,b}, G. Bard Ermentrout^{b,c} and Nathaniel N. Urban^{a,b}

^a*Department of Biological Sciences, Carnegie Mellon University,
Pittsburgh, Pennsylvania 15213, USA*

^b*Center for the Neural Basis of Cognition, Mellon Institute,
Pittsburgh, Pennsylvania 15213, USA*

^c*Department of Mathematics, University of Pittsburgh,
Pittsburgh, Pennsylvania 15260, USA*

Assemblies of (transiently) synchronized neurons have been observed in a variety of neural systems. This phenomenon is reminiscent of the formation of clusters in models of coupled phase oscillators. To investigate *real* neural networks as systems of coupled oscillators, we have recently proposed an efficient method to estimate phase-resetting curves (PRCs) in real neurons with whole-cell patch-clamp procedures. In particular, we have applied our approach to the study of the neural dynamics in the mammalian olfactory bulb (OB). First we found that i) the estimated PRC of the mitral cells have positive and partially negative regions (type II neurons or resonators); ii) these PRCs possess higher order harmonics, a necessary condition for the formation of more than one oscillator clusters. The PRC-based phase models showed that neurons quickly organized into subsets of synchronized assemblies. The type and pattern of synaptic interactions determined the nature of these assemblies. For excitatory connections neurons divided into three equidistant assemblies were obtained. For inhibitory connections two close assemblies were found. These examples suggest that this simple model can reproduce many features of (transient) synchronization and have led us to begin a more thorough investigation of these phenomena in phase models.

Key words: neural assemblies, phase-resetting curves, phase models, clustering, olfaction