Society for Neuroscience (SfN) 2008, Washington, DC (Nov. 15-19, 2008)

Stochastic response of globus pallidus neurons to randomly timed current injections

Ramana Dodla and Charles J. Wilson
Department of Biology, University of Texas at San Antonio, San Antonio, TX 78249

Globus pallidus (GP) neurons of basal ganglia are inhibitory, receive strong excitatory input from subthalamic nucleus, and are thought to play an important role in motor control disorders including Parkinson's disease. In vitro and in vivo recordings of the GP neurons display spike time variability that is found to persist even after blockade of glutamatergic (excitatory) and GABAergic (slow and fast inhibitory) inputs. The functional significance and the nature of such variability are not yet completely known. We set out to control this output spike time variability in vitro using stochastic current to rat GP neurons and study the emerging dynamic response in relation to the input stimuli under control and total synaptic blockade conditions. We recorded spike times during Poisson timed excitatory alpha function current injections using whole cell and perforated patch clamp methods. We varied the maximal amplitude of the alpha function (Gmax) and the arrival rate of input stimuli. We looked for parallels with the coherence resonance phenomenon that is known to exist in some models and some experiments in which increased levels of noisy input to an excitable membrane can generate a minimum in the coefficient of variation (CV) of inter spike intervals, and thus a maximum of spike time correlations. Slower cells showed a small and local reduction in the CV as the strength of input was increased. This suggests the presence of a coherence phenomenon that could be activated with random synaptic inputs. Faster cells showed stronger rate responses and often didn't show any CV minimum. For higher levels of Gmax, CV always increased for all the cells. These differences are explained by constructing a model that incorporates spontaneous oscillations as well as intrinsic spike time variability. The model responses are studied for random inputs similar to those used in the experiments. Our results seek to apply stochastic response theory of dynamical systems to motor control circuitry of Parkinson's disease.

Supported by NIH/NINDS NS047085

Citation:
R. Dodla and C. J. Wilson. "**Stochastic response of globus pallidus neurons to randomly timed current injections.**" Program No. 43.18. 2008 Neuroscience Meeting Planner. Washington, DC: Society for Neuroscience, 2008. Online.