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Neuroscience 2013

Presentation Abstract

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Presentation Title:	Modulation of spike time variability on the shape and type of phase response curves of oscillating basal ganglia neurons
Location:	Halls B-H
Presentation time:	Tuesday, Nov 12, 2013, 2:00 PM - 3:00 PM
Topic:	++D.15.b. Cellular physiology
Authors:	***R. DODLA**, C. J. WILSON; Biol., Univ. Texas at San Antonio, SAN ANTONIO, TX
Abstract:	Subthalamic and globus pallidus neurons of the basal ganglia exhibit intrinsic oscillations with moderate (in vitro) to high (in vivo) interspike interval variability. The spike response and the variability play central role in the functional behavior of the basal ganglia network in Parkinson's disease. The shape of the phase response curves (PRCs), i.e. the relative magnitude and the phase dependent slope, measured from these neurons can be related to the output spike variability, firing rates, and eventually the incoherent network behavior. The shape parameters also determine the nature of the average input synaptic current and the event times of the synaptic input preceding the spike response. We determined numerically the output responses and the reverse correlations of one-compartment model neurons based on the Hodgkin-Huxley equations and its variations that exhibit both type-1 and type-2 PRCs. We test the regimes of both weak and non-weak synaptic input assumptions. Realistic synaptic time constants and reversal potentials are used to examine the role of the relative magnitudes and decay time constants of excitatory and inhibitory synaptic input on the output variability and the reverse correlations. Type-1 PRC neurons exhibited reduction of firing rate with increasing inhibition. Such reduction is nearly linear when strong excitation is present. In the presence

of weak excitatory input, the drop in the firing rate becomes steep at large inhibitory synaptic conductance. In the regime of linear dependence of the rate on inhibition, the output coefficient of variation (CV) among interspike intervals is quite small, usually below 0.1. But in the regime of sharp decrease in the rate, the CV increases considerably. The skewness, or the relative shift of the PRC maximum advancement toward longer phases, did not cause significant changes in the CV or the rates. The type-2 PRC neurons exhibited similar behavior for long inhibitory time constants. But if the inhibitory input elicited postinhibitory rebound spikes or participates in postinhibitory facilitation, both the firing rate and the CV increased significantly.

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