BMC Neuroscience

Poster presentation

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Exploration of the lamprey pallidal neurons – a combined computational and experimental study

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from Eighteenth Annual Computational Neuroscience Meeting: CNS*2009
Berlin, Germany. 18–23 July 2009

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):P32 doi:10.1186/1471-2202-10-S1-P32

This abstract is available from: http://www.biomedcentral.com/1471-2202/10/S1/P32

Background

The cortex-basal ganglia-thalamic loops are critical for the selection and initiation of motor actions [1]. The output stage of the basal ganglia, Globus Pallidus interna (GPi) and Substantia Nigra reticulata (SNr) in primates, plays an important role by providing tonic inhibition to motor centers in the brain stem and thalamus. GPi/SNr are controlled by input from the striatum, the input stage of the basal ganglia and also by other basal ganglia nuclei, Globus Pallidus externa (GPe) and Subthalamic nucleus (STN). In the present combined experimental and computational study, we investigate the membrane properties and the synaptic control of the neurons in the lamprey basal ganglia output stages. We have combined electrophysiological and immunohistochemical studies to investigate morphology and physiology properties. Using patch clamp techniques, we have recorded spontaneous activity and membrane properties [unpublished data].

Model

We have constructed a model representing lamprey pallidal neuron [2] based on a previously published GPe/STN model neuron [3]. The model was re-implemented in GENESIS and tuned to replicate passive membrane properties of a lamprey pallidal neuron. Dendrites were added based on projection seen in the lamprey. The membrane conductances have been modified to fit the experimental results obtained from the lamprey preparation.

Computational investigation

The GABA synapses are differentially located on the soma-dendritic tree, while the input from STN is more widespread [4]. We have explored the impact of this spatially distributed synaptic input originating from the different nuclei in the basal ganglia and discuss this in relation of what is known of how the input might be activated during physiological situations [5]. Furthermore, we have studied the role of synaptic input for spontaneous activity.

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