Abstract View

VARIABILITY OF POSTSYNAPTIC RESPONSES TO SPIKE-MEDIATED AND GRADED SYNAPTIC INPUT

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In many sensory systems of invertebrates and also vertebrates neurons were found to transmit information via continuous transmitter release that is regulated by their level of depolarization. In principle, such graded synapses can transmit more information in shorter times than spike-mediated synapses. In this model study we analyze how the variability of the postsynaptic responses depends on graded and spike-mediated synaptic transmission and, in particular, the number of synaptic inputs.
Our model of synaptic transmission transforms with a sigmoid transfer function presynaptic signals (graded fluctuations or spikes) into postsynaptic conductance changes. The synaptic inputs are integrated by a one-compartment model and transformed into spike trains with a model of spike generation. The model was adjusted to fit data from fly visual interneurons, responding to stimuli with either graded membrane potential fluctuations or spikes.
The model analysis reveals that the postsynaptic responses and their variability are influenced by many factors including the relative amount of excitation and inhibition, the properties of the neuronal noise and the responses to a stimulus of the individual presynaptic neurons. E.g. for white noise input and balanced excitation and inhibition the postsynaptic responses depend nonlinearly on the number of synaptic inputs, showing maximal postsynaptic variability for a particular number of inputs. In contrast, deterministic changes of the presynaptic activity (like responses of fly neurons to motion stimuli) induce the stronger postsynaptic responses the more input synapses are activated.
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