Abstract:
Cochlear Nucleus (CN) is the first station in the central nervous system where processing of auditory signals takes place. It consists of several neuron types that receive direct inputs from auditory nerve fibers (ANFs) and show various firing properties. The goal of this study is to develop a model of Globular Bushy Cells (GBC) that are one of the principle cell types in CN. They fire action potentials with high temporal precision and with good entrainment for low-frequency pure tone stimuli. We examine how those firing properties are influenced by introducing depression into synapses that has been reported in many in-vitro studies (e.g. Yang and Xu-Friedman 2009). We compare results with a model without synaptic depression as observed in-vivo (Borst 2010). Our model of GBCs is a point neuron with Hodgkin-Huxley type ion channels (HPAC, Kht, Klt) described previously by Rothman and Manis (2003). It receives several excitatory inputs from an inner ear model simulating responses of ANFs. ANF activity drives endbulb of Held synapses located directly on the GBC soma. Short-term depression is modeled phenomenologically using an extended exponential recovery model from Tsodyks and Markram (1997). Simulations show that for both synaptic models synchronization improved (SI > 0.9) at low stimulation frequencies compared to synchronization of ANFs. However, high entrainment levels were achieved only by the model without synaptic depression. This model was also able to reproduce experimental results obtained from pure tone stimulations: PSTH, ISIH and receptive field maps. We conclude that the model of GBC with converging ANF excitatory inputs captures basic properties of those cells. Additionally, the results suggest that depression in-vivo
is much lower than in-vitro. In the future, the model will allow us to study the response of GBCs to complex natural stimuli like speech. Supported by the BMBF within the Bernstein Center for Computational Neuroscience, Munich (01GQ0441 and 01GQ1004B).

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