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A computational model of neurons in the Thalamic Reticular Nucleus

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ABSTRACT

The thalamic reticular nucleus (TRN), a shell of GABAergic neurons that surrounds the dorsal thalamus, generates and sustains rhythmic oscillations called sleep spindles. Recent evidence has shown that TRN neurons are connected by chemical synapses and gap junctions. Moreover, the primary chemical synapses in TRN modulated by GABAa receptors, have recently been shown to be excitatory instead of inhibitory, as previously suggested. In order to understand how TRN neurons generate and sustain sleep spindles, we develop a Hodgkin-Huxley based computational model of a TRN neuron with the currents and parameters supported by recent experimental data. The resulting computational model of a single TRN neuron demonstrates bistable behavior. We also introduce the large T-window current model and the small T-window current model as a means of reflecting the known heterogeneity of TRN neurons. To understand the network properties of TRN, we connect two model neurons with excitatory GABAa , inhibitory GABAb synapses, and gap junctions. The computational model of excitatory GABAa synapses and gap junction are consistent with experimental results. We also explore computational models of GABAb synapses in TRN neuron. Both computational simulations and experimental results indicate that TRN requires input from the thalamocortical circuit to generate oscillations.