A Biophysical Model of Graded Persistent Activity in a Single Neuron

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Abstract:

Neurons in various brain regions demonstrate graded persistent activity. This phenomenon may involve single neurons, as suggested by a recent electrophysiological study of entorhinal cortical neurons that exhibited graded persistent activity after blocking all synaptic transmissions. This activity appears to depend on a particular calcium-dependent non-specific cationic channel. Single neuron models of persistent activity have been studied by modeling calcium wavefronts[1] or by hysteresis in the cationic current activation[2]. We propose a Hodgkin-Huxley type model, based on high-threshold calcium channels and calcium-dependent non-specific cationic channels, that exhibits sustained firing activity controllable by transient external input. Figure 1 shows the response of the model to depolarizing and hyperpolarizing external current pulses of various magnitudes. The dynamics of influx and decay of intracellular calcium allow its concentration to act as a short-term memory that integrates the external input.

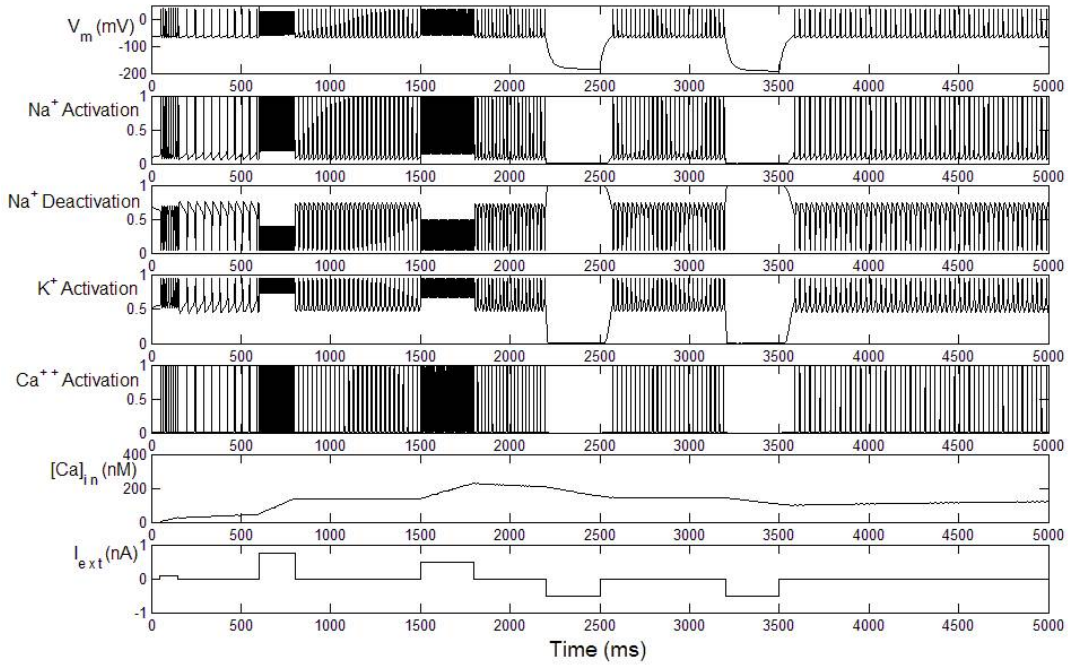

Figure 1: Graded persistent activity in a single neuron

References:

1. Y Loewenstein, H. Sompolinsky. Temporal integration by calcium dynamics in a model neuron. *Nat. Neurosci.* **6(9)**: 961-967.

2. E.A. Fransen, A.V. Egorov, M.E. Hasselmo, A.A. Alonso. Model of graded persistent activity in entorhinal cortex neurons. Program No. 557.6. *2003 Abstract Viewer/Itinerary Planner*. Washington, DC: Society for Neuroscience, 2003. Online.