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How slow K^+ currents impact on spike generation mechanism?

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Neuronal adaptation is the change in the responsiveness of a neuron over time, and may improve coding information from an environment. Adaptation originates from various factors, including single neurons, synapses, and network dynamics. Here we investigate adaptation in a responsiveness of a neuron. When a neuron received prolonged stimulation, it initially responds with a high firing rate, and the firing rate decrease. This is called spike-frequency adaptation, which is observed in most pyramidal neurons in various animals. Spike-frequency adaptation is usually accounted for by slow K^+ currents, for example, the M-type K^+ current (I_M) and the Ca^{2+}-activated K^+ current (I_{AHP}), and the conductance-based (Hodgkin–Huxley type) models including the slow K^+ currents have succeeded to reproduce the electro-physiological properties of a neuron [1].

The detailed biophysical mechanism underlying spike-frequency adaptation may impact on the coding property of a neuron [2,3]. For example, it was suggested that I_M facilitates the spike-timing coding, whereas I_{AHP} improves the spike rate-coding [2] and I_M increases the response to low-frequency input signals, whereas I_{AHP} decreases the response to low-frequency signals [3].

Due to the complexity of the conductance-based models, it is not clear how the slow K^+ currents impact on spike generation mechanism, more specifically, how the parameters of the slow K^+ currents regulate spike generation. For understanding the impact of slow K^+ currents, we have developed a framework to reduce a detailed conductance-based model with slow K^+ currents to an adaptive threshold model [4]. We have deduced a formula that links the slow K^+ parameters to the parameters of the reduced model. The formula was validated with the simulation of the detailed model. This formula clarifies how I_M and I_{AHP} impact on spike generation mechanism differently and the parameters of I_M and I_{AHP} influence spike generation.

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References

1. Koch C: *Biophysics of Computation Oxford, Oxford University Press* 1999.
2. Prescott SA, Sejnowski TJ: **Spike-rate coding and spike-time coding are affected oppositely by different adaptation mechanisms.** *J Neurosci* 2008, **28**:13649-13661.
3. Deemyad T, Kroeger J, Chacron MJ: **Sub- and suprathreshold adaptation currents have opposite effects on frequency tuning.** *J Physiol* 2012, **590**:4839-4858.
4. Kobayashi R, Tsubo Y, Shinomoto S: **Made-to-order spiking neuron model equipped with a multi-timescale adaptive threshold.** *Front Comput Neurosci* 2009, **3**:9.

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