Unique effects of Channel Noise in a conductance-based model of slow wave parabolic bursting.

Marilyn Gatica, Universidad de Santiago de Chile, Santiago.
Jean Paul Maidana, Centro Interdisciplinario de Neurociencia de Valparaíso, Valparaíso.
Mauricio Caviedes, Centro Interdisciplinario de Neurociencia de Valparaíso, Valparaíso.
Patricio Orio, Centro Interdisciplinario de Neurociencia de Valparaíso and Instituto de Neurociencia, Universidad de Valparaíso, Valparaíso, Chile.
patricio.orio@uv.cl

One important source of variability and randomness in neurons is the stochastic opening and closing of ion channels. This stochastic behavior takes the form of a multiplicative noise in the open fractions of channels. However, noise in neural models is commonly introduced as an additive noise term in the equation of the membrane current. AIM: We study whether channel noise can introduce some unique features in neural dynamics that are not reproducible by additive current noise. In order to do this, we are comparing the behavior of a model of temperature-dependent slow wave oscillation [1] under the two types of noise. Specifically, we focus on the stochastic contribution of slow ion channels that commonly produce subthreshold oscillations, resonance and bursts of action potentials. METHODS: We run numerical simulations of the model with different values of the parameters that control the density of the slow conductances, and quantify the appearance of slow oscillations, bursting, and spontaneous firing. SDEs were solved using a strong Taylor scheme of order 1.5. RESULTS: Both types of noise induce subthreshold oscillations and/or bursting under parameter values that do not produce such behaviors in the deterministic situation. However, oscillations are induced by channel noise at more parameter combinations than current noise. Also, the frequency of the oscillations induced by channel noise is more uniform and less dependent on the parameters. Bursting behavior is also observed in a wider parameter range when induced by channel noise. CONCLUSION: Introducing noise in a neural model with a simple additive current noise can skip important dynamical features introduced by channel noise. Ongoing work is focused on the chaotic behavior of a similar model [2] and the existence of unstable periodic orbits.
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