Canadian Neuroscience Meeting, CAN 2017

A novel computational model of the spiking dynamics of a subfornical organ neuron

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The subfornical organ (SFO) plays an important role in sensing blood-borne signals regarding important autonomic functions from the periphery and projecting them across the blood-brain barrier (BBB). Previous findings from in vitro studies have established that SFO neurons exhibit an immense heterogeneity in their spiking behaviour, expression of ionic currents, and responses to peptidergic signals, but the detailed mechanisms underlying these differences are less understood due to the limitations of patch-clamp techniques. Here we present a novel computational model of a subfornical organ neuron as an approach to understanding the mechanisms behind this heterogeneity. Precise current-voltage properties of our Izhikevich-style model suggests that a combination of membrane noise and subthreshold oscillations are responsible for the irregular bistability that is characteristic of SFO neurons. Reproducibility of SFO-specific spiking patterns was established through statistical analysis of spike-train variability (CV) in both the model's simulations and in vitro recordings of SFO neurons. This technique allows us to classify individual neurons as exhibiting one of two prominent behaviours seen in SFO neurons, either bursting (CV > 1) or tonic (CV < 1) firing. This model has future application in exploring the ionic mechanisms underlying the various SFO spiking profiles as well as predicting the behaviour of these neurons in response to various peptidergic signals.