

Poster presentation

Converting a globus pallidus neuron model from 585 to 6 compartments using an evolutionary algorithm

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Background

Biologically realistic neuron models are useful tools for understanding the behavior and mechanisms of neurons, but they are computationally expensive due to their fine granularity. This makes them unattractive for use in network simulations and generally leads to their replacement by simpler "integrate and fire" or black box models which are computationally cheaper, but further removed from biology. An attractive alternative is to replace a biologically realistic model with a 'reduced' version containing fewer compartments. This reduced model should largely preserve biological realism while limiting complexity and computational cost.

Methods and results

We present a 6 compartment 'reduced' model which preserves the electrotonic surface area distribution of a morphologically realistic 585 compartment globus pallidus

'full' model previously developed in the Jaeger Lab. Using an evolutionary algorithm, we searched the parameter space of the reduced model for values of R_m , R_a , and C_m which yield close matches to the passive properties of the full model. The passive fitness function is based on varying levels of current injection, at different locations, with different frequencies. Once our search was complete, we chose the values of R_m , R_a , and C_m that yield the best match with the passive properties of the full model. To match the active properties of the full model, we used an evolutionary algorithm to search the parameter space consisting of the various conductances shown in Table 1, along with their relative somatic and dendritic distributions. Our fitness function compares the FI curve, response to dendritic current injection, and various measures of spike shape. We tested approximately 120,000 different parameter sets, and the best (of many good fits) is shown in Table 1 and Figure 1. The fit between the full

Table 1: Parameter sets which yield good matches to the full model.

Param Set	NaF	NaP	Kv2	Kv3	Kv4	KCNQ	SK	Ca_HVA	IH
Full Model	350	1.015	1	11.25	20	2	4	0.3	0.2
Reduced Model	303.49	1.26	1.92	8.48	27.13	2.38	2.79	0.91	0.33

Units of conductance are in S/m². {NaF, NaP} fast, persistent sodium; {Kv2, Kv3, Kv4, KCNQ} voltage gated K⁺ channel families; {SK} calcium-activated K⁺; {Ca_HVA} L-Type calcium; {IH} hyperpolarization activated current

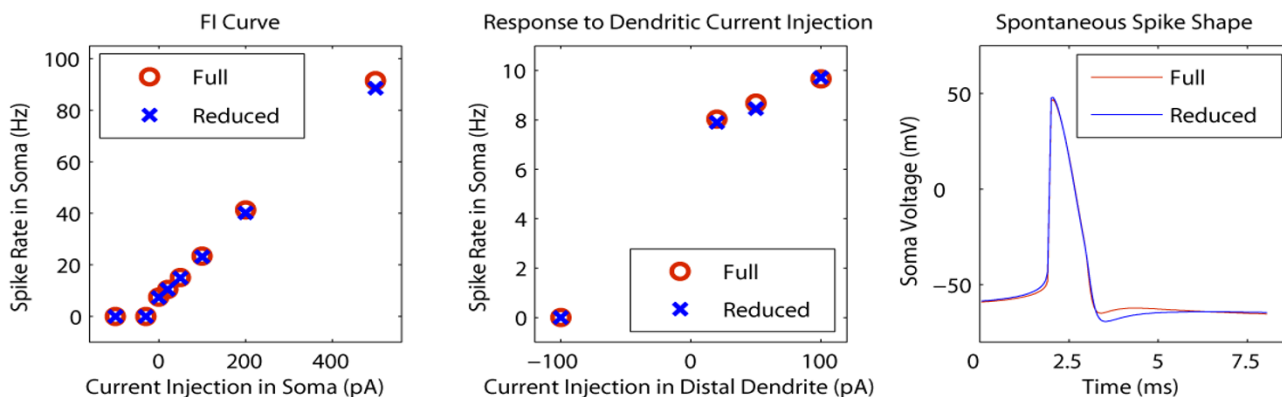


Figure 1
Fit results. Full is the output trace from the full model, and Reduced is the output trace from the reduced model.

and reduced models is extremely good for the measures tested, with the exception of the afterhyperpolarization; we suggest that this may be due to differences in axial resistance. Further characterization of the parameter space is in progress.

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