Virtual NEURON: a Strategy for Merged Biochemical and Electrophysiological Modeling

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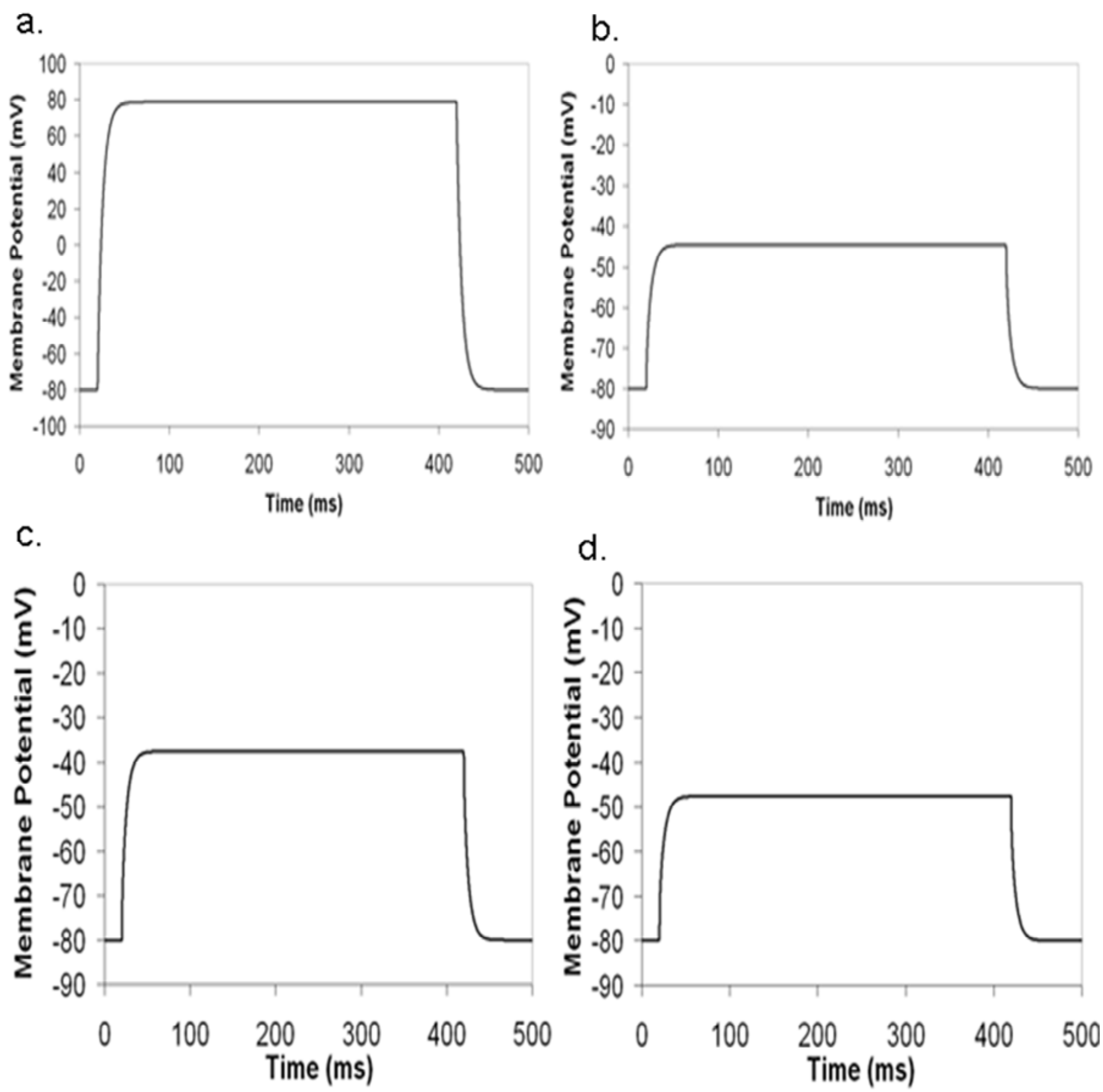
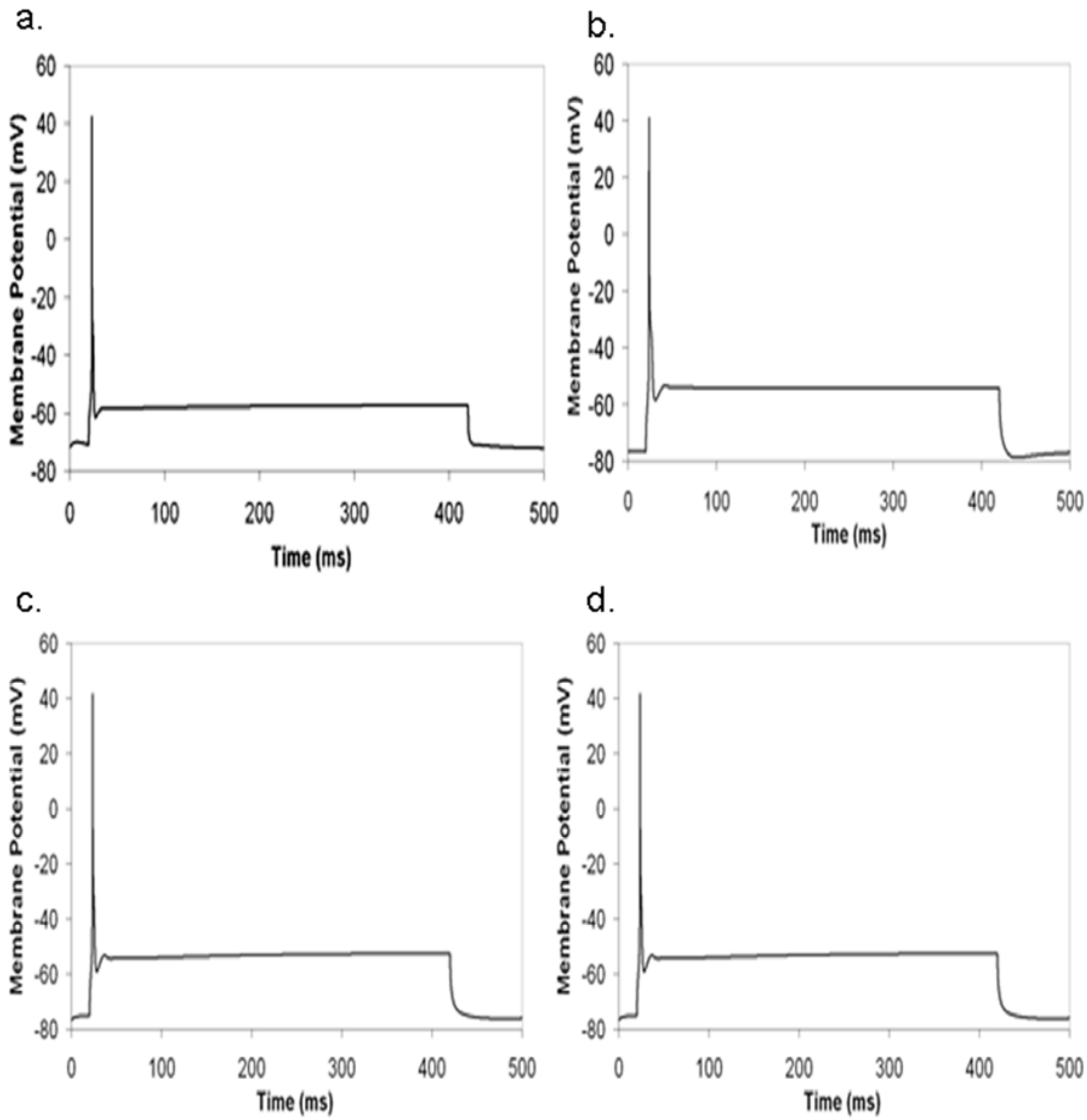
Figure S1



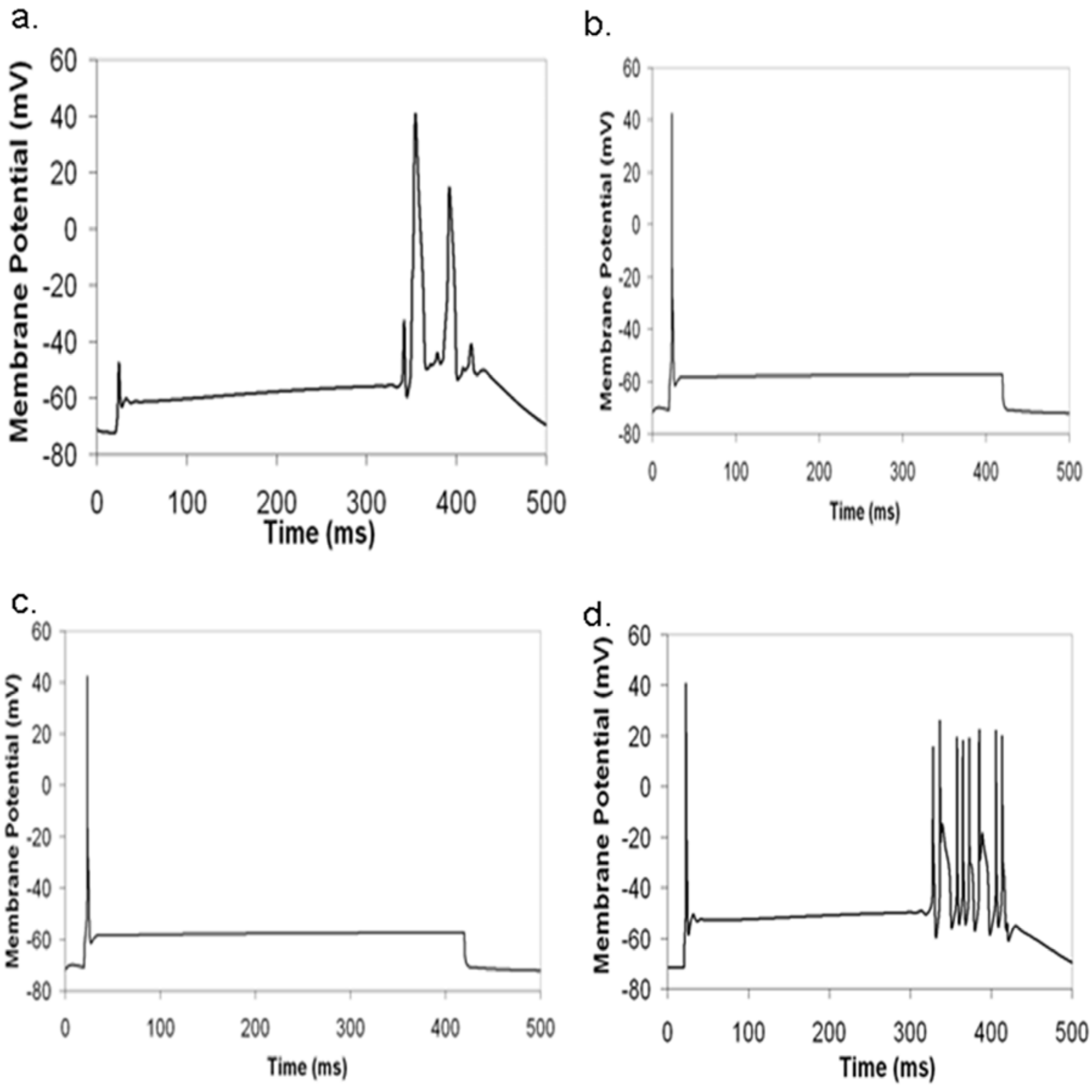
Supplemental Fig. S1 Passive electrical properties of various reduced models. *a, unscaled reduced model 1. b, reduced model scaled by 5.7. c, Bush-inspired model. d, reduced model scaled by 10.* In each case, membrane potential is measured at the soma. IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S2



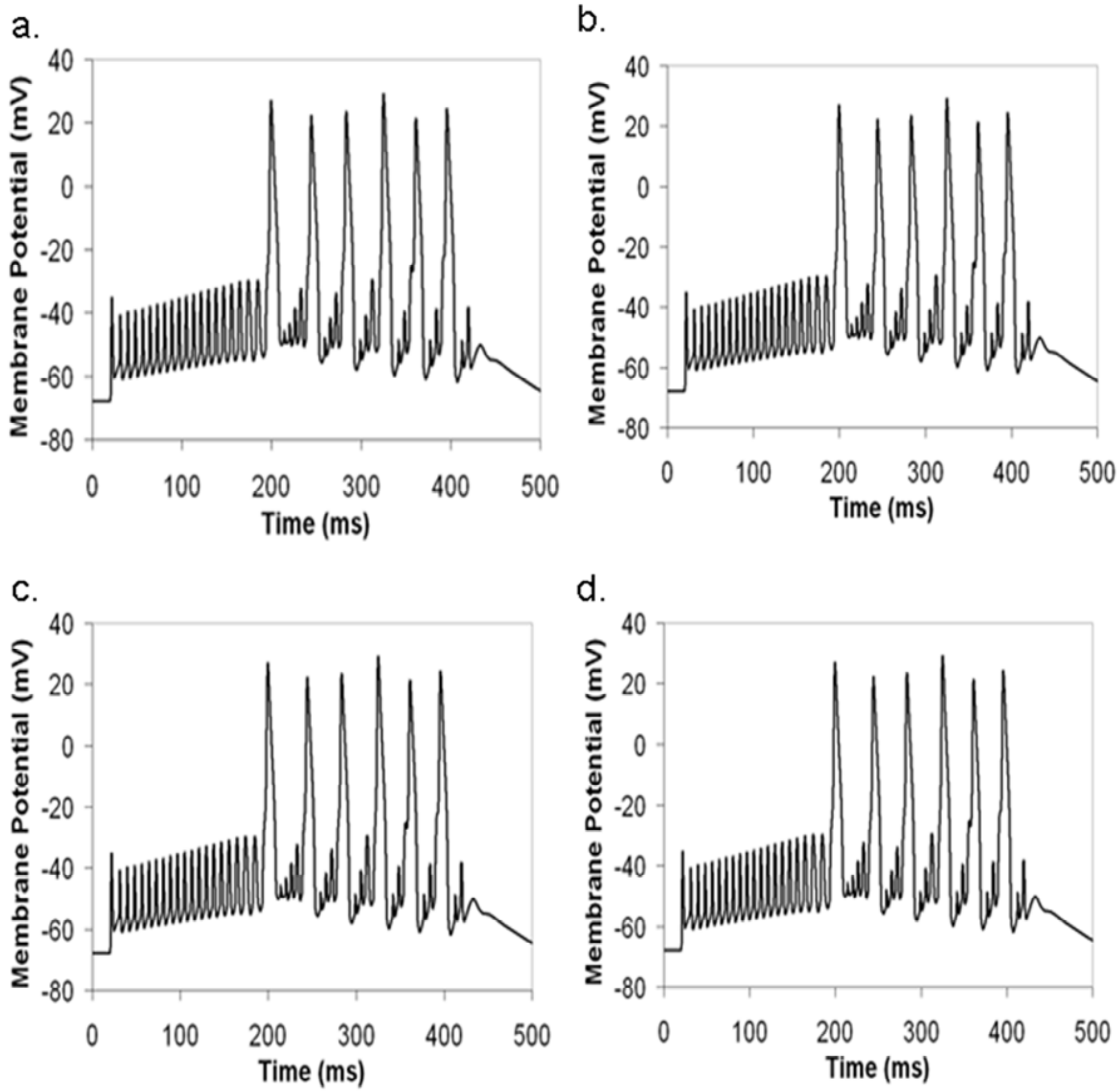
Supplemental Fig. S2 Electrical properties of various reduced models with a depolarizing current injection at the soma. a, the Bush-inspired model with active channels in the soma only, measured at the soma. *b*, the Bush-inspired model with unscaled active channels localized to the soma, dendrites, and spine, measured at the soma. *c*, the Bush-inspired model with channels scaled in the equivalent cylinders and unscaled channels in the soma, spine, and dendrites of the explicit path. *d*, the reduced model scaled by 10 with unscaled channels in the soma, spine, and dendrites. In each case, membrane potential is measured at the soma. IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S3



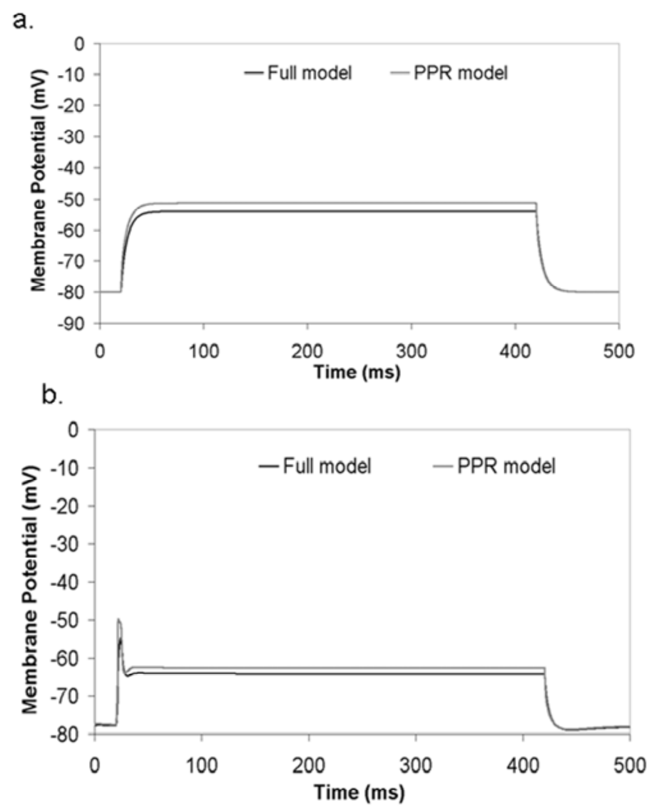
Supplemental Fig. S3 Electrical properties of the PPR model and the Bush-inspired model. *a*, In the PPR model, a depolarizing current injection at the soma gives an action potential followed by a plateau, then followed by membrane potential oscillations, when calcium influx in the equivalent cylinders is not adjusted by the scaling factor. *b*, Corresponding membrane response at the spine in the PPR model. *c*, In the Bush-inspired model with channels scaled only in the equivalent cylinders, a depolarizing current injection at the soma gives a single action potential, then a plateau, then a few action potential oscillations with calcium spike-induced plateaus at the soma. *d*, Corresponding calcium spikes at the spine in the Bush-inspired model with channels scaled only in the equivalent cylinders. IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S4



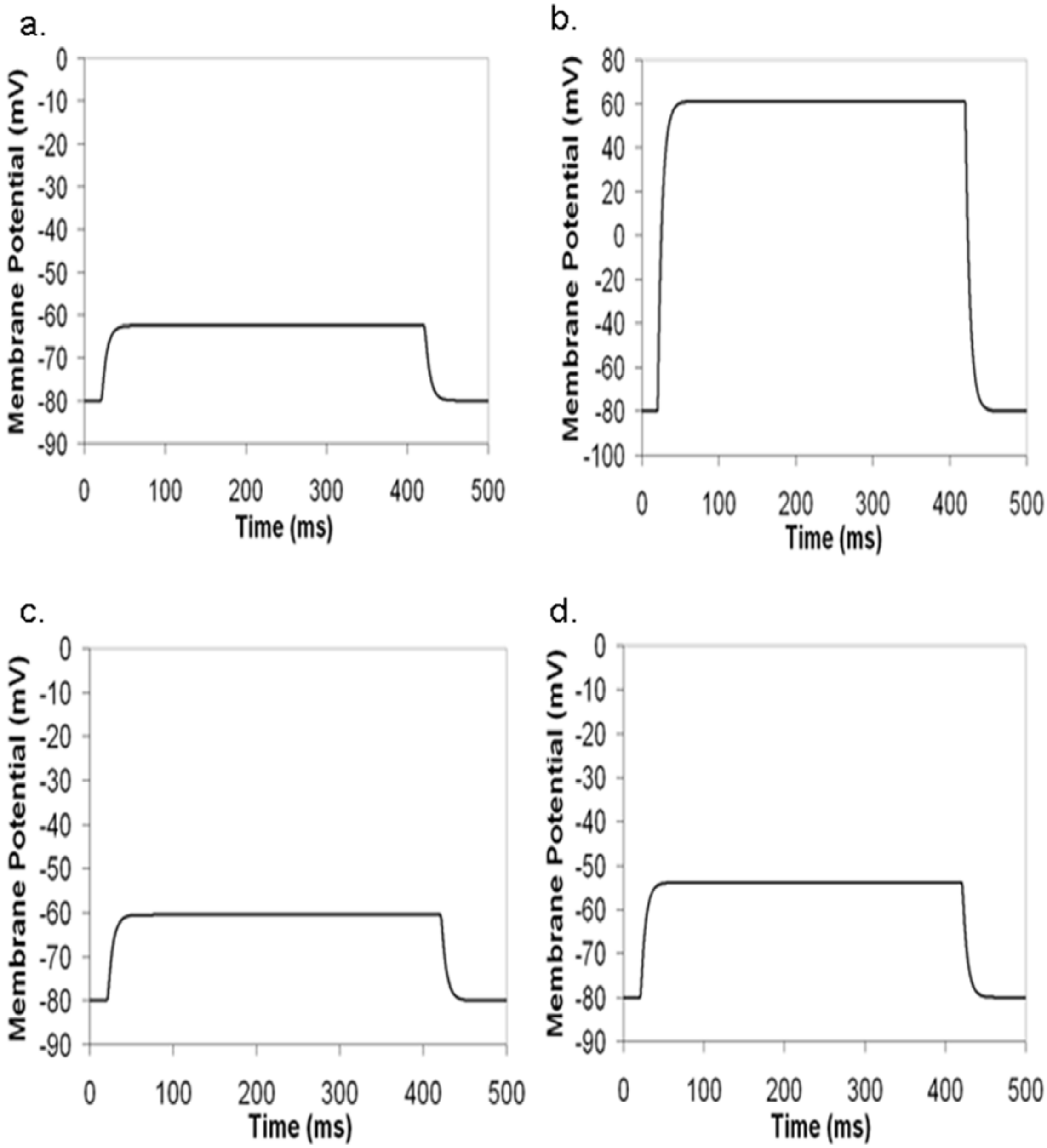
Supplemental Fig. S4 Membrane potential oscillations measured at various locations. Membrane response in the PPR model in NEURON, measured in the compartments maindendrite (*a*), smoothdistaldendriteshort (*b*), adjacentdendrite (*c*), and spine (*d*). IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S5



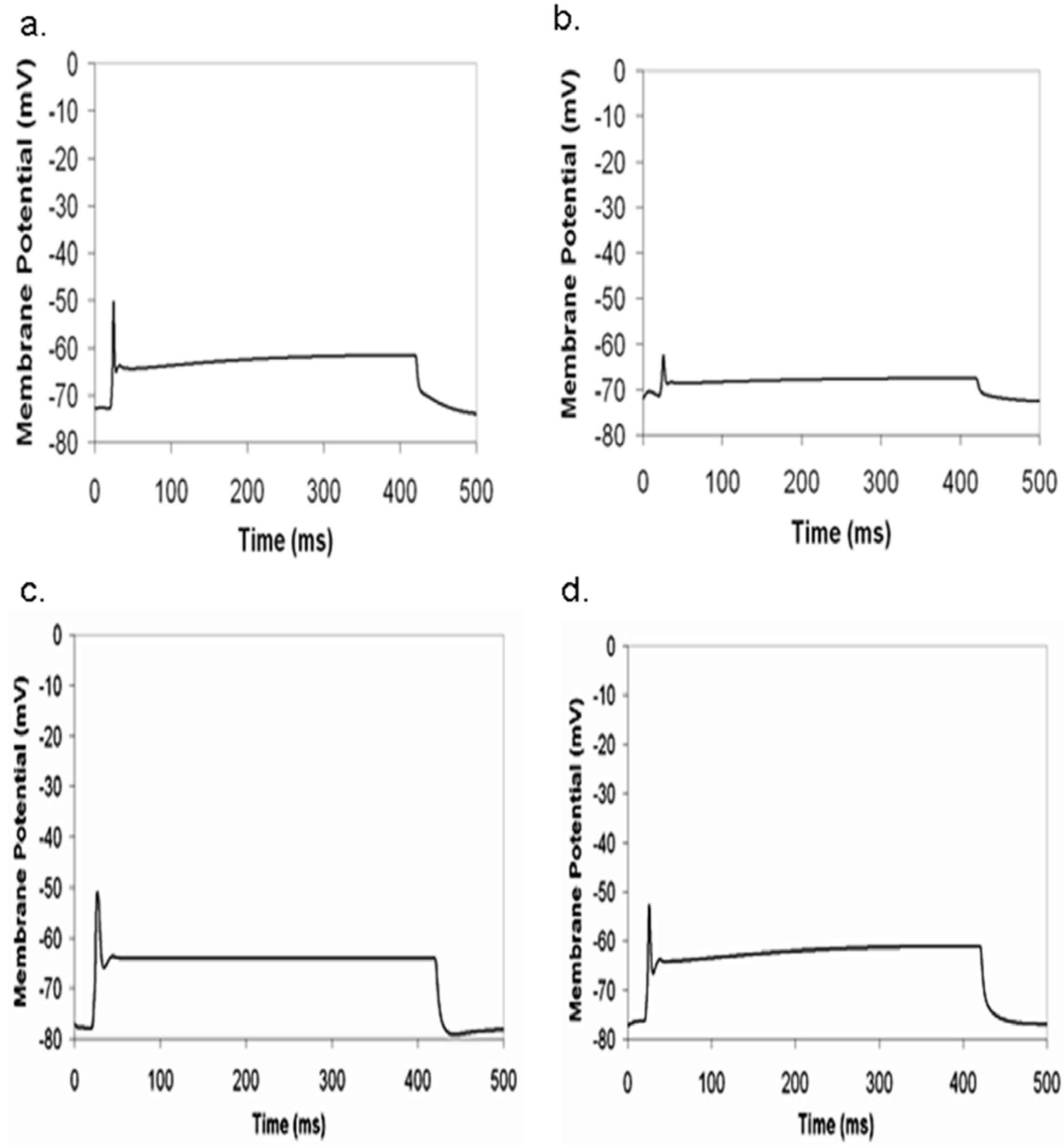
Supplemental Fig. S5 Membrane potential changes at the spine in the PPR and full models in NEURON. *a*, Passive electrical properties of the full and PPR models. *b*, Electrical properties of the full and PPR models with active channels only in the soma. IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S6



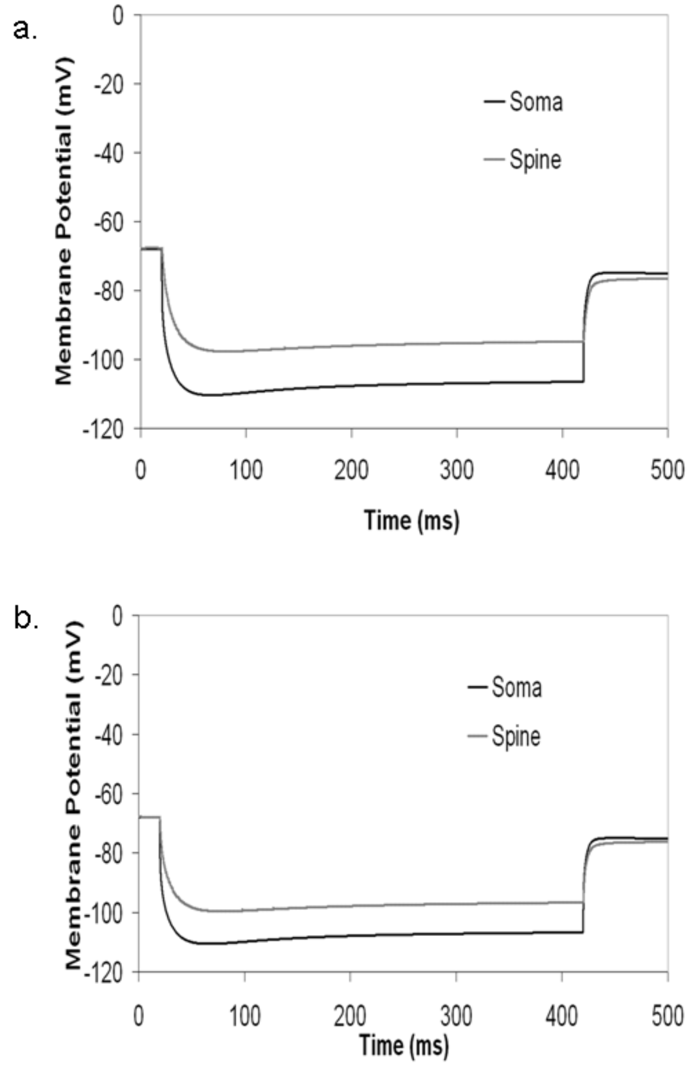
Supplemental Fig. S6 Passive electrical properties measured at the spine in various reduced models in NEURON. Membrane potential response due to depolarizing current injection at the soma in the unscaled reduced model (a), reduced model scaled by 5.7 (b), Bush-inspired model (c), reduced model scaled by 10 (d). IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S7



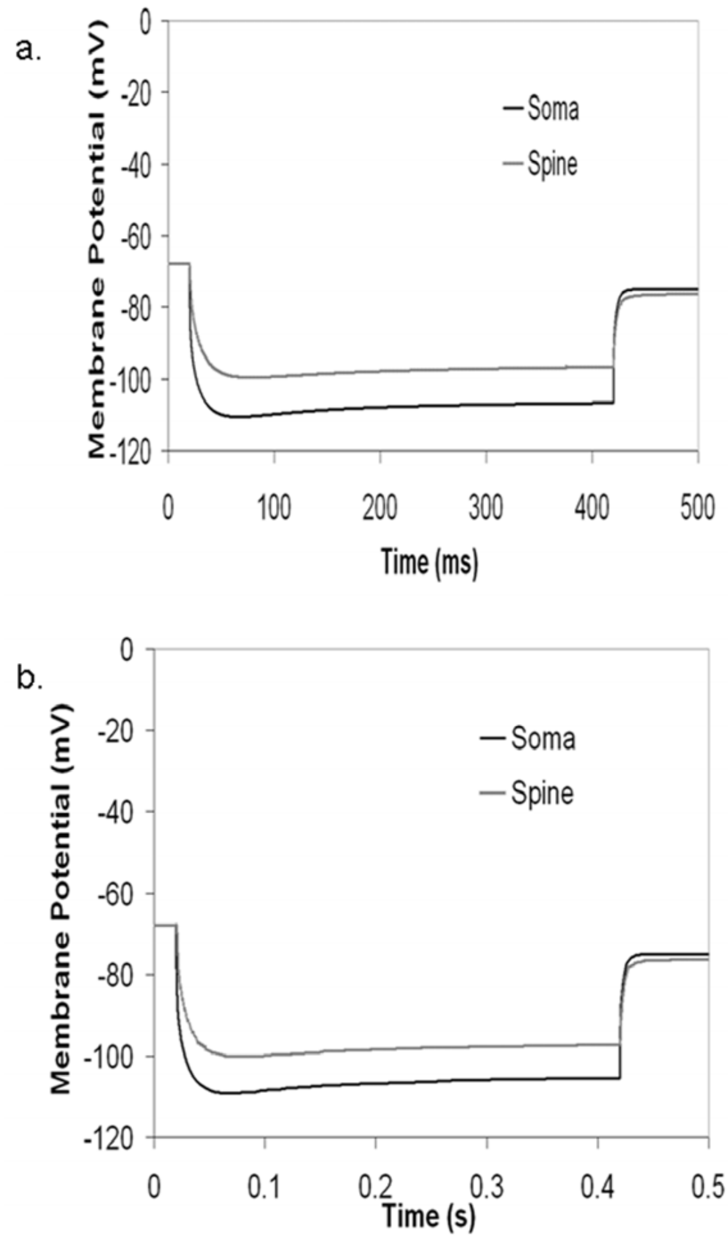
Supplemental Fig. S7 Active properties measured at the spine in various reduced models in NEURON. Membrane response in Bush-inspired model with active channels only in the soma (a). Membrane potential response with active channels in the soma, dendrites, and spine in the (b) Bush-inspired model with channels unscaled everywhere, (c) Bush-inspired model with channels scaled in equivalent cylinders, (d) reduced model scaled by 10. IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (Miyasho et al., 2001).

Figure S8



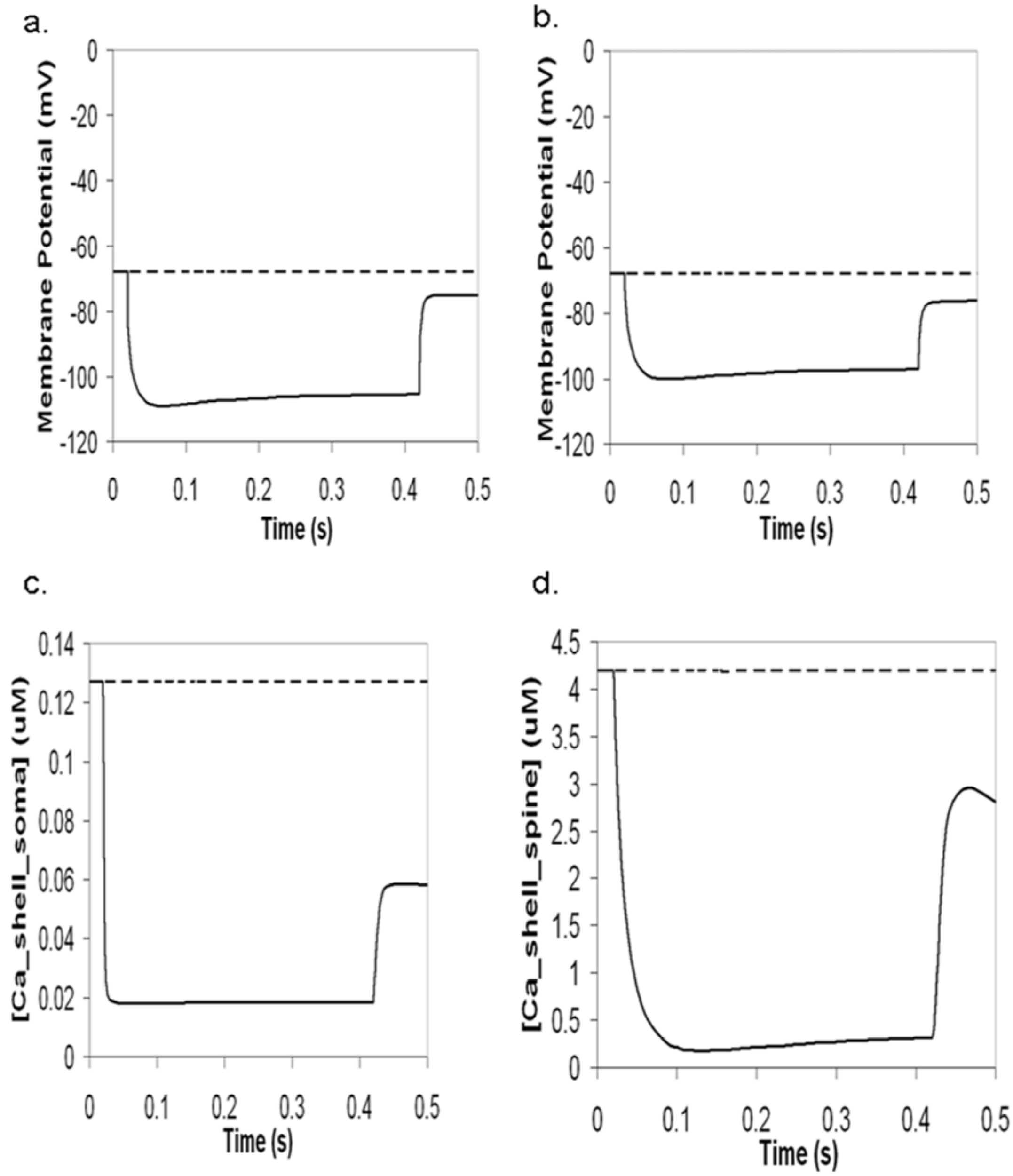
Supplemental Fig. S8 Membrane hyperpolarization in the full and PPR models in NEURON. *a*, Membrane response at the spine and at the soma due to a hyperpolaring current injection at the soma in the full model. *b*, Membrane potential response at the spine and at the soma in the PPR model. IClamp at the soma: onset 20ms, duration 400ms, amplitude -2nA.

Figure S9



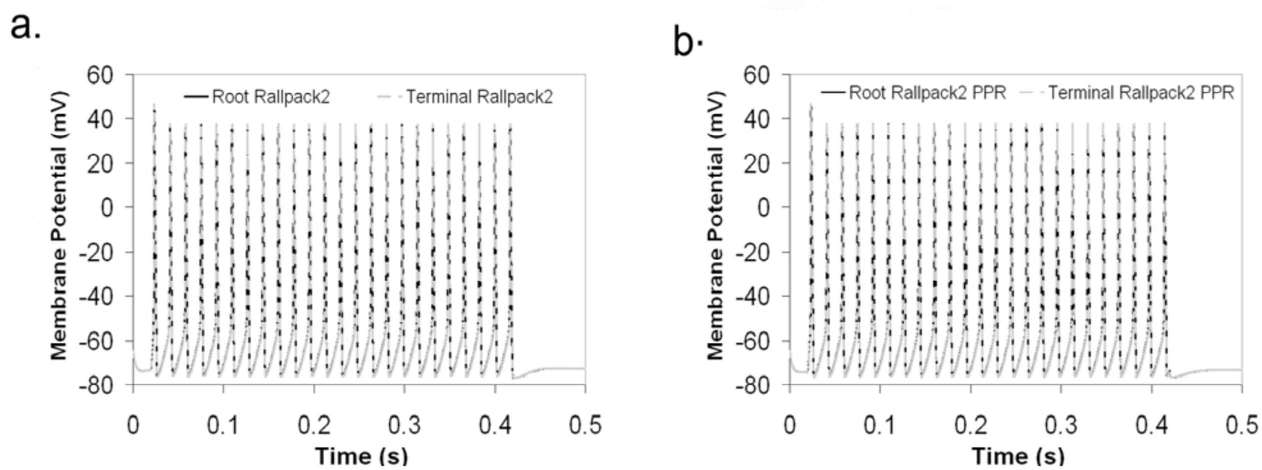
Supplemental Fig. S9 PPR model results compared in Virtual Cell and NEURON. *a*, Membrane potential depression due to hyperpolarizing current injection at the soma in Virtual Cell and NEURON. *b*, Membrane potential response at the spine due to hyperpolarizing current injection in NEURON and Virtual Cell. IClamp at the soma: onset 20ms, duration 400ms, amplitude -2nA.

Figure S10

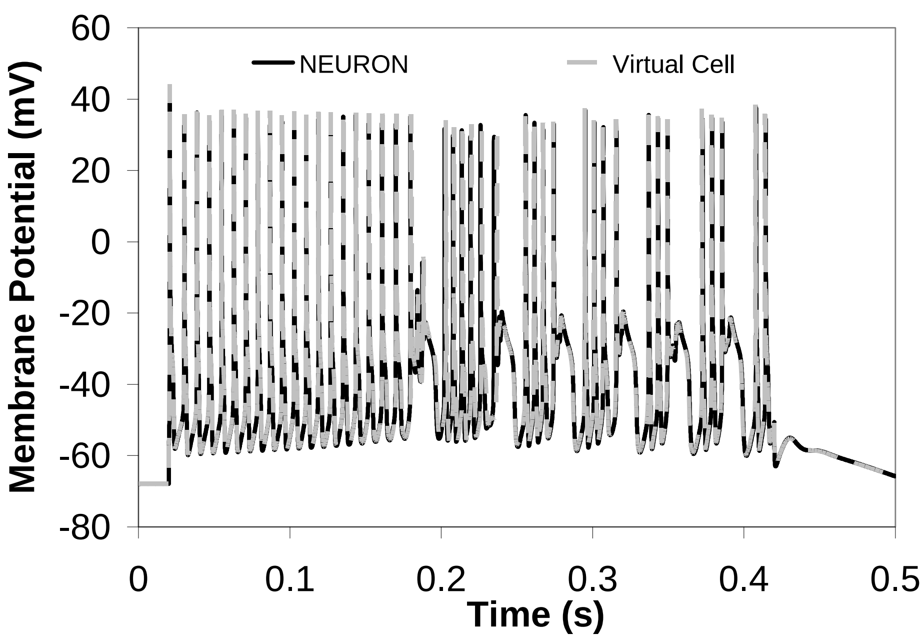


Supplemental Fig. S10 Membrane potential and submembrane calcium responses at the spine and soma in Virtual Cell. Membrane response at the soma (*a*) and the at the spine (*b*), due to sustained hyperpolarizing current injection at the soma. Submembrane calcium transients at the soma (*a*) and at the spine (*b*), due to a hyperpolarizing current injection at the soma. The hyperpolarizing current injection is the same as in Supplemental Fig. S8. In each case, the dashed line represents the membrane potential with no current injection. IClamp at the soma: onset 20ms, duration 400ms, amplitude -2nA.

Figure S11



Supplemental Fig. S11 The PPR method generalized using Rallpack. Active membrane potential changes at the root and terminal compartments in the full (*a*) and reduced (*b*) Rallpack 2 geometry coded in this study, with Hodgkin-Huxley sodium and potassium channels. Rallpack descriptions are available in the report by Bhalla et al (Bhalla et al., 1992).



Supplemental Fig. S12 Superposition of PPR Purkinje model results in Virtual Cell and NEURON. Membrane potential oscillations due to current injection at the soma in NEURON (*black lines*) and Virtual Cell (*grey dashed lines*). IClamp at the soma: onset 20ms, duration 400ms, amplitude 2nA, as in Miyasho et al, (11).