Presentation Abstract

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Title: How pyramidal neurons switch from integrators in vitro to resonators under in vivo-like conditions
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Abstract: Pyramidal neurons in the intact brain are bombarded by synaptic inputs that cause tonic depolarization, shunting, and noisy fluctuations in membrane potential; by comparison, pyramidal neurons in acute slices experience little background input. Such differences in operating conditions can compromise extrapolation of in vitro data to explain neuronal operation in vivo. For instance, pyramidal neurons have been identified as integrators (i.e. class 1 neurons according to Hodgkin’s classification of intrinsic excitability) based on in vitro experiments, but that classification is inconsistent with the ability of hippocampal pyramidal cells to resonate at theta frequency; intrinsic resonance is characteristic of class 2 neurons. Using long depolarizing stimuli and dynamic clamp to reproduce in vivo-like conditions in slice experiments, we show that CA1 hippocampal pyramidal cells switch from integrators to resonators, i.e. from class 1 to class 2 excitability. That switch is fully explained by the increased outward current contributed by shunting and/or adaptation, which shifts the balance of inward and outward currents active at perithreshold potentials and thereby converts the spike initiating mechanism as predicted from dynamical analysis of our modified Morris-Lecar model. Our conclusions were validated by multiple comparisons between simulation and experimental data. Thus, even so-called “intrinsic” properties may differ qualitatively between in vivo and in vitro conditions.

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