Active dendrites generate and transmit theta oscillations in model neurons.

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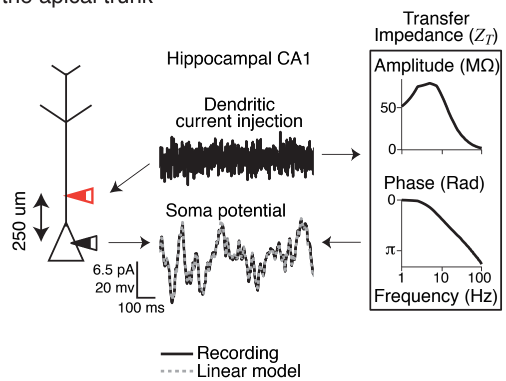
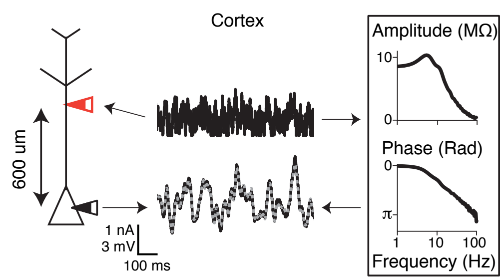
Dendrites connect the different parts of a neuron and carry signals between them. The electrical response of dendrites determines what kinds of information are carried from one part of a cell to another. We used linear systems analysis to characterize the way dendrites respond to current injection.

1) Experimental Basis

Experiments show that a linear model accounts for the somatic response to a noisy current injection in the apical trunk

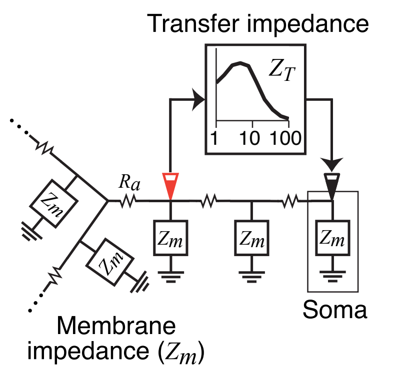


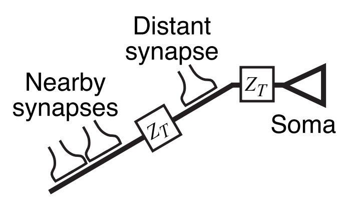


Cortical data from Matthew Larkum

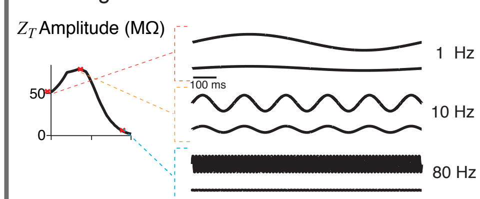
2) Model Structure

The model consists of cylindrical compartments with a linear surface impedance (Zm)





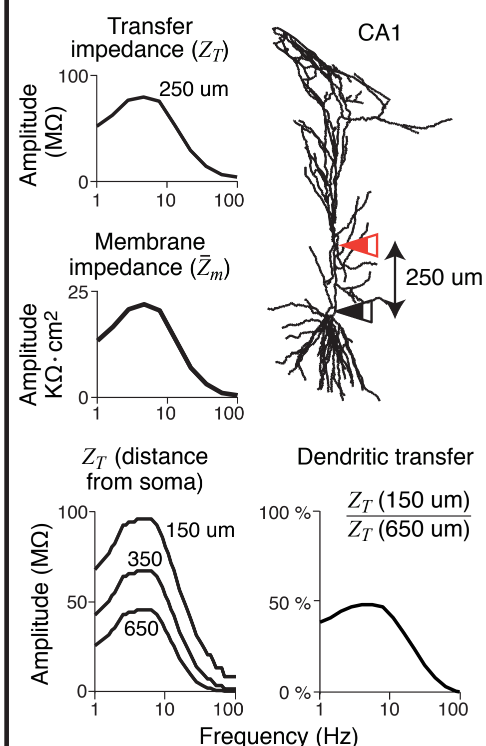
The resonant peak indicates that theta oscillations are transmitted more effectively than other signals



3) Model Results

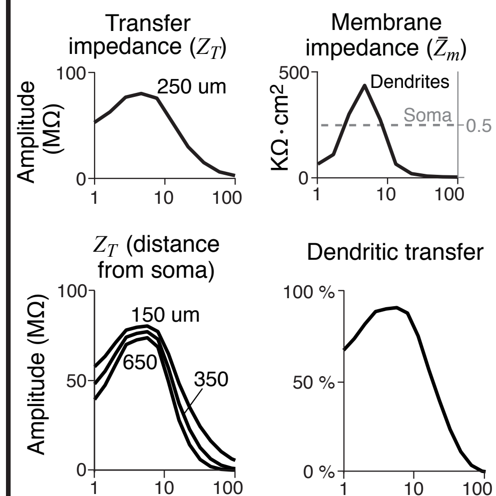
The full compartmental model perfectly reproduced the 2-port results. However, the model is compatible with many impedance profiles. We show two, which support different predictions about the transmission of theta oscillations.

Uniform Membrane Profile



High Resonance Profile

With a large conductance in the soma, the model predicts very little attenuation in dendrites



The resulting model is accurate and computationally efficient. Both impedance support the notion that dendritic membrane plays a role in generating and transmitting theta oscillations.