

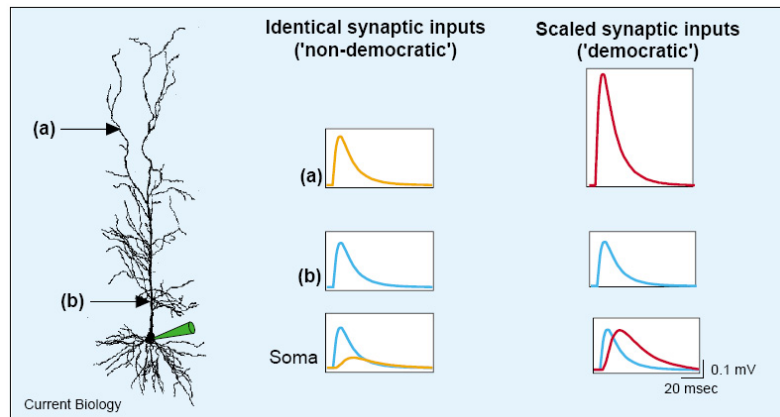
Dendritic democracy: the role of resonant currents

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Neurons receive synaptic inputs primarily onto their dendrites, which filter synaptic potentials as they spread toward the soma. There is experimental evidence that synaptic efficacy increases as a function of distance from the soma. This is most likely due to increases in receptor density and/or vesicle release probability. Distance dependent synaptic scaling is



just one of several mechanisms for achieving so-called “dendritic democracy” whereby the spatially extended single neuron can compensate for dendritic attenuation. Other mechanisms for boosting somatic response to distal inputs include sub-threshold resonance (via active currents such as I_h), local dendritic spikelets, and global dendritic spikes (see [1] for a comprehensive review). Although well studied experimentally, to date this phenomenon has not been thoroughly explored from a theoretical perspective. Recently we analysed a number of key measures of democracy using a passive model of a dendritic tree with distributed excitatory synaptic conductances [2]. In particular, for each measure of democratisation we produced and contrasted the synaptic scaling associated with treating the synapse as either a conductance change (i.e. a shunting current injection) or a direct current injection.

The main goal of this project is to investigate dendritic democracy in the presence of resonant currents in dendrites using techniques developed in [3]. As a starting point an infinite uniform resonant cable model will be considered and the synaptic scaling laws will be developed for equalising somatic responses. The focus will be on measures of equalising the maximal depolarisation at the soma (equalising voltage peak and its time-to-peak). A formalism developed for a simplified cable model will also be extended to more realistic branching structures of dendrites. A mixture of theoretical and numerical analysis will be used during this project. A comparison of the results that will be obtained in this study with the results found in a passive dendritic model will add to our understanding of the role of resonant currents in dendritic computation and will be of interest to both theoreticians and experimentalists.

The area of dendritic research offers the potential of future PhD work. I will be happy to discuss.

Relevant publications:

1. Michael Häusser (2001) Synaptic function: Dendritic democracy, *Current Biology*, Vol 11, R10–R12.
2. Y Timofeeva, S J Cox, S Coombes, K Josic (2008) Democratization in a passive dendritic tree: an analytical investigation, *Journal of Computational Neuroscience*, Vol 25, 228–244.
3. S Coombes, Y Timofeeva, C-M Svensson, G J Lord, K Josic, S J Cox, C M Colbert (2007) Branching dendrites with resonant membrane: a “sum-over-trips” approach, *Biological Cybernetics*, Vol 97, 137–149.