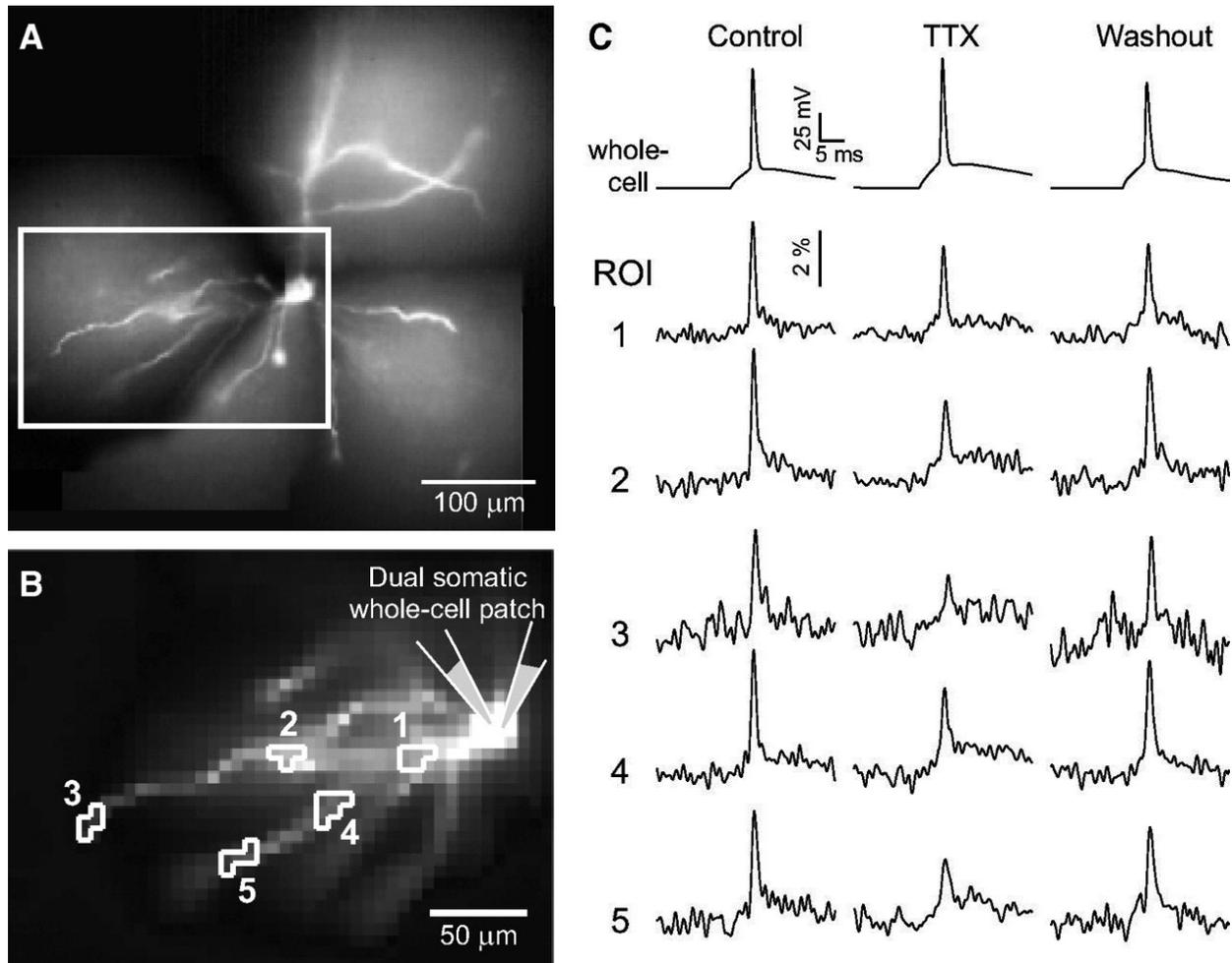


## Voltage-gated Na channels in Basal dendrites of Cortical Pyramidal Neurons

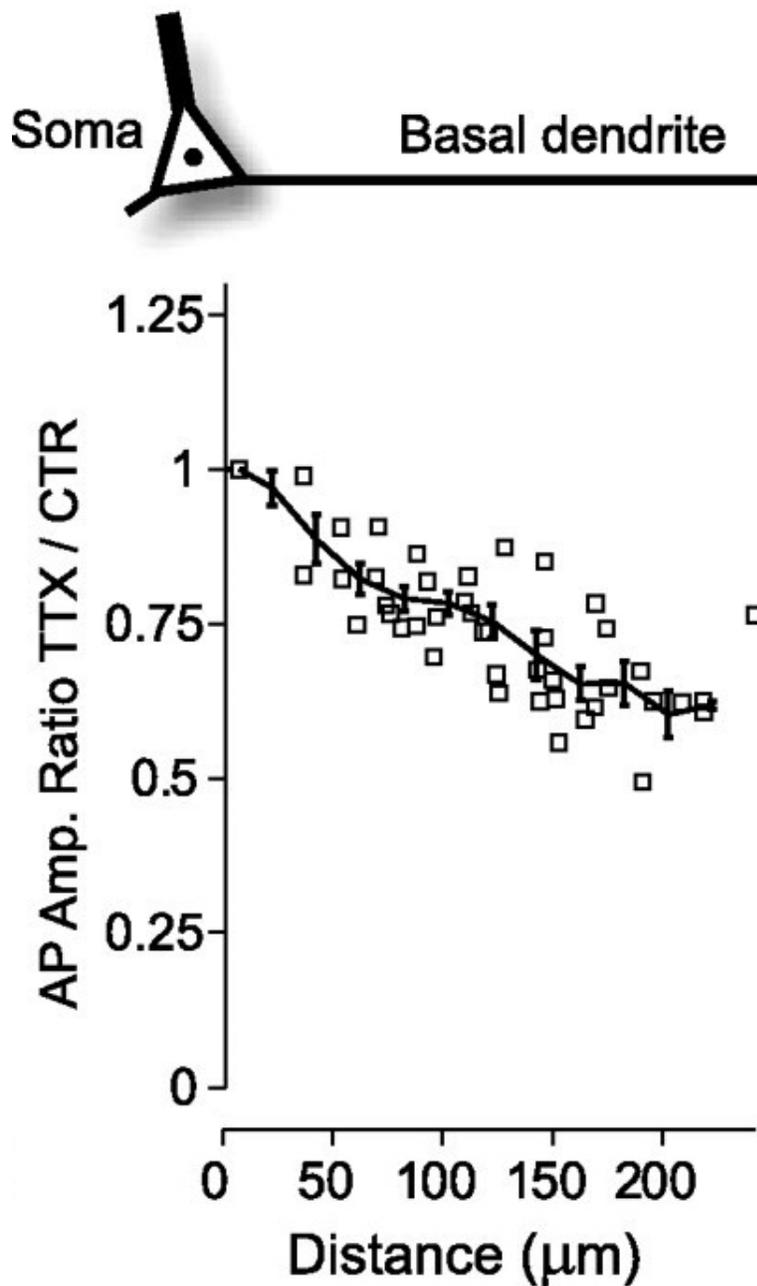
Multi-site recordings from the same dendritic branch reveal the role of dendritic voltage-gated Na channels in action potential backpropagation.



**Figure 1. Multi-site voltage-sensitive dye imaging of backpropagating action potentials (bAPs) in basal dendrites of L5 cortical pyramidal neurons.**

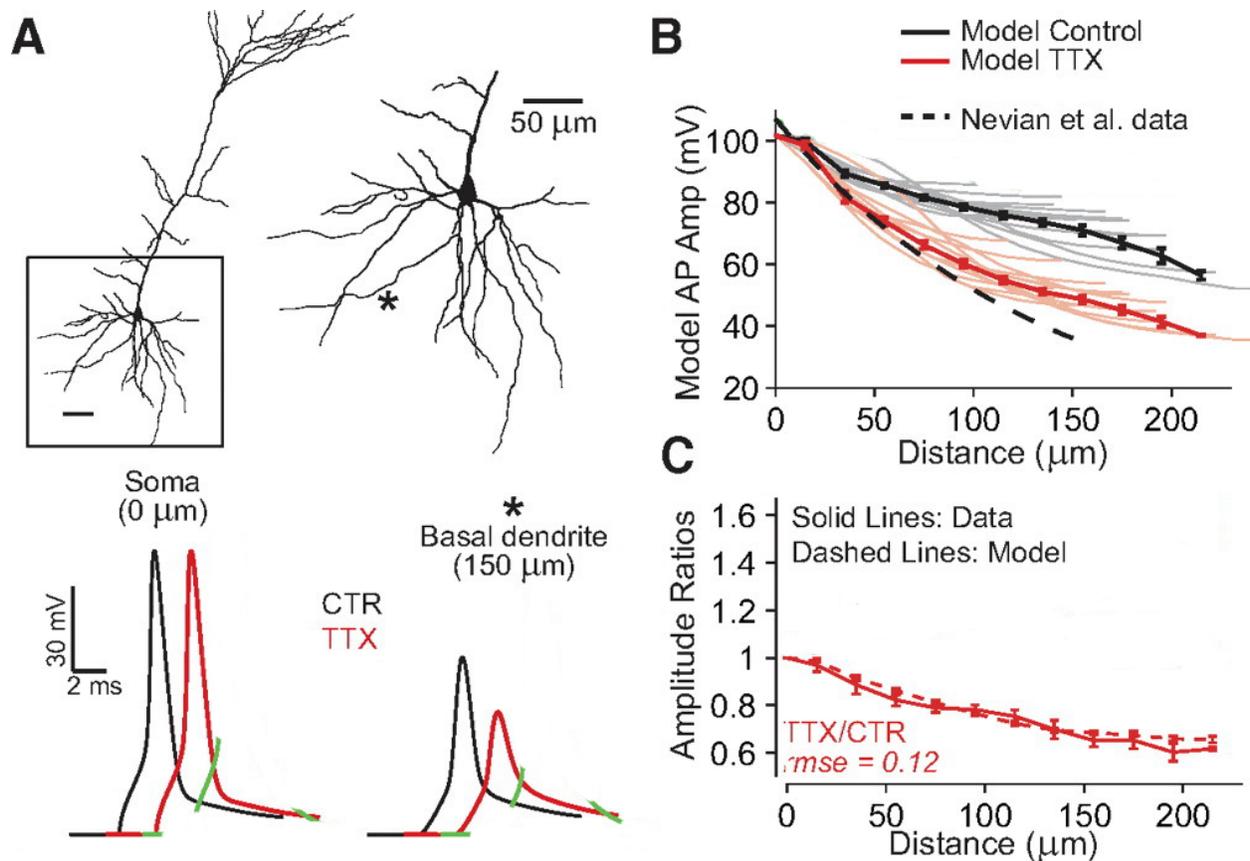
**Dual somatic whole-cell patch.** One patch pipette is in Voltage-Clamp Mode – it clamps the cell body in the shape of an action potential (AP playback). However, series resistance and capacitance prevent fast and accurate control of the cell body-voltage through voltage-clamp method. Therefore, it is necessary to compensate for the loss of AP amplitude (compensation factor). The second patch pipette is in Current-Clamp Mode – it allows us to determine the correct voltage-clamp compensation factor - it checks if the cell body is experiencing the correct AP waveform.

Dual somatic whole-cell patch is necessary in the TTX condition (Trial-2, middle column of traces). In all dendritic regions (e.g. 1 - 5), we compared voltage waveforms BEFORE and AFTER the complete block of dendritic voltage-gated Na channels (Fig. 1). We found the exact loss of AP amplitude when Na channels are blocked (Fig. 2).



**Figure 2. Contribution of Na channels to bAP amplitude in basal dendrites of L5 cortical pyramidal neurons.**

In multiple recording sites along basal dendrites, we measured three parameters: [1] AP amplitude; [2] AP duration (half-width); and [3] AP latency. Each measurement was performed BEFORE and AFTER application of the Na channel blocker TTX. Based on these 6 values (three parameters, obtained before and after TTX), we constrained our multicompartmental model of L5 pyramidal cell ([Fig. 3](#)).



**Figure 3. Best-fit model of action potential backpropagation in basal dendrites of L5 cortical pyramidal neurons.**

In **Fig. 3B**, solid black line shows bAP amplitude along basal dendrites (on average). Solid gray lines represent individual dendritic branches in the model – there is some variability between branches. In summary, our experimental measurements (**Figs. 1 & 2**), combined with computational model (**Fig. 3**) reveal that bAP achieve much greater amplitudes in basal dendrites than those suggested by patch electrode recordings using very high-resistance patch electrodes (Nevian et al., 2007).

**For precise spatial distributions of voltage-gated Na and voltage-gated A-type potassium channels, see Acker and Antic, 2009.**

Acker CD, Antic SD. Quantitative assessment of the distributions of membrane conductances involved in action potential backpropagation along basal dendrites. *J Neurophysiol.* 2009 Mar;101(3):1524-41. <https://pubmed.ncbi.nlm.nih.gov/19118105/>