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Efficient temporal summation of dendritic Calcium signals in young hippocampal granule cells

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ABSTRACT OF THE TALK

Neuronal activity is critically important for development and maturation of dendrites, axons and synaptic connections. Although Ca^{2+} is an important signal molecule for these processes, not much is known about the regulation of the dendritic Ca^{2+} concentration in immature neurons. Here we used confocal Ca^{2+} imaging to investigate dendritic Ca^{2+} signaling in young and mature dentate gyrus granule cells, identified by the expression of the immature neuronal markers polysialated neural cell adhesion molecule (PSA-NCAM) and doublecortin (DCX). Using the Ca^{2+}-sensitive fluorescent dye OGB-1, we found that both young and mature granule cells showed large action potential evoked dendritic Ca^{2+} transients with similar amplitudes, indicating active backpropagation. However, the decay of the dendritic Ca^{2+} concentration back to baseline values was substantially slower in the immature neurons. Similarly, using the low-affinity Ca^{2+} dye OGB-5N the decay time course was about 4 times slower in young (τ_w = 1060 ms) versus mature cells (τ_w = 240 ms), leading to a more efficient temporal summation and large Ca^{2+} signals during theta-frequency stimulation in the young neurons. Pharmacological blockade of the sodium-calcium exchanger (NCX), the smooth endoplasmatic reticulum Ca^{2+} ATPase (SERCA), and the plasma membrane Ca^{2+} ATPase (PMCA) showed that these pathways contribute to the decay of dendritic Ca^{2+} signals at both mature and immature stages. However, immunohistochemical analysis revealed markedly lower expression levels of Ca^{2+}-ATPases including PMCA1-3 and SERCA2 in young neurons. The large and prolonged dendritic Ca^{2+} signals in young granule cells might be important for the regulation of activity-dependent growth and remodeling of the developing dendritic tree by excitatory synaptic inputs