Principles governing the operation of synaptic inhibition in dendrites.

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Abstract:

Synaptic inhibition plays a key role in shaping the dynamics of neuronal networks and selecting cell assemblies. Typically, an inhibitory axon contacts a particular dendritic subdomain of its target neuron, where it often makes 10-20 synapses, sometimes on very distal branches. The functional implications of such a connectivity pattern are not well understood. Our experimentally based theoretical study highlights several new and counterintuitive principles for dendritic inhibition. We show that distal "off-path" rather than proximal "on-path" inhibition effectively dampens proximal excitable dendritic "hotspots," thus powerfully controlling the neuron's output. Additionally, with multiple synaptic contacts, inhibition operates globally, spreading centripetally hundreds of micrometers from the inhibitory synapses. Consequently, inhibition in regions lacking inhibitory synapses may exceed that at the synaptic sites themselves. These results offer new insights into the synergetic effect of dendritic inhibition in controlling dendritic excitability and plasticity and in dynamically molding functional dendritic subdomains and their output.

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