Control of brain waves from the brain surface

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Whether or not a neuron transmits an electrical impulse is a function of many factors. European research is using a heady mixture of techniques - molecular, microscopy and electrophysiological - to identify the necessary input for nerve transmission in the cortex.

In the central nervous system (CNS), a nerve cell or neuron has a 'forest' of elaborate dendritic trees arising from the cell body. These literally receive many thousands of synapses (junctions that allow transmission of a signal) at positions around the tree. These inputs then are able to generate an impulse, or 'spike', known as an action potential at the initial part of the axon.

Previous research has confirmed that an activated synapse will generate an electric signal as a result of neurotransmitters released from pre-synaptic axons. Electrical recordings from the neocortex have confirmed that, in line with the cable theory prediction, that modulation of potential at the dendrite is highly distance-dependent from the cell body or soma.

The 'Information processing in distal dendrites of neocortical layer 5 pyramidal neurons' (Channelrhodopsin) project aimed to shed more light on how more distal sites in the 'tree' influence the action potential of the post-synaptic neuron. Furthermore, they investigated exactly how dendritic spikes can be generated, another issue about which there is little information so far.

Recent research has highlighted the importance of activation of N-methyl-D-aspartate (NMDA) receptors to bring about the production of a signal that will proceed to the soma and then result in a spike. There is also indirect evidence that interneurons targeting dendrites can control level of dendrite excitability.

Channelrhodopsin scientists simultaneously recorded the pre- and post-synaptic electrical recordings of identified interneurons and a special type of neuron, pyramidal cells that are primary excitation units in the mammalian cortex.

The project team first characterised the different types of inhibitory neuron deep in the cortex in layer 5 at apical tuft dendrites. The researchers then showed that a special type of inhibitory interneuron in the outer layer of the neocortex can suppress dendritic spiking in layer 5.

Project results show that a superficial inhibitory neuron can impact information processing in a specific pyramidal neuron. The research will have massive implications for neuroscience and help to unravel the integrative operations of CNS neurons.

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