Physicists overturn common assumptions regarding brain activity

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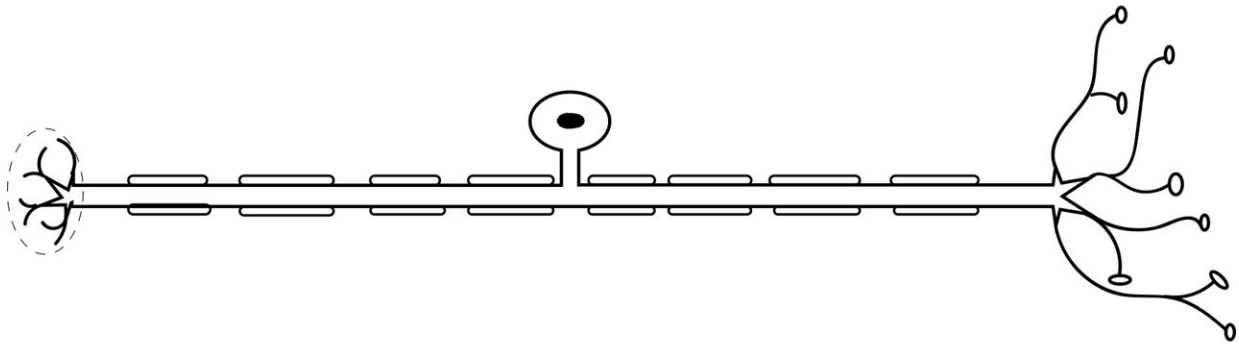

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The brain is a complex network containing billions of neurons. The soma of each of these neurons communicates simultaneously with thousands of others via their synapses (links), and collects incoming signals through several extremely long, branched "arms," called dendritic trees.

For the last 75 years a core hypothesis of neuroscience has been that the basic computational element of the brain is the neuronal soma, where the

long and ramified dendritic trees are only cables that enable them to collect incoming signals from its thousands of connecting neurons. This long-lasting hypothesis has now been called into question.

In an article just published in *Physica A*, researchers from Bar-Ilan University in Israel reveal that many dynamical features which are commonly attributed to the soma may stem from dendritic mechanisms.

"Typically, in-vitro experiments examine neurons using a fixed holding membrane potential, imitating the physiological conditions of intact brains in an awake state," said Prof. Ido Kanter, of Bar-Ilan's Department of Physics and Gonda (Goldschmied) Multidisciplinary Brain Research Center, who led the research.

"We went against conventional wisdom and performed new types of experiments, violating the physiological conditions of the brain. Results showed that neuronal features are independent of these physiological conditions, a finding which strongly pinpoints dendrites as the segments which control neuronal plasticity features, such as the neuronal firing frequency and the stimulation threshold of the neuron."

Presented experimental evidence supports previous research by Kanter and his experimental research team—conducted by Dr. Roni Vardi—indicating efficient dendritic tree learning evidence for sub-dendritic adaptation using neuronal cultures, together with other anisotropic properties of neurons, like different spike waveforms, refractory periods and maximal transmission rates.

The new results call for a re-examination of the origin of degenerative diseases, since the origin of many neuronal functionalities are beyond the traditional framework and must be attributed to the dendrites instead of the soma. In addition, results question the origin of awake and sleep states of our brain which are commonly attributed to the level of the

somatic membrane potential.

More information: Roni Vardi et al, Neuronal plasticity features are independent of neuronal holding membrane potential, *Physica A* (2023). DOI: 10.1016/j.physa.2023.129351