Role of noise in neurons

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Addressing a current issue in neuroscience, Aldo Faisal and Simon Laughlin from Cambridge University investigate the reliability of thin axons for transmitting information. They show that noise effects in ion channels in the brain are much larger than previously assumed – meaning the fidelity of transmission is compromised.

Neurons in the cerebral cortex of the brain can have a wiring density of up to 4km per mm^3 by using incredibly thin axons as wires, with an average diameter of 0.3 micrometers. Although, as in computer chips, this miniaturization economizes on space and energy, it increases the noise introduced by thermodynamic fluctuations in a neuron's voltage-gated ion channels. Axons use action potential (AP) to transmit information fast and reliably to synapses, but the reliability of transmissions down fibers of less than 0.5 micrometers in diameter was unknown until this paper.

Using detailed models of rodent and squid axons and stochastic simulations, the authors performed experiments, now published in *PLoS Computational Biology*, which took several months to simulate a few milliseconds of real time in the brain. They show how conduction along such thin axons is affected by the probabilistic nature of voltage-gated ion channels (channel noise). Channel noise destroys information in the AP, and they conclude that these effects are much larger than previously supposed and therefore must be taken into account in any future studies of neural coding and the reliability of synaptic transmission.

Source: Public Library of Science