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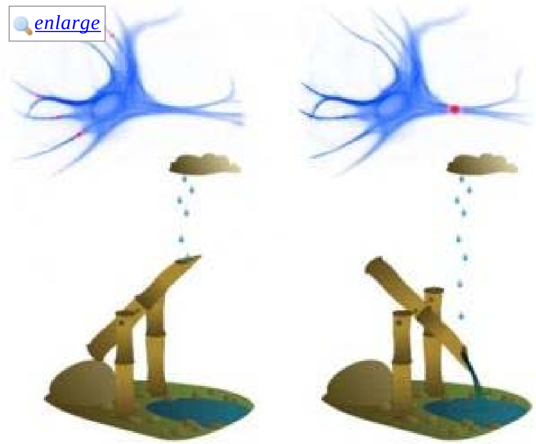
Neurons: Faster Than Thought and Able to Multiply

ScienceDaily (Sep. 10, 2010) — Using computer simulations of brain-like networks, researchers from Germany and Japan have discovered why nerve cells transmit information through small electrical pulses. The process not only allows the brain to process information much faster than previously thought, but also single neurons are already able to multiply, opening the door to more complex forms of computing.



Researchers have discovered what exactly happens right before a nerve cell emits a pulse: computer simulations reveal that the process is similar to a Japanese garden 'shishi odoshi' -- a reed of bamboo, open on one end, which tilts when a certain amount of rainwater has accumulated inside. (Credit: Image courtesy of Bernstein Center for Computational Neuroscience)

When nerve cells communicate with each other, they do so through electrical pulses -- so-called action potentials. For decades, the accepted idea was that they simply sum up the tiny potentials generated by the incoming pulses and emit an action potential themselves when a threshold is reached. For the first time, Moritz Helias and Markus Diesmann from the RIKEN Brain Science Institute (Japan) and Moritz Deger and Stefan Rotter from the Bernstein Center Freiburg (Germany) now explain what exactly happens right before a nerve cell emits a pulse.

The research appears online in *PLoS Computational Biology*, published by the Public Library of Science.

The scientists made their discovery through simulations on high performance computers, but found the perfect image for their research subject in the tranquility of Japanese gardens: the 'shishi odoshi', a reed of bamboo, open on one end, which tilts when a certain amount of rainwater has accumulated inside. Just as one tiny raindrop ultimately causes the device to tilt and spill the water, one small electric pulse will cause a neuron to produce an impulse of its own.

Although the neurons in the brain would correspond to a huge forest of bamboo, and the activity sent between them to a thunderstorm of raindrops, Helias and colleagues found a precise mathematical theory that needs to consider the detailed course of events only at the time when a neuron is about to release an action potential.

Not only does this theory explain why nerve cells process information much faster than previously thought. It also became clear that neurons do more than just add up pulses: In the decisive moments, they actually multiply. The availability of this mathematical operation, write the scientists, finally explains how the brain is able to execute complex computations. These insights in the basic processes of the brain will in turn inspire more powerful processor architectures in the future.

Story Source:

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Journal Reference:

1. Moritz Helias, Moritz Deger, Stefan Rotter, Markus Diesmann, Karl J. Friston. **Instantaneous Non-Linear Processing by Pulse-Coupled Threshold Units**. *PLoS Computational Biology*, 2010; 6 (9): e1000929 DOI: 10.1371/journal.pcbi.1000929

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