Neural Plasticity: From Synapse to Perception

Mu-Ming Poo
University of California, Berkeley, and Institute of Neuroscience, Chinese Academy of Sciences, Shanghai

The cognitive functions of the brain, such as learning and memory, depend on the ability of neural circuits to change their properties of signal processing after these circuits have been used by the organism. Many of these use-dependent changes ("plasticity") occur at synapses, where signals are transmitted between nerve cells (neurons). Depending on the pattern of neuronal activities, repetitive synaptic transmission could cause long-term potentiation (LTP) or long-term depression (LTD) of the synapse in its efficacy for future transmission. I will summarize our studies on how the timing of neuronal activities (spikes) in the pre- and post-synaptic neurons determines whether a synapse undergoes LTP or LTD, a phenomenon known as "Spike Timing-Dependent Plasticity" (STDP), and how STDP may provide the mechanism for coding and storing the information on the temporal sequence and interval of sensory signals, two key elements of episodic memory. I will also discuss in general the idea that neural plasticity is the main factor that shapes the development of neural circuits, and that neural plasticity offers the potential for functional recovery from injuries and diseases of the adult brain. Finally, to argue that higher cognitive functions in humans such self-awareness may originate from experience-dependent neural plasticity, I will present preliminary findings showing that mirror self-recognition, a cognitive function known to be limited only to humans and great apes, could be acquired by rhesus monkeys following training for visual-somatosensory association.