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Presentation Title

The Role of the Corticospinal Tract and Activity-Dependent Processes for Functional Restoration After Spinal Cord Injury

Abstract:

The sudden loss of movement after spinal cord injury (SCI) is life-changing and is a major impetus to study motor system plasticity and devise novel repair strategies. The motor cortex and the corticospinal tract are key to producing voluntary movements. In health and after injury, the spinal cord is a key site for activity-dependent plasticity of the corticospinal tract and its neuronal targets. My laboratory studies different forms of activity-dependent plasticity that can be boosted by motor cortex and spinal cord neuromodulation to promote motor function after injury: (1) corticospinal tract axon sprouting after motor cortex stimulation; (2) synaptic competition between the corticospinal tract and proprioceptive afferent fibers; and (3) long-term potentiation (LTP) at the corticospinal tract-spinal neuron synapse, induced by motor cortex neuromodulation. In addition to control of skilled movement, the motor cortex and the CST participate in activity-dependent trophic-like actions on spinal cord neurons. Persistent reduction of motor cortex activity, or loss of the CST after injury, results in substantial loss of spinal premotor interneurons through trans-neuronal degeneration. Voluntary motor impairment after SCI may thus reflect a combination of the loss of CST synaptic drive, an aberrant gain of reflex functions, and the loss of key spinal circuit elements. My presentation will focus on these myriad mechanisms contributing to motor dysfunction and on targeted neuromodulatory approaches to restore function. I will also consider how combining neuromodulation to promote repair and rehabilitation to train motor circuits after SCI can most effectively promote motor recovery.

Short CV:

Dr. Martin is a Medical Professor at the City University of New York School of Medicine; he is a neuroscience researcher and educator. His lab's research program examines how our nervous system allows us to perform skilled voluntary movements and how to restore these movements after a brain or spinal cord injury. Dr. Martin's research focuses on activity-dependent processes that guide the development of the corticospinal motor system and the maintenance of the system's connections and functions in maturity. His team uses neuromodulation approaches—including optogenetic, chemogenetic, and electrical stimulation—to promote corticospinal system structural plasticity to repair motor circuits that become damaged after a spinal cord injury and, in turn, restore movements. A major effort of Dr. Martin's research is to develop therapeutic neuromodulation approaches and to work with neuro-engineers and clinicians to translate these approaches to humans.