Adaptive Plasticity of Spinal Cord Reflexes
CNS Mechanisms and Therapeutic Uses

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In normal life, activity-dependent plasticity occurs in the spinal cord as well as in the brain. Like plasticity elsewhere in the CNS, this spinal cord plasticity occurs at many different neuronal and synaptic sites and through a variety of mechanisms. It is prominent during development and contributes to acquisition and maintenance of basic behaviors such as withdrawal reflexes and locomotion. Later in life, it contributes to acquisition and maintenance of specialized motor skills, and to compensation for peripheral and central changes associated with injury, disease, and aging. Understanding spinal cord plasticity is essential for understanding motor skills. Moreover, induction and guidance of spinal cord plasticity is important in new rehabilitation methods for motor disorders such as spinal cord injury and cerebral palsy. In addition, due to the relative simplicity and accessibility of the spinal cord, exploring spinal cord plasticity is a good starting point for describing skill development. The spinal stretch reflex (SSR) (i.e., the tendon-jerk reflex) and its electrical analog, the H-reflex, are the simplest behaviors. They change during early development, during skill acquisition later in life, and after spinal cord trauma. They also change in response to an operant conditioning protocol. Monkeys, humans, rats, and mice exposed to this protocol can gradually decrease (i.e., down-conditioning) or increase (i.e., up-conditioning) the SSR or the H-reflex. These simple skills involve plasticity in the motoneuron and elsewhere in the spinal cord. They depend on corticospinal tract activity that, in turn, depends on cerebellar-cortical connections and basal ganglia. We have found that H-reflex conditioning can improve locomotion in rats with partial spinal cord injuries, and in collaboration with other labs we have begun studies to determine whether it can also improve locomotion in humans with partial spinal cord injuries. Spinal reflex conditioning might provide a new method for improving motor function after spinal cord injury or in other disorders. When spinal cord regeneration becomes possible, methods for induction and guidance of spinal cord plasticity will be crucial for re-educating the spinal cord so that it supports effective motor function.

Review References

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