Henceforth, as each old behavior uses the newly modified spinal cord, any deficits in its key features induce behavior changes that the spinal cord may impair key features of old behaviors (e.g., step-cycle symmetry). In a state of equilibrium that serves all the behaviors in the old repertoire. When the learning of a new behavior begins, the quadriceps H-reflex often changes in the opposite direction; and reciprocal changes in pathways (Chen et al 2005 & 2011). For example, when the soleus H-reflex is increased or decreased by conditioning, the quadriceps H-reflex often changes in the opposite direction; and reciprocal changes in ankle and hip angles ensure equal hip heights.

These and related findings suggest that the spinal cord enables a new behavior (e.g., a larger or smaller H-reflex) while preserving old behaviors through a process of mutual accommodation – a negotiation among the many different hierarchies of plasticity responsible for these behaviors. Spinal neurons and synapses are maintained in a state of equilibrium that satisfies the new behavior and still serves the old behaviors. The outcome is a new spinal cord equilibrium that is now clear that the spinal cord, like the rest of the CNS, undergoes activity-dependent plasticity throughout life, as growth and aging occur, and as new behaviors are acquired (Wolpaw 2010 for review). The recognition of this plasticity raises a critical new question: When the acquisition of a new behavior changes the spinal cord, how are old behaviors that use the same spinal neurons and synapses preserved – that is, how does it come about that old behaviors are not disturbed by the plasticity involved in acquisition of a new behavior? Our lab is using a simple model of motor learning – operant conditioning of the H-reflex – to address this question.

Operant conditioning of the soleus H-reflex creates a hierarchy of plasticity in which changes in the brain act through the corticospinal tract to induce and maintain the spinal cord plasticity directly responsible for the reflex change (Thompson 2009; Wolpaw 2010). These spinal cord changes also affect locomotor EMG and kinematics; nevertheless, key features of locomotion (e.g., right/left symmetry in the step-cycle and in hip height) are preserved, apparently by compensatory plasticity in other spinal pathways (Chen et al 2005 & 2011). For example, when the soleus H-reflex is increased or decreased by conditioning, the quadriceps H-reflex often changes in the opposite direction; and reciprocal changes in ankle and hip angles ensure equal hip heights.

These related findings suggest that the spinal cord enables a new behavior (e.g., a larger or smaller H-reflex) while preserving old behaviors through a process of mutual accommodation – a negotiation among the many different hierarchies of plasticity responsible for these behaviors. Spinal neurons and synapses are maintained in a state of equilibrium that serves all the behaviors in the old repertoire. When the learning of a new behavior changes the spinal cord, it may impair key features of old behaviors (e.g., step-cycle symmetry). Henceforth, as each old behavior uses the newly modified spinal cord, any deficits in its key features induce compensatory plasticity that tends to restore these features. This plasticity may in turn affect the new behavior, as well as other old behaviors, and lead to further plasticity. The result is an ongoing iterative process, or negotiation, in which each behavior repeatedly induces plasticity that preserves its key features despite the plasticity induced by other behaviors. The outcome is a new spinal cord equilibrium that satisfies the new behavior and still serves the old behaviors.

Furthermore, in rats and humans, the new negotiation triggered by H-reflex conditioning can actually improve an old behavior (e.g., locomotion) that has been impaired by an incomplete spinal cord injury (Chen et al 2006; Thompson et al 2013). Thus, operant conditioning protocols, which can focus on each individual’s specific deficits, might supplement other rehabilitation methods and enhance recovery. In sum, the spinal cord’s ability to support the acquisition and preservation of many different behaviors depends on continual interactions among the many different hierarchies of plasticity responsible for these behaviors. Spinal neurons and synapses are maintained in a state of negotiated equilibrium.

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