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Test of the half-center model for locomotor activity in adult lamprey spinal cord

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Rhythmic motor behaviors, such as locomotion, chewing, scratching, copulation, and communication, are critical for survival. In all animals, rhythmic motor activity is produced by central patterns generators (CPGs) which consist of neuronal modules that are coupled by a coordinating system. For example, in a cat separate spinal modules control the movements of each limb, and the coordinating system can couple the modules in different ways to produce different gaits (walk, trot, gallop). Each module can be divided into oscillators that usually are connected by reciprocal inhibition (i.e. "half-center" model) to produce alternating motor patterns (e.g. flexion « extension). These oscillators generally are assumed to be autonomous and able to function without the reciprocal connections. In the lamprey, locomotion (swimming) is produced by pairs of oscillators that are distributed along the spinal cord and connected by left-right reciprocal inhibition (Hagevik and McClellan, 1994). In adult lamprey, we tested the half-center model by investigating whether the phasing of left-right burst activity could be correctly maintained in the absence of left-right reciprocal coupling. Adult lamprey received a longitudinal midline lesion in the rostral spinal cord (10% à 35% body length). After the midline lesion, the animals were able to swim, and the appropriate phasing of left and right muscle burst activity was present in both caudal and rostral parts of the body. After a spinal transection was made at 35% body length to isolated the rostral left and right halves of the spinal cord from intact cord, locomotor-like burst activity was no longer present in the rostral spinal cord. We obtained similar results in larval lamprey (Jackson et al., 2005). Thus, in lamprey, the data do not support the "half-center" model because left and right spinal cord oscillators are not autonomous but appear to require left-right reciprocal coupling to function properly.