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Integrating multiple sensory systems to modulate neural networks controlling posture

Lavrov I., Gerasimenko Y., Burdick J., Zhong H., Roy R., Edgerton V.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2015 the American Physiological Society. In this study we investigated the ability of sensory input to produce tonic responses in hindlimb muscles to facilitate standing in adult spinal rats and tested two hypotheses: 1) whether the spinal neural networks below a complete spinal cord transection can produce tonic reactions by activating different sensory inputs and 2) whether facilitation of tonic and rhythmic responses via activation of afferents and with spinal cord stimulation could engage similar neuronal mechanisms. We used a dynamically controlled platform to generate vibration during weight bearing, epidural stimulation (at spinal cord level S1), and/or tail pinching to determine the postural control responses that can be generated by the lumbosacral spinal cord. We observed that a combination of platform displacement, epidural stimulation, and tail pinching produces a cumulative effect that progressively enhances tonic responses in the hindlimbs. Tonic responses produced by epidural stimulation alone during standing were represented mainly by monosynaptic responses, whereas the combination of epidural stimulation and tail pinching during standing or epidural stimulation during stepping on a treadmill facilitated bilaterally both monosynaptic and polysynaptic responses. The results demonstrate that tonic muscle activity after complete spinal cord injury can be facilitated by activation of specific combinations of afferent inputs associated with loadbearing proprioception and cutaneous input in the presence of epidural stimulation and indicate that whether activation of tonic or rhythmic responses is generated depends on the specific combinations of sources and types of afferents activated in the hindlimb muscles.

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Keywords

Locomotion, Postural control, Spinal cord stimulation, spinal cord transection, Vibration