Slow potentials of the sensorimotor cortEx

during rhythmic movementS of the ankle

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The objective of this research was to more fully understand the role of the human brain in the production of lower extremity rhythmic movements. Throughout the last century, evidence from animal models has demonstrated that spinal reflexes and networks alone are sufficient to propagate ambulation. However, observations after neural trauma, such as a spinal cord injury, demonstrate that humans require supraspinal drive to facilitate locomotion. To investigate the unique nature of lower extremity rhythmic movements, electroencephalography was used to record neural signals from the sensorimotor cortex during three cyclic ankle movement experiments. First, we characterized the differences in slow movement-related cortical potentials during rhythmic and discrete movements. During the experiment, motion analysis and electromyography were used characterize lower leg kinematics and muscle activation patterns. Second, a custom robotic device was built to assist in passive and active ankle movements. These movement conditions were used to examine the sensory and motor cortical contributions to rhythmic ankle movement. Lastly, we explored the differences in sensory and motor contributions to bilateral, rhythmic ankle movements. Experimental results from all three studies suggest that the brain is continuously involved in rhythmic movements of the lower extremities. We observed temporal characteristics of the cortical slow potentials that were time-locked to the movement. The amplitude of these potentials, localized over the sensorimotor cortex, revealed a reduction in neural activity during rhythmic movements when compared to discrete movements. Moreover, unilateral ankle movements produced unique sensory potentials that tracked the position of the movement and motor potentials that were only present during active dorsiflexion. In addition, the spatiotemporal patterns of slow potentials during bilateral ankle movements suggest similar cortical mechanisms for both unilateral and bilateral movement. Lastly, beta frequency modulations were correlated to the movement-related slow potentials within medial sensorimotor cortex, which may indicate they are of similar cortical origin. From these results, we concluded that the brain is continuously involved in the production of lower extremity rhythmic movements, and that the sensory and motor cortices provide unique contributions to both unilateral and bilateral movement.