ABSTRACT
CORTICAL OSCILLATIONS DURING A LATERAL BALANCE PERTURBATION WHILE WALKING

Joseph J. Lee, B.S.

Marquette University, 2016

The role of sensory systems in the cortical control of dynamic balance was examined using electroencephalography (EEG) recordings during balance perturbations while walking. Specifically, we examined the impact of sensory deficits on cortical oscillations using vibratory stimuli to suppress sensory feedback and by comparing cortical oscillations during balance perturbations while walking in people with sensory deficits associated with cervical myelopathy and neurologically intact controls. Balance during walking provides a rich framework for investigating cortical control using EEG during a functionally relevant task. While this approach is promising, substantial technical challenges remain in recording and processing EEG in the noisy, artifact laden environment associated with walking. We therefore first investigated the role of sensory attenuation in healthy, adult controls within the framework of a simple, motor task. We then examined the effectiveness of using independent component analysis and machine learning techniques such as clustering and linear classifiers for differentiating noise from actual brain activity in EEG signals during walking. Finally, we examined a more complicated experimental framework using a custom cable-servomotor system to deliver a lateral pull to the waist of participants with cervical myelopathy while walking and measured their cortical activity using high density EEG.

We observed that the attenuation of sensory input in healthy controls induced a similar change in beta band modulation as found previously in spinal cord injury for simple movements of the ankle. During walking, large increases in theta band power throughout the cortex were observed to modulate with lateral balance perturbations. Theta band modulations in the frontal areas of the cortex were significantly delayed in time and displayed a more spatially lateralized cortical localization for participants with cervical myelopathy compared to age-matched, healthy controls. The timing of these theta power modulations were significantly correlated with the initiation of a widening step width correction in response to the balance perturbation. Our results support a link between the modulation of cortical oscillations and sensorimotor integration in simple and complex motor paradigms.