Important Feature of Walking Adaptation: A Review of the Nervous System's Ability to Regulate and Maintain Sensory Input During Split-Belt Walking

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Gait adaptation studies focus on the ways in which individuals adapt their walking pattern (gait) to a split-belt treadmill. Adaptation is defined as the modification of a movement from trial to trial based on error feedback (Bastian et al., 2008). A split-belt treadmill is a treadmill with two separate belts that can operate at different speeds. These studies are conducted for the purpose of determining body mechanisms responsible for gait and gait adaptation. Furthermore, these studies provide insights for rehabilitative innovations that are useful for populations with neurological deficits. We reviewed 42 studies to determine which measures to use for the characterization of gait adaptation on a split-belt treadmill.

Most commonly, gait adaptation is measured by the way an individual's step length asymmetry changes as they walk on the split-belt treadmill. Step-length asymmetry is defined as the distance between the ankles when the leading leg contacts the ground. Step length starts asymmetric, and over the course of adaptation, becomes more symmetric, even though the belts are moving at different speeds (Reisman et al.,2005). However, researchers have more recently focused on the way in which adaptation could be driven by changes in metabolic cost. Metabolic cost is defined as the energy used by the body during movement. It is thought that reductions in asymmetry, seen during adaptation, are driven by the body's ability to use external assistance from the treadmill to decrease metabolic cost (Roper et al., 2013; Sanchez et al., 2019).

Many studies have focused on split-belt treadmill adaptation in populations with neurologic damage.These studies have found that different parts of the nervous system are responsible for different aspects of gait adaptation, and impairments in gait adaptation are dependent on the type and extent of neurologic or musculoskeletal damage. These studies include populations of people post-stroke, with Parkinson's disease, and/or with essential tremor. In addition, some studies have focused on populations with musculoskeletal damage,-like amputees and those who have undergone anterior cruciate ligament (ACL) reconstruction.

Our review investigates common measures used to characterize gait adaptation on a split-belt treadmill. Understanding how step length, asymmetry and metabolic cost are influenced by neurologic and musculoskeletal damage allows researchers to inform rehabilitative innovations. Because most studies have focused on populations with degenerative disorders, further research regarding the peripheral nervous system in younger populations will provide a better understanding of how the nervous system controls gait adaptation. Furthermore, few studies have investigated the nervous system's role in tasks that involve all four limbs and there are few studies that investigate the nervous system's ability to control stability. Our findings suggest that more research is needed to determine potential modifications in gait adaptation for individuals with limb loss. Additional studies must be executed before we can truly understand the role of the peripheral and central nervous systemin gait adaptation for populations with limb loss.

Statment of Research Advisor

Abbrianna has gathered information from several studies that understand how people control their walking in new settings and how adjustments are made to ensure gait remains efficient and stable. Her work will have significant impact in identifying areas of focus for the future if the field and shed light on how we can use current findings to help populations with neuromuscular deficits walk better.

–Jaimie A. Roper, Kinesiology

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