Unraveling the layers of gait variability in aging and neurodegeneration: Pearls and Precautions

Average gait speed is a powerful predictor of many clinical outcomes. Nonetheless, important information and insights into motor control can be gleaned by studying the stride-to-stride fluctuations of the gait pattern. This presentation will summarize early work using footswitches to evaluate gait variability in healthy aging and in patients with neurodegenerative disease. We will describe the so-called continuous and episodic gait disturbances that are common among patients with Parkinson’s disease and the related changes in gait variability, focusing on the perplexing and debilitating phenomenon known as freezing of gait. We will also show how gait variability provides understanding into the cognitive control of walking and fall risk, highlighting the role of the dorsal lateral pre-frontal cortex, and demonstrate how body-fixed sensors and 24/7 continuous monitoring can be used to provide sensitive measures and quantify gait dynamics, potentially serving as a bio-marker of Parkinson’s disease and cognitive decline. Finally, we will illustrate how gait dynamics respond to therapeutic interventions and steps that should be taking when considering the multiple aspects of gait variability metrics.

Dr. Karl M. Newell, Barry T. Bates, Honorary Keynote Speaker
Department of Kinesiology
University of Georgia

The Acquisition of Coordination in Movement Skills

In this talk I will elaborate on the perspective of Nikolai Bernstein (1967) that skill in movement tasks is, in effect, the mastery of the redundant degrees of freedom (DFs). The study of motor learning and performance has, however, been dominated by task demands to scale an already producible coordination mode - thus restricting the coordination of the joint space DFs in many laboratory motor learning tasks. The acquisition of new patterns of coordination in whole-body sport motor skills, in contrast, gives emphasis to the coordination and control of multiple joint DFs and the motion and stability of the torso in every activity. It remains a challenge in the theory and practice of movement science to understand the roles of the many DFs in the formation and acquisition of movement coordination, control and skill over the lifespan.
Dr. Janet Dufek, Guest Speaker  
School of Allied Health Sciences  
Department of Kinesiology and Nutrition Sciences

See How (S)he Lands: Modeling to Performance Strategies

The task of landing from an airborne activity is accomplished by controlling and arresting the mechanical energy possessed by the system in a safe and efficient manner. In many cases, the intent is to manipulate the body in such a way that the vertical velocity of the system center of mass is reduced to zero. In other cases, if ground contact is not the intended terminal movement outcome (such as in a triple jump), the purpose is to control the system center of mass velocity and re-direct it in the desired direction of subsequent motion. In either case, landing is often viewed as a simple task that is performed similarly by all. Our initial investigations into landing performance suggested this is not the case. We initially examined effects of mechanical energy on ground reaction forces by way of height and horizontal landing distance manipulations. We modeled these landings, using kinematic parameters, to predict force outcomes. By way of several experiments that followed, we learned that individuals use unique strategies to produce desired movement outcomes. In this presentation, we will examine the evolution of techniques developed to both model landings and identify movement strategies. Variability in performance will be addresses in the definition and execution of the developed landing strategy models. An eye toward injury potential and injury prevention will also be weaved into this presentation.

Dr. Jesse Dean, Guest Speaker  
Division of Physical Therapy  
Medical University of South Carolina

The problem of gait instability: Can a biomechanics-based approach provide unique insight?

Human walking is inherently unstable, requiring active control to avoid losses of balance – particularly in the frontal plane. Neurologically intact adults address this problem in part through step-by-step variation in step width. Importantly, this variation is not random noise, but is largely predicted by the mechanical state of the body’s center of mass. Unfortunately, this step-by-step stabilization strategy is disrupted in many chronic stroke survivors. These individuals instead tend to place their paretic leg quite far laterally, independent of the body’s mechanical state. Recent evidence indicates that disruption of this stabilization strategy predicts an increased fall risk. We have developed a force-field able to influence step width in real-time. This device has shown promise for both assisting and perturbing the mechanics-dependent control of step width. Ongoing work is testing the potential of using this device as a training tool among stroke survivors at a high risk for falls.
The functional significance of motor output variability

Motor output variability is defined as the unintentional variations in the output of voluntary contractions. In the first part of this presentation, I will introduce the possible sources of motor output variability and focus on motor unit discharge rate variability and modulation of the motor unit pool. In the second part, I will provide functional implications of the age-related increase in motor output variability. Specifically, I will provide evidence that increased motor output variability in older adults impairs their ability to learn new motor tasks and impairs their ability to react fast in laboratory and simulated functional tasks, such as driving.