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Balancing Trade-offs between Effort and Stability during Healthy and Pathological Gait

Walking is one of the many skills that we learn during development through trial-and-error practice. We eventually gain the ability to not only walk with little effort over flat, unobstructed terrain, but we also learn to adapt our walking pattern to changes in the environment or changes in the body that result from aging or disease. What factors govern the locomotor strategies that we choose during these forms of adaptive learning? Likely candidates include a combination of objectives related to effort, instability, aesthetics, and fear of falling. The relative weighting of these objectives impacts not only how we adapt our walking pattern when features of our environment change, but it also dictates how our preferred movement strategies change when there is damage to the nervous system, as is the case following stroke. I will share results from our recent efforts to understand the trade-offs between two primary objectives in human walking: effort minimization and minimizing fall risk. Through use of empirical studies and biomechanical simulations, I will show that asymmetric walking patterns can, in certain contexts, be considered optimal with respect to effort and balance-related costs for both healthy individuals and people post-stroke. I will conclude by making a case for a more personalized approach to identifying targets for locomotor rehabilitation, one that relies on predictions of optimal movement patterns given the constraints imposed by the neuromuscular system.