GRADUAL TRAINING INDUCES NOVEL INTER-LIMB KINETIC STRATEGIES FOR ASYMMETRIC SPLIT-BELT TREADMILL WALKING

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INTRODUCTION
Gradual training has been shown to be an effective method to introduce gait perturbations. Previous studies have shown that, when compared to a sudden introduction of asymmetrical walking on a treadmill, gradual training results in efficient motor learning and balance control, and decreased cognitive demand during retention [1]. The kinetic strategies needed to affect these outcomes have yet to be explored. During late stance and initial swing phases of the gait cycle, the ankle and hip joints are known to play a critical role in controlling propulsion and limb swing mechanics [2]. Thus, the purpose of this study was to examine the effect of gradual training on ankle work during the late stance phase of walking and hip work during the initial swing phase. It was hypothesized that the gait asymmetry induced by split-belt treadmill walking would result in adoption of a novel inter-limb kinetic strategy, and that this strategy would be partially resolved during a retention test.

METHODS
Fourteen able-bodied participants were recruited and provided informed consent for this IRB-approved study. Participants were randomized into either a gradual training or sudden training group. The gradual training group underwent a change in the speed of one leg on the treadmill, starting at 1:1 and increasing to 2:1 over 720 strides, with increases of 0.02 m/s every 20 strides. The sudden training group began at a 1:1 belt ratio, and the belt on one leg was immediately accelerated (at 10m/s^2) to a 2:1 ratio, at which the participants walked for another 720 strides. All participants returned for a retention test at 24 hours, and walked asymmetrically at a 2:1 ratio with a sudden change in belt speed. Kinematic and kinetic data were collected throughout acquisition and retention, and joint work was calculated using inverse dynamics. Independent T-tests were run to compare work produced during and after gradual training to work during and after sudden training.

RESULTS AND DISCUSSION
Initial results indicate that during acquisition the gradual training group performed more work at the hip joint during initial swing phase compared to the sudden training group. However, these results were not significant (p > 0.05). During retention, this inter-limb kinetic strategy was reduced. These changes were more pronounced in the slow limb (Figure 1). There appeared to be little to no changes during acquisition or retention between the sudden and gradual groups at the ankle joint (Figure 2). A preliminary examination of these data indicates that an inter-limb kinetic strategy is adopted during acquisition. This is primarily observable in the slow limb, where the gradual training group demonstrated greater work at the hip during initial swing phase compared to the sudden training group.

CONCLUSIONS
The improvement in motor learning and balance control and decreased cognitive demand previously reported [1] appears to be partially due to the novel inter-limb kinetic strategy adopted during gradual training. While the differences in hip work between sudden and gradual training during acquisition and retention were not significant, trends indicate an adoption of this novel strategy during acquisition. Future efforts should investigate how other motor learning strategies can be utilized during split-belt walking for training of clinical populations.

REFERENCES