DOES THE RELATIONSHIP BETWEEN WHOLE-BODY ANGULAR MOMENTUM AND STEP PLACEMENT CHANGE IN INDIVIDUALS POST-STROKE?

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Introduction: Individuals post-stroke typically have impaired balance and are at an increased risk of falling [1]. Gaining a more thorough understanding of how balance recovery strategies are altered post-stroke could drive more effective rehabilitation strategies and improve the function of assistive devices for a post-stroke population. Here, we aimed to investigate how step width is modulated in response to frontal plane instability in neurotypical and post-stroke individuals. We hypothesized that H1) neurotypical individuals would display a weaker correlation between balance and step placement compared to post-stroke individuals, as post-stroke individuals typically have weaker ankles, which inhibit the ankle strategy that neurotypical individuals use to combat small perturbations. We also hypothesized that H2) correlations would be stronger for steps where the non-paretic limb is in stance in comparison to the paretic limb, due to the higher joint moment demand on the stance limb in comparison to the swing limb when making step width adjustments.

Methods: One post-stroke participant walked on a treadmill at 0.8 m/s while being exposed to ground translation perturbations. We applied 5 cm perturbations that varied in direction (anteroposterior, mediolateral) and onset timing (double stance; early, mid, late single stance). We applied each perturbation condition 3 times to the paretic and non-paretic limbs. We collected a full-body marker set and identified gait events using a kinematic method [2]. We calculated integrated frontal whole-body angular momentum (WBAM) using OpenSim and custom Matlab scripts. We calculated step width using the mediolateral distance between heel markers. We also used our previously collected open-source data set to provide 11 neurotypical participants with condition-matched perturbation trials for comparison [3]. We evaluated the correlation between integrated frontal WBAM and step width in the perturbed and recovery steps.

Results & Discussion: We expected low R^2 values for neurotypical individuals, as lateral ankle strategy is typically sufficient to combat minor amounts of instability whereas step width modulation is required for more severe perturbations. However, we still saw moderately strong correlations in the perturbed (R^2=0.46) and recovery (R^2=0.20) steps, which were roughly equal to or greater than the paretic and non-paretic comparison; this did not support H1. In the perturbed step, there is a stronger correlation in non-paretic stance steps (R^2=0.48) than in the paretic stance steps (R^2=0.27), supporting H2. However, in the recovery step, there was a stronger correlation in paretic stance steps (R^2=0.05) than in non-paretic stance steps (R^2=0), which does not support H2. These results are preliminary and only include a single stroke participant; we have collected and are analyzing additional post-stroke participants to incorporate in this analysis.

Significance: Understanding how individuals' balance and recovery strategies are affected following a stroke could enable therapy strategies that target more comparable balance responses to a neurotypical population. Additionally, uncovering asymmetries and insufficiencies in post-stroke balance recovery could help inform controllers for wearable robots that alter assistance between the paretic and non-paretic limbs or customize assistance to individual post-stroke users.

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References: [1] Weerdesteyn et al. (2008), *JRRD* [2] Zeni et al. (2008), *Gait Posture* [3] Leestma et al. (2023), *J Exp Biol*

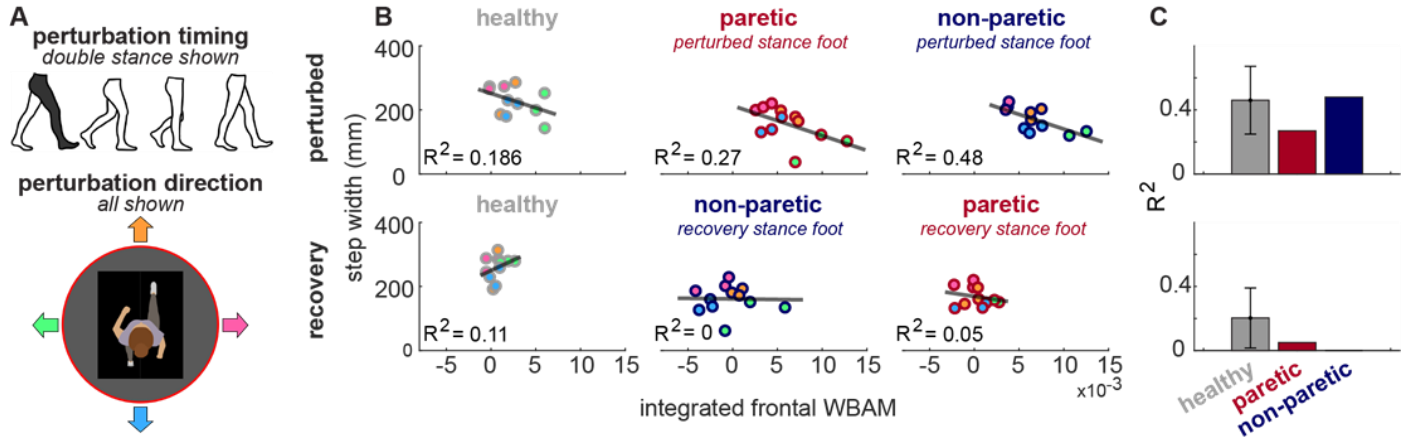

Figure 1: (A) Data shown in plots are for the double stance onset time across all perturbation directions. **(B)** Correlations between integrated frontal whole-body angular momentum (WBAM) and step width during the perturbed (top row) and recovery (bottom row) steps; grey outlines are for a representative healthy participant, red outlines indicate the paretic foot is in stance, navy outlines indicate the non-paretic foot is in stance. **(C)** The R^2 value for the relationships in the plots. The healthy group (grey) contains the mean and standard deviation for R^2 values from 11 participants, the paretic (red) and non-paretic (navy) data shows the R^2 value for a single stroke participant.