LOWER EXTREMITY MYOELECTRIC DIFFERENCES DURING LOCOMOTIVE STATE TRANSITIONS

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INTRODUCTION
Identifiable neuromuscular changes have been reported in speed transitions, yet little is known about what changes during state transitions [1]. The aim of this study is to assess relative peak activation and timing of peak activation during gait cycles around locomotive transitions.

METHODS
Fifteen able-bodied subjects provided written informed consent for this IRB-approved study (twelve male 23.5±4.5 years; 1.75±0.07m; 76.9±10.2kg and three female 21.3±1.7 years; 1.58±0.05m; 56.9±5.4kg). Surface electrodes were placed on the tibialis anterior (TA), medial gastrocnemius (MG), vastus lateralis (VL), rectus femoris (RF), biceps femoris (BF), gluteus maximus (Gmax), and gluteus medius (Gmed) of the right leg. Subjects completed eight transition types at a self-selected pace: Level Ground [LG] to Stair Ascent [SA], LG to Stair Descent [SD], LG to Ramp Ascent [RA], LG to Ramp Descent [RD], SA to LG, SD to LG, RA to LG, and RD to LG. Electromyography (EMG) data were collected at 1500Hz, bandpass-filtered (20-500Hz), full-wave rectified, and low-pass filtered with a 4th order Butterworth filter (6 Hz). Five consecutive gait cycles were analyzed for each transition with the third cycle ending at the heel-strike of the second locomotor state (Figure 1).

![Figure 1: Gait cycle definitions.](image)

Each gait cycle was partitioned into four phases: First heel contact (0% gait cycle), Stance (first 60% of gait cycle), Swing (last 40% of gait cycle), and the last moment before ensuing heel-strike (100% gait cycle). From each phase, peak amplitude and timing were extracted. Eight Two-Way (Cycles by Muscles) Repeated Measures ANOVAs (α<0.05) were used to determine main effects between cycles of the same transition. Post-hoc analysis was used to isolate cycle differences from Pre1 within a single transition (adjusted α<0.0125).

RESULTS AND DISCUSSION
Stair transitions, ascent and descent, demonstrated a greater number of significant changes in timing and peak amplitude than ramp transitions. As subjects transitioned from the first locomotive state to the second, the greatest change occurred from Tr to Post1, suggesting that a majority of the change occurs after the transition. However, activation changes were observed in Tr that carried through Post1, highlighting subtle identifiable differences that occurred before transition. Furthermore, the changes observed in Post1 continued through Post2 with minimal addition, suggesting that the transitional period was completed within Post1 (Figures 2 & 3).

![Figure 2: LGRA peak amplitude comparison between Pre1 and other gait cycles per phase. Gray: no significant difference, Green: significant increase.](image)

![Figure 3: LGSA peak amplitude comparison between Pre1 and other gait cycles per phase. Gray: no significant difference, Green: significant increase, Red: significant decrease.](image)

Sheehan & Gottschall [2] reported similar observations in approaching hill transitions, concluding that the transitional gait cycle is a unique, independent cycle that is neither a continuation of the first locomotor state, a switch to the second locomotor state, nor the average effect of the two states.

CONCLUSION
Stair transitions elicited more amplitude and timing differences than ramp transitions. Ramp and level-ground walking EMG patterns appear effectively indistinguishable. The shank musculature provided the most insight into EMG signaling differences. Ongoing research will investigate myoelectric differences in the contralateral limb during transition. These observations will benefit the design of more robust classification algorithms for the control of powered assistive devices.

REFERENCES