ARE EFFECTS OF MUSCLE FATIGUE THE SAME IN SINGLE AND DUAL TASK WALKING?

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INTRODUCTION
Simultaneously walking and performing a cognitive task may occur concurrently with increasing muscle fatigue toward the end of some daily activities or jobs. Walking has been shown to be altered with lower extremity fatigue [1, 2]. Although previous research has demonstrated independent effects of fatigue and working memory tasks on walking [3], their interaction is rarely considered. The purpose of this study was to examine changes in gait balance control and working memory task performance of healthy young adults when lower extremity muscles are fatigued.

METHODS
Twenty-three healthy adults (11 females, 20.7±1.3 yrs) performed the following three tasks before and after a muscle fatigue protocol in a random order: 1) walking at a self-selected speed, 2) sitting and performing a 3-back test, in which participants listened a series of digits over a loud speaker and were instructed to verbally respond “yes” whenever a digit matched the one from three steps earlier in the sequence (Nback), and 3) walking and performing a 3-back test simultaneously.

A 30-minutes sit-to-stand task at a pace of 0.5 Hz was performed to induce the muscle fatigue. The maximal voluntary isometric strength of knee extensors was assessed using a dynamometer immediately before and after the fatigue protocol and at the completion of the entire study protocol. Whole body motion data were collected from a set of 29 retro-reflective markers with a 10-camera motion system. The whole-body center of mass (CoM) was calculated as the weighted sum of 13 body segments. Gait speeds were calculated as the average forward CoM velocity during a gait cycle. Gait balance control was examined using the total medial-lateral center of mass displacement (M-LCoM) and peak forward velocity of center of mass (vCoM). Dependent variables for walking characteristics included stride length and stride width of a gait cycle.

Two-way ANOVA with repeated measures was used to examine effects of fatigue (pre- and post-fatigue) and gait condition (with and without concurrent cognitive task). Alpha level was set at .05.

RESULTS AND DISCUSSION
An average of 22.7% knee extensor strength reduction was observed immediately after the completion of fatigue protocol, and it was recovered to approximately 12.4% by the completion of study protocol. The average time-to-fatigue during the sit-to-stand task was 24.7 minutes.

Accuracy of 3-back test showed a significant interaction effect (Figure 1). The 3-back test was significantly less accurate in the dual-task condition than in the single-task condition. In single-task the accuracy improved after fatigue, while in dual-task the accuracy decreased after fatigue.

Significant main effects of fatigue (Table 1) and gait condition (Table 2) were observed in a variety of measured variables. Subjects both walked more slowly and had lower peak forward velocity when performing dual-task compared to single-task. Additionally, subjects before and after fatigue had significantly decreased stride lengths during dual-task relative to single-task. Stride length almost exhibited an interaction effect (p = 0.053).

On the other, subjects did demonstrate significant increases in stride width when fatigued during single- and dual-tasks. M-L CoM was not significantly affected by muscle fatigue or gait condition, although it was close to exhibiting a fatigue main effect (p = 0.052).

REFERENCES

ACKNOWLEDGEMENTS
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Table 1: Main effects of fatigue.

<table>
<thead>
<tr>
<th>Stride Width (cm)</th>
<th>Pre-fatigue</th>
<th>Post-fatigue</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8±0.4</td>
<td>8.7±0.04</td>
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Table 2: Main effects of gait condition.

<table>
<thead>
<tr>
<th>Gait Velocity (m/s)</th>
<th>Walking</th>
<th>Walking+Nback</th>
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</thead>
<tbody>
<tr>
<td>1.21±0.02</td>
<td>1.17±0.02</td>
<td></td>
</tr>
<tr>
<td>Peak Forward Velocity (m/s)</td>
<td>1.34±0.03</td>
<td>1.28±0.03</td>
</tr>
<tr>
<td>Stride Length (m)</td>
<td>1.22±0.03</td>
<td>1.17±0.02</td>
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