VISUAL FLOW DOES NOT ALTER MUSCLE ACTIVITY DURING TREADMILL WALKING OR RUNNING

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The current study examined the effect of visual flow (patterns of visual movement of surroundings) on muscle activity during treadmill walking and running. Participants (n=14) walked (1.39 m·s⁻¹) and ran (2.78 m·s⁻¹) in visual flow and control conditions. Activity of the vastus medialis (VM), biceps femoris (BF), gluteus maximus (GM), gastrocnemius (GA), tibialis anterior (TA), erector spinae (ES), rectus abdominis (RA), and C4 paraspinal (C4) were assessed via electromyography (EMG) during each condition. Repeated Measures ANOVA revealed EMG differences (p < 0.05) between walking and running for RA, VM, GM, and BF. There were no differences in speeds for the other muscles, or across the visual conditions for any of the muscles. Visual flow does not alter muscle activity during walking or running.

KEY WORDS: perception & action; peripheral effect; electromyography

INTRODUCTION: Treadmill locomotion (TM) has often been used as a training and/or research modality to examine overground locomotion. However TM, via either running or walking, has been shown to differ from overground locomotion (van Ingen Schenau, 1980; Frishberg, 1983; Lee & Hidler, 2008; Mooses, Tippi, Mooses, Durussel, & Mäestu, 2015). Thus the use of TM as a replacement for overground locomotion has been questioned. The cause of the difference has been theorized to involve visual and auditory feedback (van Ingen Schenau, 1980; Reiser, Pick, Ashmead, & Garing, 1995; Hashiba, 1998; Kong, Koh, Tan, & Wang, 2012) and resulting changes in muscle activity (Lee & Hidler, 2008). Visual flow refers to information obtained visually for self-motion and may provide the illusion of moving; thus it has been used as a means of adjusting locomotion (Mohler, Thompson, Creem-Regehr, Pick, & Warren, 2007). Visual feedback has been noted to be important in controlling posture during both static and dynamic situations (Hashiba, 1998; Derave, Tombeux, Cottyn, Pannier, & De Clercq, 2002; Brandt, 2003). Because visual flow can be used to alter movement, it was hypothesized to result in altered muscle activity during TM walking/running. However, the current authors are unaware of any research that has examined this question. Therefore, the purpose of the current study was to examine the effects of visual flow on muscle activity during TM walking and running.

METHODS: Fourteen participants (10 females, 4 males, Mean ± SD Age = 22.1 ± 4.1 years; stature 169.6 ± 8.9 cm; mass = 67.0 ± 12.0 kg) walked at 1.39 m·s⁻¹; then ran at 2.78 m·s⁻¹. Each speed consisted of two, 5 minute trials at a grade of 1% (Jones & Doust, 1996), one as a visual flow condition and one as a control. Walking trials always preceded running, while visual flow conditions were randomly assigned. All experimental procedures were reviewed by the Institutional Review Board (HS13-560) and the participants completed an informed consent and Physical Activity Readiness-Questionnaire before data were collected. A visual flow pattern of moving along a local street was projected onto three, 2.5m x 2.5m, rear projection screens located 1.5m in front and to either side of the participant. The design of the visual flow pattern at a speed comparable to the TM speed was chosen to elicit the illusion of walking/running with the scenery moving past the participant on the sides and toward them from the front.
RESULTS: Significant differences in the muscle activity between walking and running were found for the vastus medialis, biceps femoris, gluteus maximus, and rectus abdominis (p < 0.05), while other muscles did not differ (see Table 1). There were no differences in EMG across the control/visual flow condition for any of the muscles (p > 0.05); neither were there any significant interactions for speed versus visual condition (p > 0.05) for any of the muscles.

Table 1. Mean (±SD) muscle activity (mv) for walking and running with and without Visual flow (n = number of participants assessed for that muscle).

<table>
<thead>
<tr>
<th>Muscle Location</th>
<th>Walk Control</th>
<th>Walk Flow</th>
<th>Run Control</th>
<th>Run Flow</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectus Abdominis*</td>
<td>0.004618 (0.003482)</td>
<td>0.004827 (0.004055)</td>
<td>0.018261 (0.016295)</td>
<td>0.011381 (0.011584)</td>
<td>10</td>
</tr>
<tr>
<td>Vastus Medialis*</td>
<td>0.014591 (0.010697)</td>
<td>0.016799 (0.001169)</td>
<td>0.043155 (0.025389)</td>
<td>0.046418 (0.025762)</td>
<td>11</td>
</tr>
<tr>
<td>Tibialis Anterior</td>
<td>0.023739 (0.008885)</td>
<td>0.020151 (0.001118)</td>
<td>0.044229 (0.025018)</td>
<td>0.049636 (0.023863)</td>
<td>6</td>
</tr>
<tr>
<td>C4 Paraspinal</td>
<td>0.006435 (0.007053)</td>
<td>0.006503 (0.000784)</td>
<td>0.011987 (0.022577)</td>
<td>0.025177 (0.037755)</td>
<td>9</td>
</tr>
<tr>
<td>Erector Spinae</td>
<td>0.005943 (0.003266)</td>
<td>0.005658 (0.002376)</td>
<td>0.036267 (0.060030)</td>
<td>0.037033 (0.058685)</td>
<td>9</td>
</tr>
<tr>
<td>Gluteus Maximus*</td>
<td>0.011034 (0.008846)</td>
<td>0.007433 (0.004871)</td>
<td>0.015214 (0.009081)</td>
<td>0.015026 (0.007558)</td>
<td>7</td>
</tr>
<tr>
<td>Biceps Femoris*</td>
<td>0.009632 (0.005290)</td>
<td>0.011034 (0.005795)</td>
<td>0.030450 (0.009870)</td>
<td>0.032098 (0.016495)</td>
<td>9</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>0.016117 (0.003913)</td>
<td>0.016467 (0.006570)</td>
<td>0.061123 (0.091428)</td>
<td>0.063083 (0.008296)</td>
<td>6</td>
</tr>
</tbody>
</table>

* Significant difference between Walking and Running at the 0.05 level.

DISCUSSION: The main finding of the current study was that muscle activity, as assessed via EMG, was not affected during walking or running with visual flow. Previous authors have reported that visual flow influences the speed at which an individual changes from walking to...
running (Mohler et al., 2007) and balance following walking or running (Hashiba, 1998; Derave et al., 2002). Lee and Hidler (2008) have shown a difference in muscle activity between TM and overground walking for vastus medialis, biceps femoris, and tibialis anterior. They suggested that individuals altered muscle activity to achieve similar movement patterns. Because balance and locomotion speeds are both controlled by alterations of muscular contractions, it was hypothesized that muscular activity might also change between the visual flow and control conditions; however, this was not the case for the muscles examined in the current study. Reiser and colleagues (1995) suggest that other environmental factors (e.g. the sound of wind), biomechanical, and other proprioceptive feedback may also alter movement. Virtual reality goggles were considered rather than the screens used in the current study; however, it was felt that the size and weight would result in mechanical loading that would alter gait in and of themselves. Therefore screens were used in the current study.

Muscle activity was increased for running when compared to walking in the vastus medialis, biceps femoris, gluteus maximus, and rectus abdominis muscles. For the remaining muscles studied, a tendency toward greater activity was present during running, but the large degree of variability likely obscured any difference (see Table 1). An increase in muscle activity during running is in agreement with previous research (Kyröläinen et al., 1999; Jensen et al., 2015) and would be expected based on the increase in required force production during running (Kyröläinen et al., 1999).

**CONCLUSION:** The lack of differences in EMG between the visual flow and control conditions indicates that this aspect of visual information does not alter muscle activity when walking or running on a treadmill. As such differences identified between TM and overground running are likely due to other factors such as auditory, biomechanical, and/or proprioceptive feedback. Therefore it might be of interest to compare the effect of virtual reality goggles to screens and to overground locomotion to see if there are differences. In addition, further research regarding the cognitive effects/stimulation of normal treadmill walking/running vs. visual flow walking/running should be investigated.

**REFERENCES:**


