

CHANGING THE DEMAND ON SPECIFIC MUSCLE GROUPS AFFECTS THE WALK-RUN TRANSITION SPEED

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INTRODUCTION

Some have proposed that local, muscle specific factors trigger the walk-run transition. Hreljac (1995) suggested that overexertion of the ankle flexor muscles during fast walking triggers the walk-run transition. Similarly, Prilutsky and Gregor (2001) determined that swing-phase (flexor) muscles influence the walk-run transition speed. Contrary to the flexor muscle overexertion hypotheses, Neptune and Sasaki (2005) proposed that impaired force production in the ankle extensors makes fast walking less effective. They suggested that running at and above the preferred transition speed allows for an improved contractile state of the muscles.

Our purpose was to determine if changing the demand on the “trigger” muscles alters the preferred walk-run transition speed. We hypothesized that decreasing the demand on trigger muscles would increase the transition speed and conversely, increasing the demand on trigger muscles would decrease the transition speed.

METHODS

On 20 volunteers, we first determined the normal preferred walk-run transition speed (PTS) on a motorized treadmill using a step-wise protocol with a randomized speed order. We then determined PTS while subjects walked with external devices that decreased or increased the demand on specific muscles. We concurrently measured the electromyographic (EMG) activity of several lower leg muscles at each speed and condition.

One external device applied a horizontal force near the subject’s center of mass (Figure 1a). This force can pull the person forward, providing an aiding horizontal force (AHF) that decreases the need of the propulsive muscles (ankle extensors) during walking. Additionally, this device can pull the person backward, providing an impeding horizontal force (IHF) that increases the need of the ankle extensors during walking (Gottschall and Kram 2003). A leg swing assist (LSA) device applied forward pulling forces at the feet (Figure 1b), effectively

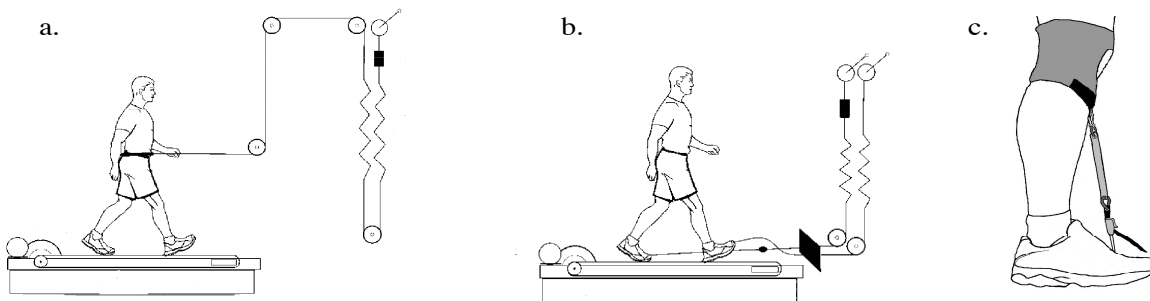


Figure 1. External assist devices: a) aiding horizontal force, b) leg swing assist, c) dorsiflexor assist.

aiding the leg muscles (hip flexors) during swing (Modica and Kram 2005). For this study, we developed a dorsiflexor assist (DFA) device (Figure 1c) that reduced the demand on the ankle flexor muscles. The DFA externally exerts a torque that reduces activity in the ankle flexor muscles during the first half of swing and at heel strike.

RESULTS AND DISCUSSION

When muscle demand was decreased (AHF, DFA and LSA), the preferred walk-run transition speed significantly, but modestly, increased ($p < 0.001$). When the muscle demand was increased (IHF) the preferred walk-run transition speed significantly, but modestly, decreased ($p < 0.001$).

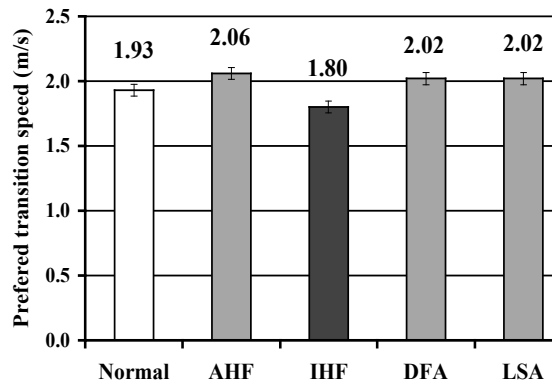


Figure 2. The preferred transition speed when walking normally and with external devices.

Compared to normal walking at the PTS, activity of the ankle extensor muscles (Figure 3a) was significantly less when walking with the aiding horizontal force (AHF) and significantly greater with the impeding horizontal force (IHF). Activity of the tibialis anterior muscle, an ankle flexor (Figure 3b), was significantly less during walking with the dorsiflexor assist (DFA). Rectus femoris (hip flexor) EMG decreased while walking with the leg swing assist (not shown).

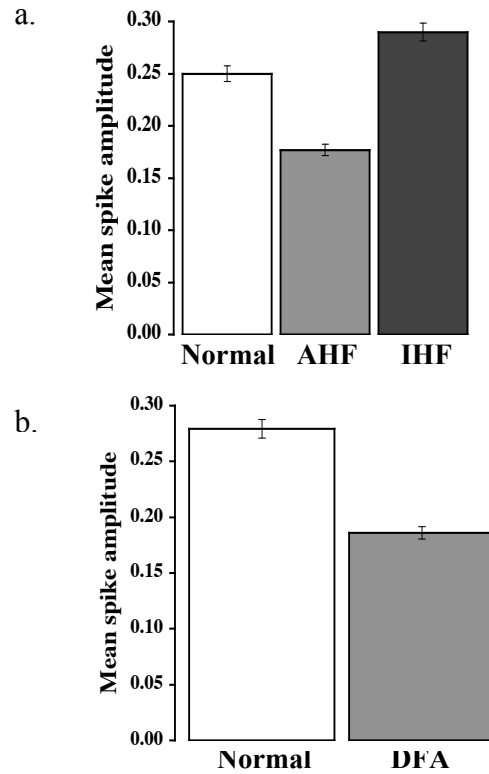


Figure 3. EMG activity of the medial gastrocnemius (a) and tibialis anterior (b) while walking at PTS normally and with external devices. Mean \pm SEM.

SUMMARY AND CONCLUSIONS

Changing the demand on specific muscle groups can alter the walk-run transition speed, supporting the idea that local, muscle specific factors trigger the walk-run transition.

REFERENCES

- Gottschall, J.S., Kram, R. (2003). *J Appl Physiol*, 94:1766-72.
Hreljac, A. (1995). *J Biomech*, 28:669-77.
Modica, J.R., Kram, R. (2005). *J Appl Physiol*, 98:2126-31.
Neptune, R.R., Sasaki, K. (2005). *J Exp Biol*, 208: 799-808.
Prilutsky, B.I., Gregor, R.J. (2001). *J Exp Biol*, 204:2277-87.