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## Background

Incline treadmill walking (ITW) has been used in different patients receiving physical therapy. Given the critical role of visual information in human locomotion, integrating visual perturbation (VP) to treadmill training could induce the challenge to patients, magnifying the training effects.

However, literature regarding how VP influences muscle activation during ITW is limited. Knowledge gaps exist in whether and how the muscle is modulated by the systematically manipulated visual information.

## Hypothesis

We hypothesized that VP could increase muscle activation during ITW, and larger VP could elicit higher muscle activation.

## Experimental Setting

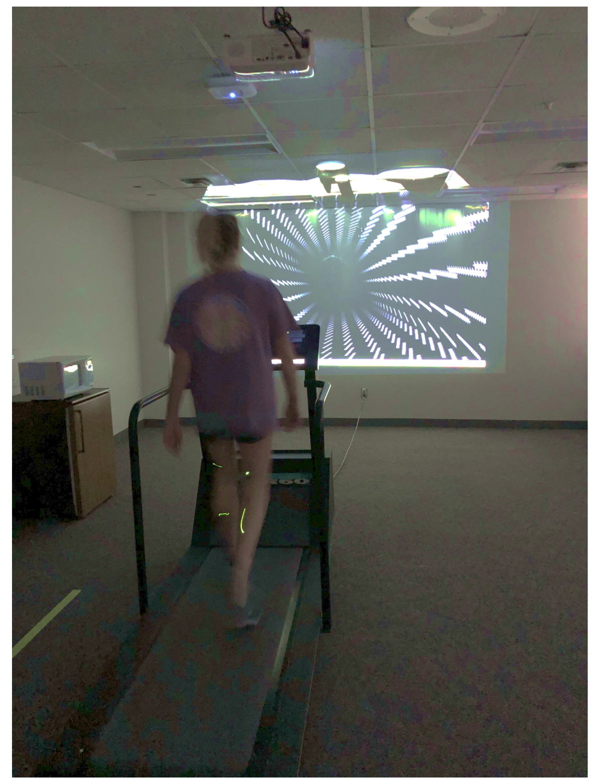

**Figure 1.** A virtual moving corridor was projected in front of the treadmill to display optic flow, and the VP was created by rotating the optic flow.

Experiment One (EXP1): 12 females, 6 males. Age: 24±2.3 years old.

Experiment Two (EXP2): 7 females, 3 males. Age: 23±1.2 years old.

For both experiments, the surface electromyography (EMG) was used to record the muscle activation of quadriceps, hamstring, tibialis anterior (TA) and gastrocnemius of the right leg.

Root-mean-square (RMS) of the EMG was calculated at the stance phase, swing phase and the total gait cycle.

## Methods

EXP1: The subjects were instructed to walk on the treadmill at the preferred walking speed for 8 conditions (two visual conditions: normal and VP; four inclinations of treadmill: 0,3,6,9-degree) with 2 minutes each. In the normal condition, the optic flow was in concert with the walking speed. In the VP condition, the optic flow rotated for 180˚ at 20˚/s.

EXP2: There were 4 conditions on the 9-degree incline treadmill, consisting 360˚ rotating VP at 4 different speeds (10˚, 20˚, 30˚, 60˚/s). All the other settings were the same as EXP1.

## Results- EXP1

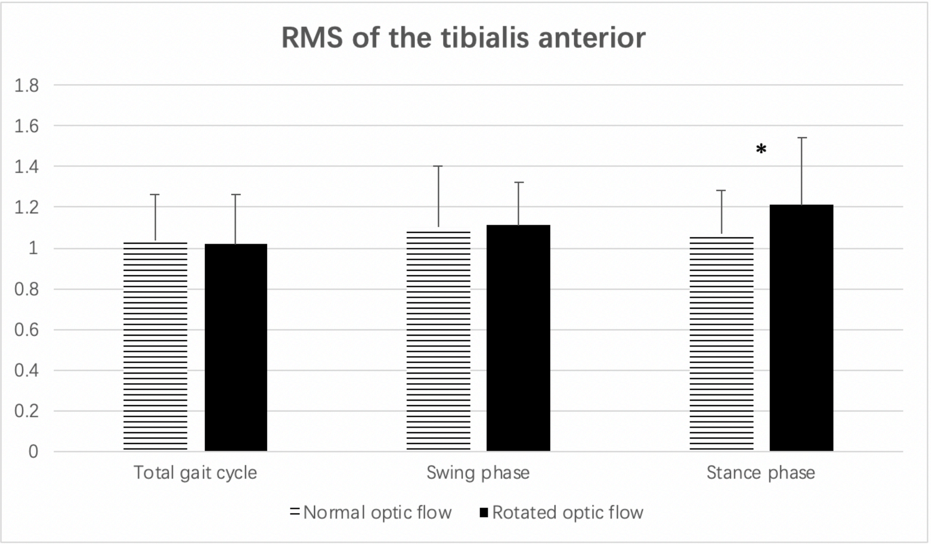


**Figure 2**. For the TA, the RMS of VP condition was higher than normal condition (P=0.004) at the stance phase, whereas no significant difference for other gait events.

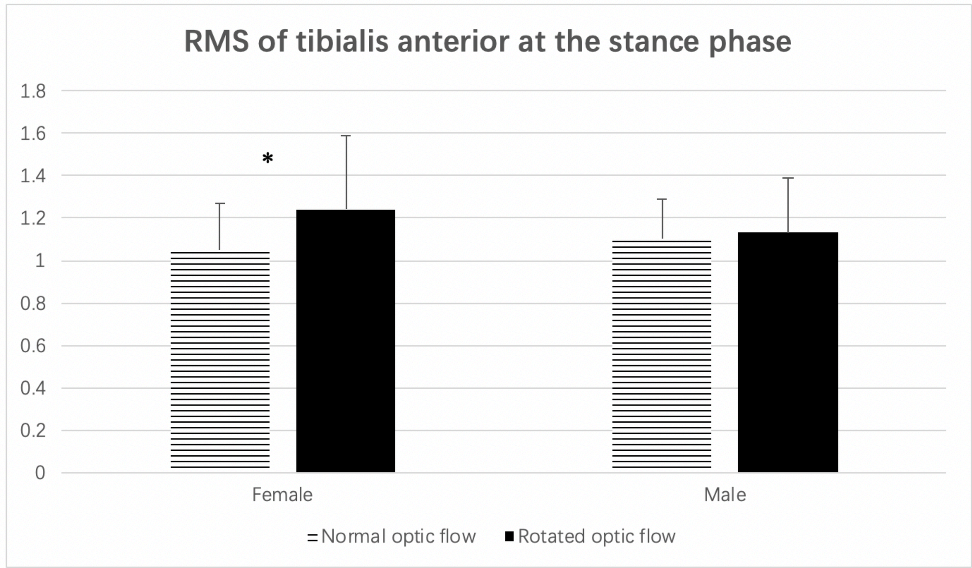


**Figure 3.** For the RMS of TA at stance phase, VP was significantly higher than normal condition only in females (P< 0.05), not in males (P> 0.05).

## Results- EXP2

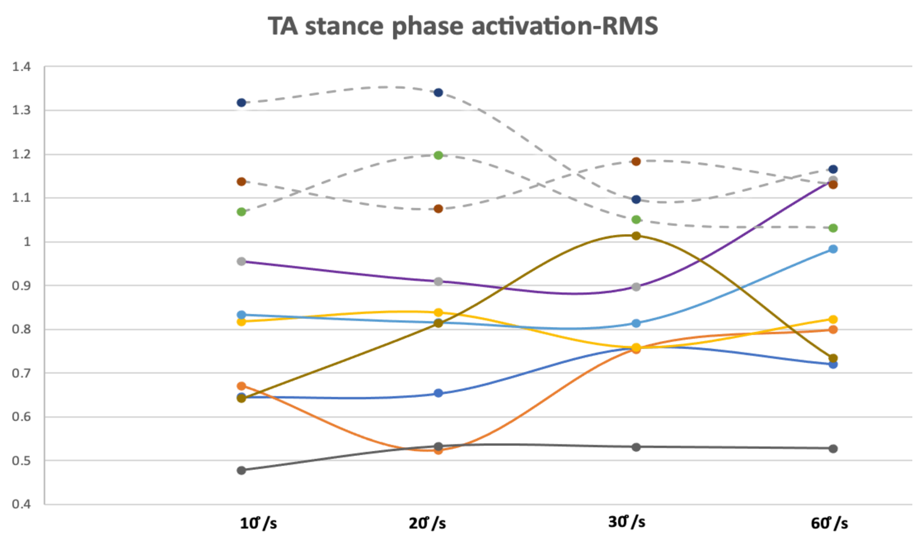


**Figure 4.** With limited samples in EXP2, the individual descriptive analysis was used and indicated that 6 females and 1 male exhibited higher TA activation at 60˚ VP compared to 10˚ VP at the stance phase.

## Conclusions

Integrating VP into ITW could elicit specific muscle response. VP increased the TA activation at the stance phase during ITW, and this effect was found dominantly in females. Specifically, higher magnitude of VP could elicit higher TA activation.

## Clinical relevance

The effect of ITW regarding muscle activation could be augmented by adding environmental challenges, such as virtual optic flow. VP could be integrated into ITW to elicit specific muscle activation; however, the magnitude of VP needs to be considered based on the expected outcome of training.

The gender difference on responding to VP might lead to additional consideration in designing the ITW protocol. Further research is warranted to confirm such unexpected gender discrepancy.

## References

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3. M.M. Salinas, et. al., How humans use visual optic flow to regulate stepping during walking, Gait Posture (2017)