The effect of a cognitive task and an attentional focus on postural control

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Abstract

Recent studies have shown that the use of an external focus has a favorable effect on posture (Frazer, 2008 and Wulf et al., 2001). Furthermore, the execution of a cognitive task leads to a significant improvement of an individual's posture in comparison to the effect of an external focus (Polskaia et al.,2014). It is hypothesized that the possibility of an automated mode caused by stiffness in the ankles and a reduction of degrees of freedom could be associated with that. In this study, measurements of the electrical activity in the muscles associated with ankle movement will be analysed under different conditions to evaluate postural control. This will be used to determine if improvement in posture is due to ankle stiffness, or if it is due to the aforementioned automated mechanism.

Muscle stiffness is not expected to be associated with postural control in any of the conditions. Posture will rather be controlled by automated mechanisms responsible for postural control.

Method

- Thirteen participants, young adults (19.8±2.7)
- Five 60 second trials per condition were conducted. For all trials, participants were asked to stand and remain as immobile as possible on the forceplate with their feet together and their arms at their sides. EMG electrodes were placed on the tibialis anterior and medial gastrocnemius to measure electrical activity in the muscles. All trials were randomized.
- 5 conditions were performed:
    - Standing feet together (FT).
    - Internal focus (IF): minimizing movement of the ankles.
    - External focus (EF): minimizing movement of markers on the ankles.
    - Single number sequence (SNS): counting the occurrence of a randomized single digit in an auditory 3-digit sequence recording.
    - Double number sequence (DNS): counting the occurrence of two randomized single digits in an auditory 3-digit sequence recording.

Statistics

- Multiple ANOVAs were used to determine the significance of the data for each of the five conditions.
- Simple effects and interactions were then decomposed once significant.

Results

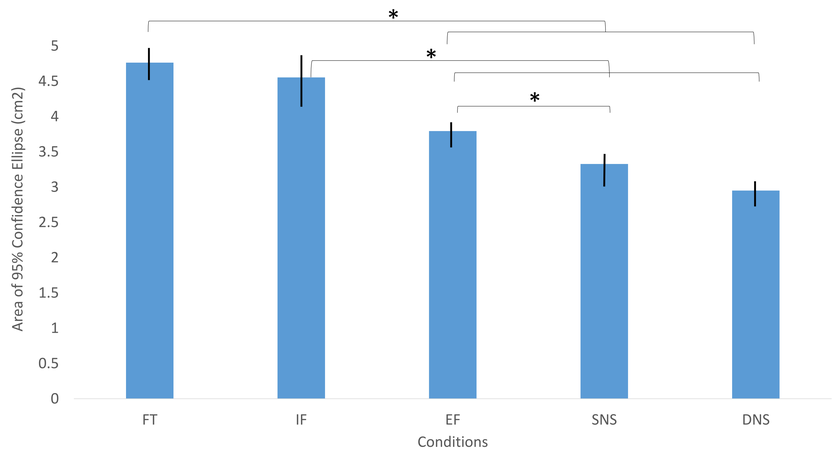

Fig.1: Mean + SD of area of 95% Confidence Ellipse (cm2) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=14.00: *p<0.00001)

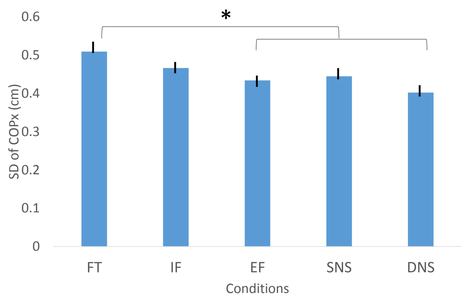

Fig.2: Mean + SD of COPx (cm) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=7.38: *p<0.0001)

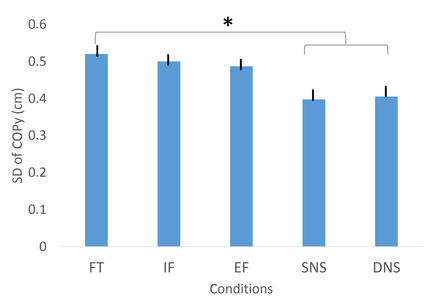

Fig.3: Mean + SD of COPy (cm) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=6.35: *p<0.0004)

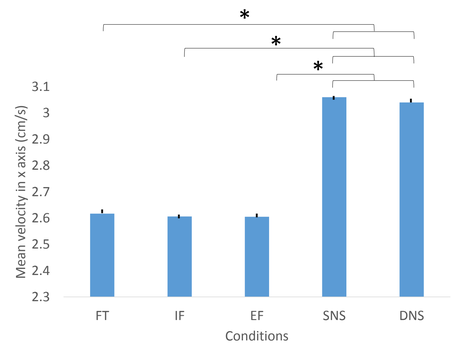

Fig.4: Mean + SD of velocity in x (cm/s) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=28.25: *p<0.00001)

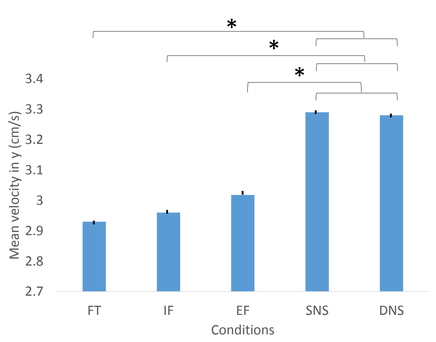

Fig.5: Mean + SD of velocity in y (cm/s) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=29.72: *p<0.00001)

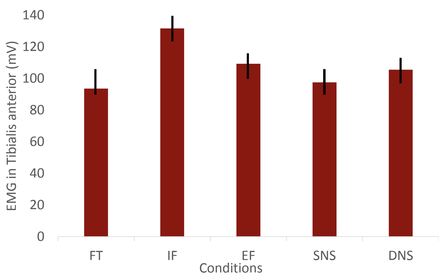

Fig.6: Mean + SD of electrical activity in tibialis anterior (mV) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=1.55: p<0.05)

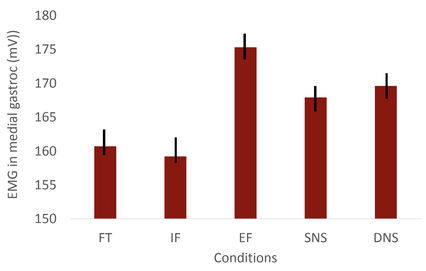

Fig.7: Mean + SD of electrical activity in medial gastrocnemius (mV) with feet together, internal focus, external focus, DNS and SNS. (F(4,48)=0.22: p<0.05)

Discussion

- There is a significant improvement in postural stability in the area of 95% confidence ellipse between internal/external focus and SNS/DNS suggesting that posture is improved when executing a cognitive task (Polskaia et al.,2014).
- Velocity in x and y is higher in SNS and DNS conditions. This leads to the belief that ankle stiffening is the responsible factor, but as shown by Fig. 6 and 7, there was no significant difference in muscle activity between internal/external focus and SNS/DNS conditions.
- Improvement in the posture when executing a cognitive task such as SNS and DNS are not due to ankle stiffening but perhaps to an automated mechanism regulating posture that requires further research.
- No significant difference in electrical muscle activity was obtained throughout all conditions.

Conclusion

- Electrical activity in the medial gastrocnemius and the tibialis anterior did not show any stiffening for any of the conditions of this study. Therefore, they are not a contributing factor to postural control.
- Posture is controlled by automated mechanisms during cognitive tasks and attentional focus. These automated mechanisms do not involve any muscle contractions around the ankles.

References

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- Wulf G, *Directing attention to movement effects enhances learning:* A review. Pychonomic bulletin and review, 2001, 648-660.
- *Polsakaia N. et al, Continuous cognitive tasks promotes greater postural stability than an internal or external focus of attention.* Gait and posture, 2014.