WALKING AND POLE WALKING AT DIFFERENT SPEEDS: ANALYSIS OF MOVEMENT PATTERN AND COMPLEXITY

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Introduction
Pole walking (PW) is a walking-like physical activity that has increased in popularity in recent years. Compared to ordinary walking (OW) PW has been associated to additional trunk muscle coactivation (Zoffoli et al., 2016). However, there is a paucity of research on how the use of poles may influence the shape and complexity of the walking pattern and thus the stress induced to the body by the poles during walking. Accordingly, this study compared the shape and complexity of the OW and PW movement patterns at different speeds.
Methods
Two accelerometers were secured at C7 and S2 level on 20 healthy adults prior to performing a W and a PW bout of 1 minute at 60% and 100% of the walk-to-run preferred transition speed (PTS-60 and PTS-100, respectively). The anterior-posterior (AP), medial-lateral (ML) and vertical (VT) accelerations (ACC) of 30 strides per trial were analyzed. Movement complexity (ENT) was evaluated in each direction by the fuzzyEn algorithm. The effects of walking style (OW or PW) and speed (PTS-60 or PTS-100) on ENT and shape of the ACC patterns were investigated for the AP, ML and VT directions at both C7 and S2 level using a zero- and a one-dimensional 2-way repeated measures ANOVA (Pataky et al., 2015), respectively. Similarly, zero- and one-dimensional paired t-tests were used for posthoc comparisons. The alpha level of significance was set at 0.05 with Bonferroni corrected p-values for the multiple tests.
Results
Compared to the lower speed, walking and pole walking at the higher speed increased ENT in all directions and acceleration amplitude in the AP and VT directions, at both C7 and S2 level. At C7 level only, but for the majority of the phases of the stride, PW increased ENT significantly more than OW in all directions at both speeds. At C7 level, PW also resulted in greater acceleration amplitudes than OW, particularly during the mid-stance phase of the stride (VT direction), and in higher deceleration peaks at the toe-off (both AP and VT directions).
Discussion
Compared to OW, the increased ACC (AP and VT directions) at C7 level found during PW suggests that the use of poles requires greater upper trunk oscillation. PW is also associated to higher movement complexity over OW, possibly because of the increased arm engagement. In conclusion, an increased level of trunk muscle coactivation during PW may be required to contrast the higher upper-trunk ACC and ENT.
References
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INDIVIDUAL GAIT PATTERNS IDENTIFIED WITHIN A LONG-TERM FOLLOW-UP STUDY

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Introduction
Despite the common knowledge about the individual character of human movements, inter-individual differences in gait patterns are often neglected in biomechanical analysis and therapeutic interventions, as they are rather oriented on the idea of average behaviour and normality. Previous studies could distinguish gait patterns from individuals and emphasize the relevance of individualized diagnoses and therapy (Schöllhorn et al., 2002). However, small sample sizes are a limitation in the field of probabilistic subject identification on the basis of gait patterns and little is known about the persistence of subject-specific characteristics over time. The aim of this study was (1) quantifying the distinction of gait patterns from individuals within a larger sample and (2) quantifying the long-term (7-16 month) persistence of individual gait patterns.
Methods
A sample of 128 healthy participants (52 female, 76 male; M age: 23.8 years, SD 9.1) walked 10 times a distance of 10 m. Two force plates (Kistler, 1000 Hz) recorded the three-dimensional ground reaction forces during a double step at a self-selected walking speed under barefoot conditions. A subsample of 46 subjects repeated this procedure after 7-16 months. Firstly, the data from 128 subjects who participated in the first assessment session was classified by means of support vector machines (subject-classification). Secondly, the data from 46 subjects who participated in both assessment sessions was classified in order to quantify the persistence of individual gait patterns (subject-follow up-classification). The classification rates were calculated by means of the Liblinear Toolbox 1.4 (Fan et al., 2008) using a leave-one-out cross-validation.
Results
The application of support vector machines resulted in a classification rate of 99.8% (1278 out of 1280) and 99.4% (914 out of 920) for the subject-classification and the subject-follow up-classification, respectively.
Discussion
The present study pointed out that gait patterns based on time-continuous three-dimensional ground reaction forces were unique for an individual and could be differentiated from those of other individuals. Within a sample of 128 subjects, support vector machines classified gait patterns almost error-free to the corresponding individual. Hence, human gait is not only somehow different between individuals, but rather exhibits unique characteristics for an individual that are persistent over months or years. Our findings provide evidence for the clearly individual nature of human walking and emphasize the demand to evaluate clinical approaches for diagnoses and therapy that are based on individual needs.
References
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