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## **IDENTIFICATION OF INDIVIDUAL GAIT PATTERNS BY MEANS OF SUPPORT VECTOR MACHINES**

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Human movements exhibit individual features, which should find consideration in training [1]. Differences of gait patterns from different individuals have been stated by inter-subject variability [2]. Within this range of variability, gait patterns from individual persons can be distinguished from each other by pattern recognition tools [3, 4]. However, small sample sizes are a limitation of previous studies on individual gait characteristics.

**Research aim** - to search for discernable characteristics of time continuous gait patterns between individual persons by means of support vector machines.

**Methods.** 128 healthy subjects (52 female, 76 male;  $23.8 \pm 9.1$  years;  $1.76 \pm 0.08$  m;  $71.3 \pm 13.0$  kg) without gait pathology and free of lower extremity injuries participated in the study. The study was carried out according to the Declaration of Helsinki and all subjects provided their informed written consent. The subjects walked ten times over a distance of ten meters, while the three-dimensional ground

reaction force was recorded by two force plates (Kistler, Type 9287CA, Switzerland) at a frequency of 1000 Hz. The subjects were instructed to walk barefoot at self-selected speed. The gait analysis was conducted for one gait stride per trial. The stride was defined from right foot heel strike to left foot toe off and was determined using a vertical ground reaction force threshold of 25 N. The ground reaction force data was filtered by a second order Butterworth bidirectional lowpass filter at a cut off frequency of 30 Hz and normalized to the subject's body mass. Each variable was time-normalized to 100 data points and scaled to a global minimum of 0 and a global maximum of 1. The classification of gait patterns based on concatenated vectors of all variables, which results in an input vector of 1x600 per trial. In total, a matrix of size 1280x600 (1280 = 128 subjects x 10 trials; 600 = 100 time points x 2 ground contacts x 3 dimensions) built the data basis of the support vector machines classification. Support vector machines [5] are supervised learning approaches for pattern recognition. The ability to distinguish gait patterns of one subject from gait patterns of other subjects has been investigated in a multiclass classification using a "one-versus-all" algorithm. The L2-regularized L2-loss support vector classification of the Liblinear Toolbox 1.4.1 [6] was used with a linear kernel function. The classification rates were conducted by a cross-validation through the leave-one-out-method [7].

**Results.** The results emphasize the remarkable amount of individual characteristics in human gait. The application of support vector machines result a classification rate of 99.6% or rather 1275 of 1280 gait vectors have been assigned correctly to the corresponding individual. Thus, support vector machines are able to find unique characteristics for gait patterns of an individual, which can be differentiated from gait patterns of other individuals. A comparison between the given classification rate of 99.6% and the theoretical random classification rate by dividing one by the total number of cases (in this experiment  $1/128 = 0.8\%$ ) verifies the significance of

the present findings. The results are in agreement with previous studies [3, 4] and show even higher classification rates, which might be due to barefoot walking and unchanged walking condition in the present study. Furthermore, the results emphasize that clustering normal subjects into “families” of walking strategies or functional groups [8] as well as quantifying the amount of variability in terms of inter-subject-variability [2] are coarse approaches on the topic of individual differences in gait patterns. Individual differences of gait patterns illustrate their importance for therapy [3, 9] and the design of investigations [8]. In this context, gait analysis based on group averages and normal reference data might not be capable to respect individual needs properly.

**Conclusions.** Similar to the human finger print, gait patterns exhibits unique characteristics for an individual person. Gait patterns from different individuals can be distinguished for a comparatively large sample of 128 subjects and provide evidence for the clearly individual nature of walking. Hence, diagnoses and therapy should respect individual persons rather than focus on stereotypes and normal data.

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**RELATIONSHIPS BETWEEN ADOLESCENTS AND THEIR BEST CLASSMATES' PHYSICAL ACTIVITY: A PILOT STUDY IN LITHUANIAN, NORWEGIAN AND SWEDISH HIGH SCHOOLS**

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Physical activity (PA) plays an important role in our life because of several reasons. Well known that regular physical activity reduce the risk of: hypertension, coronary heart disease, diabetes, stroke, cancer or depression (1). That's why it is important to understand physical activity determinants. In one study it was find out, that boys and girls of primary school, whose best friends are physically active, have higher level of physical activity (2).

**Research aim** - to investigate the relationships between high school students' of Lithuania, Sweden and Norway and their best class friends' physical activity levels.