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Psychological stress affects trial-to-trial variability of temporal-spatial gait parameters, but not of muscle synergy activation coefficients

Paul Kaufmann [1], Catherine Hlavac [1], Clara Scheer [2], Matthias Wiplinger [1], Arnold Baca [1], Hans Kainz *[1]

[1] *University of Vienna, Biomechanics- Kinesiology and Computer Science in Sport - Centre for Sport Science and University Sports, Vienna, Austria*

[2] *University of Vienna, Biomechanics- Kinesiology and Computer Science in Sport - Sport Psychology, Vienna, Austria*

Introduction

The muscle synergy theory posits that a limited set of spatially fixed synergy vectors is activated through central commands – known as activation coefficients [1]. Recent studies showed that the trial-to-trial variability of temporal activation coefficients plays a crucial role in movement control [2, 3].

In everyday life, we face a lot of psychological stressors, commonly induced by situations of social threat [4]. It has been demonstrated that posture and movement are strongly influenced in situations of stress. For instance, acute stress led to freezing gait behaviors [5] and changes of temporal and spatial gait parameters [6]. However, the impact of acute stress on muscle synergies remains uncertain.

Research Question

Is the trial-to-trial variability of temporal-spatial gait parameters and synergy activation coefficients influenced by psychological stress?

Methods

Eight participants (23.7 ± 2.8 years) performed two walking conditions on a treadmill with self-selected and constant velocity in a randomized order: normal walking (NORM) and walking under psychological stress (STRESS). The Paced Auditory Serial Addition Task [7] was employed to induce stress. Electrodermal activity electrodes (Shimmer3 GSR+ Unit) measured tonic skin conductance, force insoles (Novel, Germany) determined foot contacts, and surface electromyography electrodes (Cometa, Italy) recorded the activations of 4–7 muscles on each leg. The participants' stress level was characterized by the averaged z-normalized values of processed (PhysioData Toolbox) tonic skin conductance signals. The stance-phase to gait-cycle ratio was used to determine the temporal-spatial aspect of gait, with the coefficient of variation among steps characterizing trial-to-trial variability. Filtered, rectified, time and amplitude-normalized electromyography signals from both conditions were concatenated to extract muscle synergies via non-negative matrix factorization [8]. The knee-point of the total variance accounted for curve determined the number of required synergies [9]. The trial-to-trial variability of synergies was calculated as the average Pearson correlation coefficient (z-transformed [10]) of all pairwise combinations of activation coefficients from different gait cycles within each synergy for each condition [2]. Paired t-tests assessed differences between NORM and STRESS for the stress level, temporal-spatial gait variability, and activation coefficient variability.

Results

Participants exhibited higher stress levels ($p < 0.01$) and increased temporal-spatial gait variability ($p < 0.05$) in STRESS compared to NORM. Three to seven synergies were required to perform the walking tasks. No significant difference was observed for the variability of synergy activation coefficient (Figure 1).

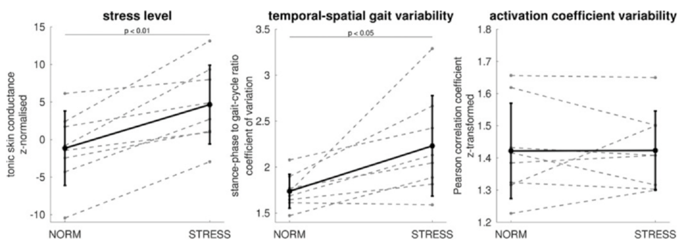

Figure 1: Dashed lines = individual participant. Thick line = mean and standard deviation across participants.

Discussion

In line with previous studies [6], our results showed that psychological stress increases the trial-to-trial variability of the temporal-spatial gait parameter, therefore decreasing movement consistency. Surprisingly, the trial-to-trial variability of synergy activation coefficients was not different between NORM and STRESS. This suggests that, regardless of movement alterations during stress, the underlying movement control mechanisms remain unaffected.

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Asymmetric sitting may contribute developing asymmetric hip and pelvis rotational profiles during walking for healthy adolescents: A pilot study

Buse Kara *[1], Aleyna Kızılcan [1],
Nazif Ekin Akalan [1,2], Shavkat Kuchimov [2]

[1] *Istanbul Kultur University, Faculty of Health Sciences-Division of Physiotherapy and Rehabilitation, Istanbul, Turkey*
[2] *Istanbul Kultur University, Motion Analysis Center, Istanbul, Turkey*

Introduction

Sitting behavior in developing children is highly variable, and loads are variably distributed to lower extremity joints such as the hip and pelvis. Depending on sitting behaviors, loads are applied to the hip and pelvis in three planes, which can slightly influence the musculoskeletal structure around the proximal femur over time. Slight musculoskeletal changes on the hip and pelvis can alter walking biomechanics. Therefore, the purpose of the study is to investigate the relationship between sitting behavior, rotational hip, pelvis kinematics during walking in typically developing adolescents.

Research Question

How does different sitting postures affect typically developed adolescents' rotational pelvic and hip kinematics during walking?

Methods

7 healthy [Age: 21,14 ± 1.46, height:160,78 ± 6.10 cm, weight: 54,6 ± 4.97 kg Bmi:20,74 ± 1.21 kg/m2] volunteers participated in the study. Families were requested to provide photographs of their childhood (1-5y,o) sitting positions on the floor by sending photography. According to hip rotations, sittings were divided into