EFFECT OF FATIGUE ON MOTOR SYNERGIES

Abstract

Motor synergies are defined as a specific central nervous system organization that maintains the task-specific stability of motor actions. The uncontrolled manifold (UCM) analysis has been used to assess motor synergy. The UCM allows for a quantitative variability assessment of body structures involved in the movement, which occurs from repetition to repetition during the performance of the motor task. Moreover, motor synergies and the UCM assume a hierarchical organization of the system with effective control of movements with at least two levels of control (higher and lower).

Because in the fields of kinesiology, sports sciences and physiology, the effects of fatigue on strength and endurance have been studied the most it is relatively well understood. Moreover, based on the current state of knowledge, it is not possible to clearly determine the effects of fatigue on motor coordination (in the aspect of forming motor synergies). Therefore, the main aim of this dissertation was to determine the impact of different types of fatigue on the formation of motor synergies.

38 right-handed, males voluntarily participated in the study. Data collections were divided into 3 stages. The first two stages assessed the reliability of a novel measurement system and a pilot for the third stage. An experimental method was used. A 10-channel surface electromyography (EMG) and a measuring device created for the purposes of the experiment dedicated to measuring forces through the upper limbs were used. Five dominant and non-dominant limb muscles were selected for the analysis of EMGs: biceps brachii, brachialis, brachioradialis, flexor carpi radialis, and flexor carpi ulnaris.

The first stage of the study aimed to determine the reliability for the created measuring system "DIATOS". The second stage was performed to determine the necessary number of trials for the application of UCM analysis in the force production task with different levels of intensity. The test measurements (stage III of the study), preceded by a specific warm-up, consisted of eight consecutive sessions in the laboratory with an interval of at least 48 hours between each sessions. All motor tasks in the third stage were performed in a sitting position in static conditions, using Scott's bench. Participants perform efforts dedicated to the upper limbs (dominant, non-dominant, both limbs) in different conditions (static, dynamic). The main task of the study was the force production task of the intensity of 30% of the MVF *(ang. maximal*

voluntary force) test and comprised of 15 repetitions of the elbows flexion immediately after performing a given fatigue protocol.

The conducted reliability analysis using the intraclass correlation coefficient (ICC) showed excellent reliability of the measuring system "DIATOS" and allowed to determine the necessary number of trials of the motor task to identify motor synergies reliably. In order to assess the impact of fatigue on the studied motor task, a one-factor analysis of ANOVA (factor: fatigue) was used, while to determine the differences between the types of fatigue and between the conditions of their performance, a 2 x 3 repeated measure ANOVA (factors: fatigue, limb) analysis was used. Fatigue significantly affected the examined motor task. A decrease in the generated forces, an increase in the EMG and a decrease in the frequency of the EMG signal was demonstrated. In addition, for the effective performance of the examined motor task, the choice of the limb that performed the effort turned out to be more important than the conditions for its performance. The performance of efforts of various nature also significantly influenced the formation of motor synergies. For muscle synergies, changes were shown for factor loadings, determining the role of individual muscles in synergy during the performance. For motor synergies of both higher and lower levels of hierarchical control, a significant increase in the variance obtained after fatigue was demonstrated. A higher level of assumed control showed greater sensitivity (increase in synergy and positive variability) to the indicated changes than a lower one (increase in negative variability). In addition, significant differences in the synergy ratio (higher hierarchical level) between the fatigue conditions (static/dynamic) were demonstrated. Based on the results obtained, further research related to the effect of fatigue on the formation of motor synergies is necessary.