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JANUSZ LAPSZO, MARTA WARCHALEWSKA, BEATA LATECKA, KATARZYNA PRUSIK
University School of Physical Education and Sport, Gdańsk, Poland

THE INFLUENCE OF MOTOR ACTIVITY ON THE SPEED OF SEQUENTIAL, RECIPROCAL AND CYCLIC ARM MOVEMENTS AT AN ADVANCED AGE

INTRODUCTION

Daily arm activities are usually performed in the form of sequential, reciprocal and cyclic movements. Aging slows down our motor control and the execution processes [1]. At the advanced age changes in the central nervous system [7, 8] and in muscle composition and activation occur. A reduction in neurons occurs in the brain regions that are related to movements. Aging changes in the motor system are connected with the loss of muscle mass [5] and slower contracting muscle fibres [6]. Motor and intellectual activity can slow down the aging changes in the nervous (information) and execution (motor) systems.

The present study was aimed at investigating the influence of an active lifestyle on the speed of movements that are fundamental for daily motor activity (food preparation, gardening, office work etc.). We tested the speed of motor active (declaring specific motor activity) and inactive people. 22 active (12 males and 10 females, mean age of 69.6 years) and 22 inactive (12 males and 10 females, mean age of 72.1 years) elderly subjects participated in the study. The sequential and reciprocal movements were tested with the use of a set of micro-switchers, computer keyboard, digitizer, optotrack and video technique. The application of tactile sensors (comfortable movement performance, no markers) with a relatively big tactile plate in our study enabled performing movements with a real maximum speed (no mechanical parts to be pressed) and in conditions similar to daily motor activities. Many other studies tested tapping, finger and foot tapping speed, tapping forces, pointing, and hitting targets. Cognitive self-regulation, anxiety and memory were also examined on the basis of tapping. The horizontal forearm tapping, measured in this study, constitutes the fundamental movement for such daily activities as cleaning windows, washing up, stirring liquids, etc, and it occurs more often in daily life than finger or leg tapping, pointing or hitting the targets.

METHODS

A psychomotor efficiency timer consisting of a computer, a controller and a measurement station was used in the study [3]. The measurement station consisted of a measurement plate and six tactile sensors located in different places in the sequential (Fig. 1, a) as well as the reciprocal and tapping (Fig. 1, b) movement tasks. The tested movements were performed with the right and left hand in response to light and sound signals from the sensors. The movement initiation (MIT), execution (MET) and total time (MTT) were measured. MIT expresses the time from touching one sensor to releasing it, while MET from releasing one sensor to touching another. MTT is a sum of MIT and MET and it expresses the speed of information and execution processes (psychomotor process speed), while MIT and MET are measures of information (MIT) and execution (MET) processes speed. The sequential and reciprocal movement psychomotor speed was analyzed. MIT and MET were measured separately, while the tapping speed in a comprehensive way (only MTT).

In the sequential movement task the subjects followed the light coming on in the sensors located in the corners of a 25 cm side square. Sensors 1, 2, 3 and 6 and 3, 4, 5 and 6 were used to test the left and the right hand sequence speed, respectively. Both kinds of sequences started from sensor no. 6. The subjects performed a 12-movement constant (the same order of movements) sequence, three times with each hand, in seven sequences. Four sequences were masking sequences. The left-hand sequences were mirror reflections of the right-

Correspondence should be addressed to: Janusz Lapszo, University School of Physical Education and Sport, ul. Wiejska 1, 80-336 Gdańsk, Poland, e-mail: Lapszo@awf.gda.pl

hand sequences. The average movement initiation (MITS) and execution (METS) times for 11 movements (after the sequence initiating performance of the first movement) in the constant (psychomotor speed in movement sequencing) and three trails were the final results of the experiment.

In the reciprocal movement task subjects performed reaching movements from the same starting position (Fig. 1, b) in five different directions to the sensors located on the perimeter of a circle of a 25 cm radius (Fig. 1, sensors 1, 2, 3, 4). The subjects performed four series of ten movements. The average movement initiation (MITR) and execution times (METR) for all movements in the series and the last three tests (series) for the left (MITRl, METRl) and the right hand (MITRr, METRr) were the final results of the study (Fig. 3 and 4).

The tapping was performed in the horizontal plane between the starting position sensor and two other sensors (sensor 1 – left hand, sensor 5 – right hand tapping, Fig. 1).

Subjects performed two trials of eleven movements for each hand. The average tapping movement total time (MTTT) for all movements and all trails for the left (MTTTl) and the right hand (MTTTr) were the results of the study (Fig. 2 and 3). In each task subjects performed one trail as a learning trail.

RESULTS

The ANOVA analysis was used to investigate the differences between the tested groups. The obtained results are presented in figures 2 and 3.

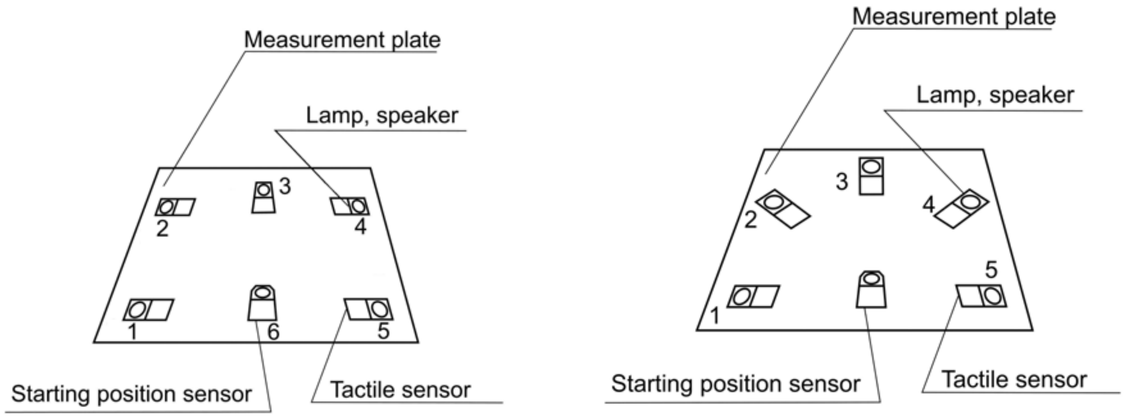


Figure 1. The sequential (a), reciprocal and tapping (b) movement speed measurement station

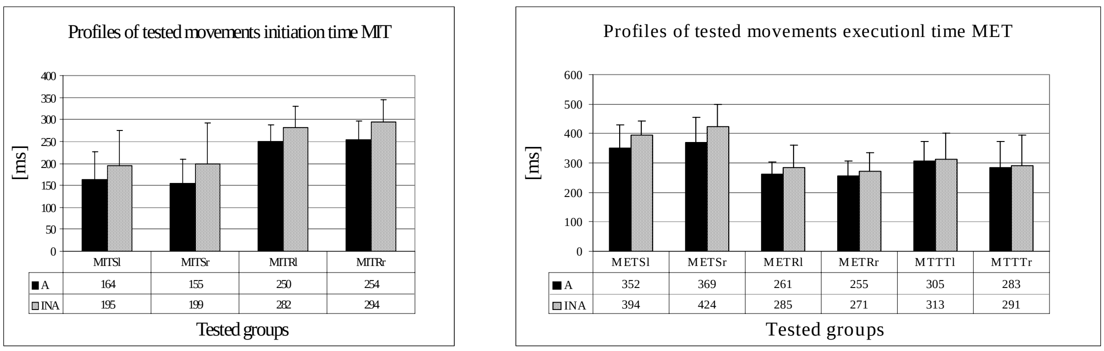
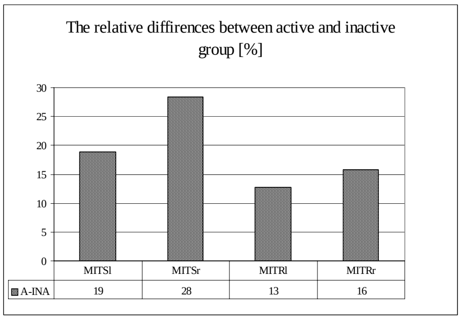


Figure 2. The profiles of tested times (ms) for the active (A) and inactive (INA) groups



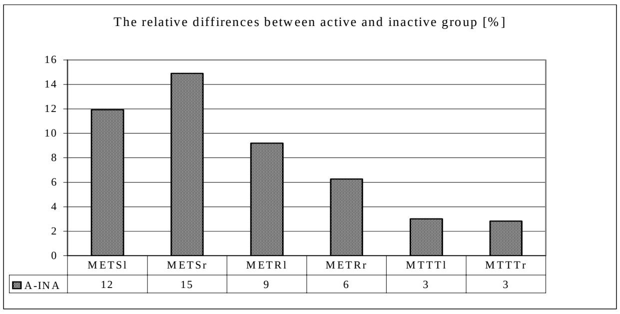


Figure 3. The relative differences (%) in tested factors between the active (A) and inactive (INA) groups

DISCUSSION

On average longer initiation (MIT) and execution (MET) times were noted in the inactive (INA) group than the active (A) group, by 23.5% and 13.5% in sequencing, and 14.5% and 7.5% in reciprocal movements, respectively. The relative differences were more significant with respect to movement initiation MIT (19% for all tested movements) than execution MET (10.5%) time. The findings indicate that active life improves not only motor speed, but also the speed of information process. The study has shown that motor inactivity impairs the right hand more than the left hand in sequential movements, and the left hand more than the right hand in reciprocal movements. In the tapping task we only measured the movement total time (MTT=MIT+MET). The MTT time for the left (MTTTl) and right (MTTTr) hand is presented in Fig. 3b. Our research has shown only 3% slower tapping movements speed between the active and inactive groups. The differences were the most significant (by 24% in sequential and 7.5% in reciprocal movements total time MTT) between the inactive and active women. The obtained results indicate that admittedly the motor activity typical of elderly people (jogging, biking, gardening etc.) improves the psychomotor speed (MTT=MIT+MET) of sequential (16%), reciprocal (11%) and tapping (3%) movements that are fundamental for daily arm activity, but the improvement is much smaller than in the speed of locomotion (20%) and rotation movements (17.5% – half-turns, 29% – full turns, [2]). The study has also shown that motor inactivity impairs psychomotor efficiency of women much more than men. We have also found that men are more efficient than women in the active as well as in the inactive group. All analyzed differences were statistically significant ($p < 0.05$).

The research constitutes a part of our wider work on development of a multidimensional method of testing daily psychomotor efficiency.

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