Analysis of the Reaction Time and Dominance in Elderly Men: A Pilot Study

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Abstract: The study analyses reaction times in elderly subjects and investigates the reactivity of the dominant and non-dominant hand and foot. 20 men (73.3 ± 3.1 years), healthy, free from injury and without any physical problem that could affect the test results. The tests are the baseline reaction times, the plate tapping test and foot tapping test. Descriptive statistical procedures are presented as mean ± SD and the percentage changes (Δ%) were calculated for each test. The significance level was $P<0.05$. In baseline reaction time test, the non-dominant hand showed a shorter reaction time than the dominant hand of about 28 msec ($p = 0.05$). In the plate tapping test, on the other hand, the dominant hand was more reactive than the non-dominant hand (7%, $p = 0.002$). In the foot test, the difference between the dominant and non-dominant feet was 3% ($p = 0.1$). The difference in performance between the tests performed could be due to the difficulty of the required motor task. The study lays the foundation for developing a motor work protocol focused on reactivity, a motor ability that physiologically degenerates with age and is of fundamental importance for the individual's physical and cognitive well-being.

1 INTRODUCTION

Reactivity is a useful measure to define how quickly an organism can respond to a particular stimulus, specifically the reaction time is defined as the time interval between the moment in which the brain represents a sensory stimulus and the moment in which the subsequent behavioral response takes place (Welford AT, 1980). In fact, reactivity has been extensively studied as its practical implications can have a great consequence, at any age.

Many factors have been shown to influence reaction times, such as age, gender, left or right hand, physical fitness, fatigue, distraction, breathing cycle, type of stimulus and the decline in processing speed are some of the hypotheses formulated to explain the changes observed in reaction times at different ages (Hultsch DF. et al, 2002; Adam JJ et al, 1999).

Adult human reaction times in response to simple tasks slow with age at a rate of 2–6 ms per decade (Fozard JL et al, 1994; Gottsdanker R, 1982). Simple reaction time shortens from infancy into the late 20s, then increases slowly until the 50s and 60s, and then lengthens faster as the person gets into his 70s and beyond (Jevas and Yan, 2001; Rose et al., 2002). Luchies et al. (2002) also reported that this age effect was more marked for complex reaction time tasks.

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In an experiment using a computer mouse, Peters and Ivanoff (1999) found that right-handed people were faster with their right hand (as expected), but left-handed people were equally fast with both hands. The preferred hand was generally faster.

As age increases, problems in cognitive abilities also increase, such as divided attention, memory decline, etc. (Lu et al, 2017). Dementia and other diseases with cognitive impairment have become a major global problem as the number of older adults increases and they affects individual quality of life (Bruce et al, 2014). Reaction time is related to cognitive functions (Christ B.U et al, 2018; Chen K et al, 2017). A study by Phillips et al. (2013) found that patients with mild cognitive impairment and Alzheimer's disease had significantly longer reaction times than normal aging control groups. MacDonald et al. (2008) found that reaction time variability in older adults was usually associated with slower reaction times and worse recognition of stimuli, and suggested that variability might be a useful measure of general neural integrity.

The hemispheres of the cerebrum are specialized for different tasks. The left hemisphere is regarded as the verbal and logical brain, and the right hemisphere is thought to govern creativity, spatial relations, face recognition, and emotions, among other things. Also, the right hemisphere controls the left hand, and the left hemisphere controls the right hand. This has made researchers think that the left hand should be faster at reaction times involving spatial relationships (such as pointing at a target). The results of Boulinquez and Bartélémy (2000) and Bartélémy and Boulinquez (2001 and 2002) all supported this idea.

The present study aims to demonstrate this hypothesis by relating it to the motor task in the elderly over 70 years old and it want to establish a starting and reference point on reaction times in elderly subjects in order to then be able to intervene on the ideal motor activity to be performed in elderly

Moreover the study wants to investigate the motor behavior recorded in different tasks, simple reaction and frequency of movement in upper and lower limbs.

2 METHODS

2.1 Sample

20 elderly men (73.3 ± 3.1 years), healthy, free from injury and without any physical problem that could affect the test results. Subjects with a history of balance deficits, neurologic disorders or musculoskeletal injury were excluded from the study.

Nineteen men have a dominance on both right hand and foot; just one of them has a dominance to the other side both on his hand and foot.

Written informed consent was obtained from all the participants after familiarization and explanation of the benefit and risks involved in the procedures of this study. All participants were informed about the study protocol and gave their informed consent to participate and they were informed that they were free to withdraw from the study at any time without penalty. This study was approved by the Internal Research Board of the University of Rome "Tor Vergata".

2.2 Assessment

Baseline Reaction Times Test

The test, performed with the Norway ergotest Muscle Lab, consists of a succession of 5 green stimuli (diameter 6-8 cm.) displayed in the centre of the PC monitor. The background is black. No focus point is ever given to the subjects in order to assess their ability to detect the signal without the help of cues. The subject is required to press the space key on the computer keyboard in response to the presentation of a stimulus. In all tests, responses given in under 180 ms, which according to the literature is the threshold for a simple visual reaction, were not accepted as correct as there would be insufficient time to organize a response and reaction. Instead, these are considered anticipated responses, that is, as action initiated before the appearance of the stimulus. If the subject fails to respond, the stimulus disappears from the screen after 6 s. The disappearance of a stimulus is followed by an interval which varies according to a fixed sequence between 0.8 and 2.5 s. The test is preceded by 6 practice trials in which the program indicates whenever an error is made so as to facilitate learning by trial and error. At the end of the test, the program provides the single response times. The number of anticipated responses and omissions and the results of the test trials are memorized on computer and may be printed as required (De Danti et al. 1998).

Plate Tapping Test

Each subject was asked to touch two clips (diameter of 3 cm) as quickly as possible to the right and left on a desk. The test is performed by the dominant hand (DH) and the non-dominant hand (NDH) and a 10-second test is performed three times with each hand and the best result is recorded (Eurofit, 1988).

Foot Tapping Test
The subjects sitting on a chair must touch with their feet as quickly as possible the right and left part of the floor bordered by a central line.

The test performed three times with each foot and the best result is recorded in 10 seconds (Eurofit, 1988).

2.3 Statistical Analysis

The results are expressed as mean ± SD. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity. Paired *t*-test were performed to assess the significance of differences. The corresponding P values are provided for each analysis. The value of statistical significance was accepted with $P<0.05$. IBM - SPSS 20.0 for Windows (SPSS, Inc. Chicago. IL, USA) was used for statistical analysis.

3 RESULTS

Results for each test are presented in table 1.

Table 1: Data are mean ± SD.

	dominant limb	*non-dominant limb*	*Δ*	*p*
Reaction time test (sec)	0.277 ± 0.07	0.249 ± 0.02	10%	0.05
Plate tapping test (taps)	31.20 ± 6.00	29.06 ± 6.00	7%	0.002
Foot tapping test (taps)	30.00 ± 4.90	29.00 ± 4.50	3%	0.1

In baseline reaction time test (figure 1), the non-dominant hand performs a lower reaction time than the dominant hand of about 28 msec (Δ10%, p=0.05).

In the plate tapping test, on the other hand, the dominant hand is more reactive than the non-dominant hand ((Δ7%, p = 0.002).

In the foot test, the difference between the dominant and non-dominant feet is 3% not statistically significant (p = 0.1).

4 CONCLUSIONS

The study represents a valid starting point to carry out further studies on a larger sample and to place the difference between men and women.

this exploratory study aimed to quantify the reaction times of a representation of the elderly population in order to then be able to adapt and propose an ad hoc motor activity protocol focused on reactivity, a declining ability in this age group.

The difference in performance between the performed tests could be due to the difficulty of the required motor task. In the reaction time test, motor participation is reduced to the hand portion only, while the tapping tests, hand and foot, involve a larger body compartment in which more aspects converge, not just fully reactive.

It would be also interesting going through what the dominance value could induce by looking at a larger sample of people with a left hand/foot dominance in order to reinforce Peters and Ivanoff's study.

Moreover, it's really important to keep ongoing with that theory by thinking of other aspects: gender, physical activity level, frequency of movement including other tasks and cognitive diseases.

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