BALNEO RESEARCH Balneo and PRM Research Journal
English Edition
e ISSN 2734 - 8458 p ISSN 2734 - 844X ROMANIAN ASSOCIATION OF BALNEOLOGY

Research article

Device for testing and improving students' reaction speed

Cîrdei Albert-Sebastian [1,2], Moroșan-Larionescu Virgil-Adrian [1,2,*] and Leuciuc Florin-Valentin [1,2]

Citation: Cîrdei A-S, Moroșan-Larionescu V. A., Leuciuc F.V. - Device for testing and improving students' reaction speed
Balneo and PRM Research Journal
***2025**, 16(3): 859*

Academic Editor(s):
Constantin Munteanu

Reviewer Officer:
Viorela Bembea

Production Officer:
Camil Filimon

Received: 10.06.2025
Published: 30.09.2025

Reviewers:
Mihail Hoteteu
Sebastian Giuvara

Publisher's Note: Balneo and PRM Research Journal stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1 Faculty of Physical Education and Sport, 'Ștefan cel Mare' University, Suceava, Suceava, Romania;
2 Interdisciplinary Research Center in Motor Sciences and Human Health, Suceava, Romania;

* Correspondence: virgil.larionescu@usm.ro

Abstract: The article presents the description and use of an apparatus designed to test and improve the reaction speed of students in order to accurately quantify the cognitive performance and motor reactions of high school students. This experimental study includes different traditional and modern methods of analysis and control such as: test method, video method, observation method, experiment method, assistive devices method, etc. The present research includes a series of tests that allow the evaluation of reaction speed, adapting to the level of each subject. The tests applied were for the dexter hand, the non-dexter hand and simultaneously for both upper segments. We observed an improvement in reaction speed in the experimental group. The apparatus used in the tests can also be used as a specific means for the development of reaction speed in secondary school students. The overall conclusion is that the introduction of interactive and accessible technologies in the educational environment can have a positive impact on pupils' performance, especially in terms of reaction speed and coordination. The study provides a solid basis for extending the research to larger groups and a variety of educational contexts.

Keywords: reaction speed, assessment, assistive devices, test, skill

1. Introduction

Physical education has a very important role in the development of students. In secondary school education, the discipline of Physical Education continues to play a key role in sensitizing students to the importance of regular physical exercise for cultivating an active and healthy lifestyle. In the current context of modern education, the development of students' cognitive and motor skills is gaining increasing importance, especially in terms of preparing them for the increasingly dynamic demands of society.

According to, Cârstea, G. [1](p.52-66) speed is defined as, "the ability of the human organism to perform motor acts or actions, with the whole body or only with certain segments of it in the shortest possible time, with maximum rapidity, depending on the existing conditions".

Reaction speed is one of the essential components of motor skills and plays a significant role in school, sport and everyday activities. In this sense, the identification and application of effective methods for the assessment and improvement of this ability become a priority in the instructional-educational process. [2] (p. 68-72)
A basic characteristic that influences the ability of human performance in a variety of activities, from everyday tasks to complex activities such as driving, playing sports or social interactions, is reaction speed. The ability to react promptly and accurately to stimuli is often associated with an individual's level of agility and efficiency in dealing

with various situations and demands". A prompt reaction speed is of benefit to every person but especially in athletes it is essential to improve this motor quality. Atan, T., Akyol, P. [3] (, p.74). Some authors consider that there is a major difference between reflex and reaction speed. Whereas the reflex act is not conditioned by a reaction and action of the central nervous system, while the reaction speed is conditioned a lot by the plasticity of the cerebral cortex, to a certain extent relying on already experienced situations as well as on attention.

Complicated situations often arise in volleyball, especially in relation to the movement of the ball and the players. Even if these moments are hard to anticipate, speed can help players learn to anticipate what their opponents, teammates and the ball will do. Good reaction speed is useful in sport and beyond. It is also called latent motor reaction time. Cârstea, G. [1] (p.17).

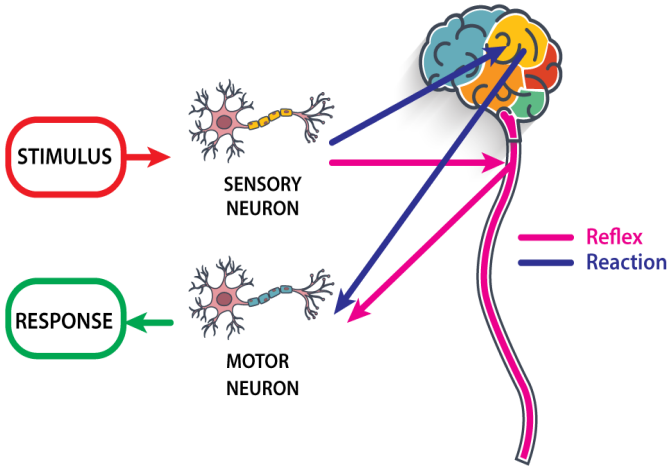

Fig. 1 Different communication pathways in reflex and reaction speed - (Microgate)

Attention is at the basis of all cognitive functions according to Hagovska, M. & I., Nagyova, [4] (p. 133-142). In order to have a very good reaction speed, attention must be focused on the opponent's actions, ball movement and game situations.

Hand-eye coordination plays a very important role in volleyball as well as in other sports. As the game is played at high speed, the player needs to see the ball, anticipate its trajectory and react immediately. In order to achieve this, an efficient hand-eye coordination is needed, according to Menevșe, A. [5](p. 114-118).

2. Materials and methods

2.1. Working hypotesis

We started from the idea that the use of an assistive device in lessons, using balls in testing and developing reaction speed, approximating the conditions in bilateral play will lead to improved reaction speed.

The aim of this study was to assess the reaction speed of students to a visual stimulus using a specialized testing device. The research aims to highlight the reaction speed of students with both the dominant and non-dominant arm.

2.2. Participants

The experiment included 30 ninth graders from Filadelfia High School. Their ages ranged from 14 to 15. Students were randomly selected from those who expressed a willingness to participate. Both boys and girls were included, with no known physical conditions affecting their ability to respond. Pupils were also not informed in advance about the exact timing of the test to ensure spontaneity of reaction speed.

2.3. Organization of the research

The article emphasizes the use of an innovative equipment, a device designed to test and improve the reaction speed of students. It has been designed not only as a simple means of assessment, but also as an interactive educational device, which can be easily integrated into classroom activities or physical education and sport classes. The main purpose of this device is to obtain objective and accurate data on pupils' reaction time, while at the same time offering the possibility to improve this motor skill through different specific exercises.

A very important thing to keep in mind is that the reaction speed is not identical in all body segments.

The research presented in this paper is based on an experimental study, which involved the application of a set of tailored tests for both the dominant and non-dominant hand, as well as for both upper segments simultaneously. By using complementary methods such as: test method, observation method, video method. Also, in order to have a series of results as accurate as possible, we also used the method of repetitions, alternative [6] (p. 61).

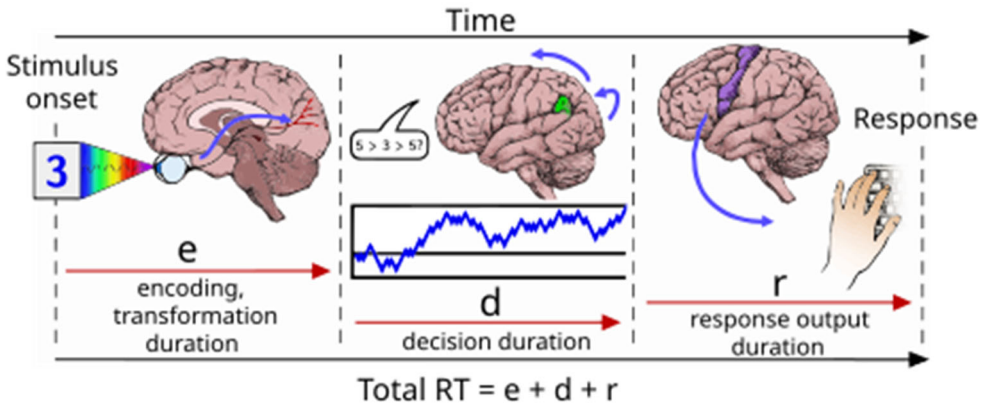

Fig. 2 Visual representation of the hypothetical stages of a reaction time task and the association of each stage with diffusion model parameters. after Emily Willoughby

The form of manifestation we want to develop is reaction speed. Reaction speed is the most important form of speed in volleyball because it helps players respond quickly to changes that occur during the game. This, according to some authors such as [7](p. 226), [8] (2024, p. 3-5) [9] (p.14) is composed of:

- Simple reaction speed - when there is only one stimulus and only one possible response.
- Complex reaction speed - found when there are multiple stimuli and/or multiple response options.

The upper limbs have a faster reaction speed because they have a more direct connection to the brain via the CNS (Central Nervous System). Because there is a shorter connection, the signal can be transmitted more quickly and automatically a faster reaction. Another detail may be that the upper limbs are involved in different daily activities that require a quick response (grasping a glass, forks, etc). Muscle size also plays an important role in reaction speed. Large muscles may be involved in accomplishing a fine motor skill, but small muscles are the main contributors to the goal of that skill according to [10] (p. 2-14). That is why we chose to test the reaction speed in the upper segments.

To test the reaction speed, a device was invented and adapted to the needs of the students in order to obtain objective results.

This apparatus is based on the principle of the ruler test but reinterpreted. The apparatus is placed on the basketball hoop. A plank is placed on the basket and two strings come down from the plank and are passed through two pulleys. The ropes are graduated in centimeters and at the end of the ropes are two volleyballs that come down when the teacher lets go of the rope. The student stands in front of the teacher with arm(s) extended forward at level 0 having their fist semi clenched, and the string must pass through their fist. The moment the teacher releases the string, the ball comes down and the pupil must clench his fist.

The reaction speed is measured from the moment the teacher releases the string and the pupil squeezes it by tracing the distance in centimeters from the 0 level of the string.

Students were tested with both left and right hands. Each student performed 3 tests on each limb. Testing was also performed with both upper limbs simultaneously and the data were correlated as this is a new method of measuring reaction speed with the ruler test.

3. Results

The testing of students with the RESPONSE device can be observed in figures 3 and 4, with the balls being dropped from the same height, the testing conditions being similar.

In both the initial left-handed and right-handed tests, the results of the two groups, control and experiment, were close in terms of values as can be seen in Figures 5 and 6. One thing that caught our attention and that is the results obtained by the subjects were better on the non-clumsy segment, symbolizing that increased attention led to reduced reaction time, being the non-clumsy hand.

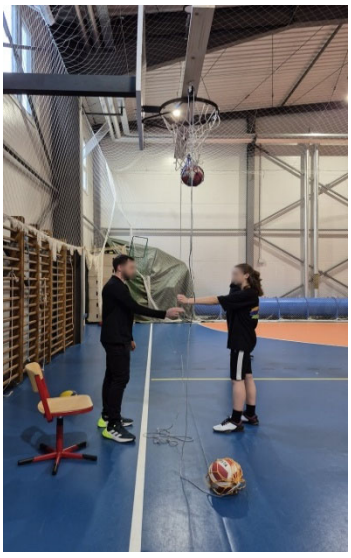

Fig. 3 Testing one-handed reaction speed with RESPONSE

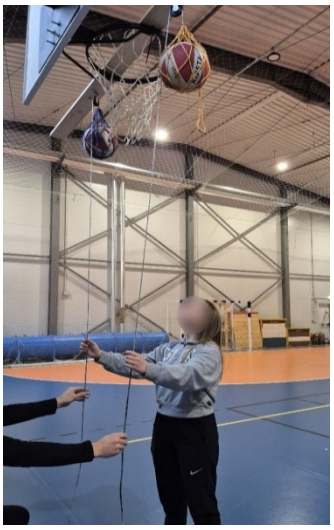

Fig. 4 Testing two-handed reaction speed with the RESPONSE device

Following the experiment, in the final tests, we obtained lower values in the experimental group on the right hand of 18.40 cm and in the control group 21.80, and in the left hand of 15.40 in the experimental group and 19.00 in the control group. We can see that in both tests the better values were in the left hand, possibly as a concentration of attention on this segment, which is usually less used.

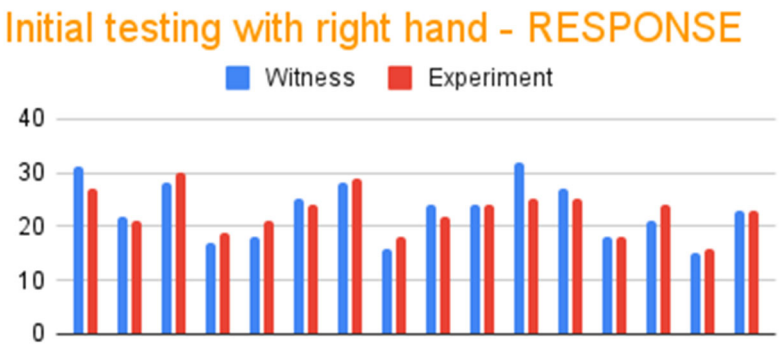

Fig. 5 Representation of the results from the initial hand dexterity test

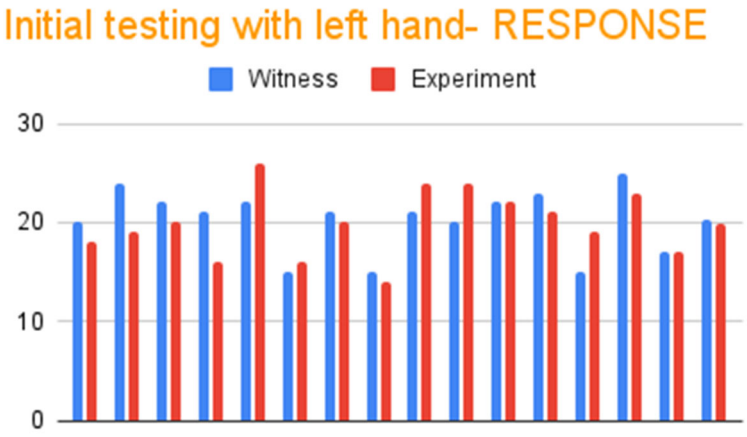

Fig. 6 Representation of the results from the initial testing of the clumsy hand

Fig. 7 Representation of the results of the final dexter hand test

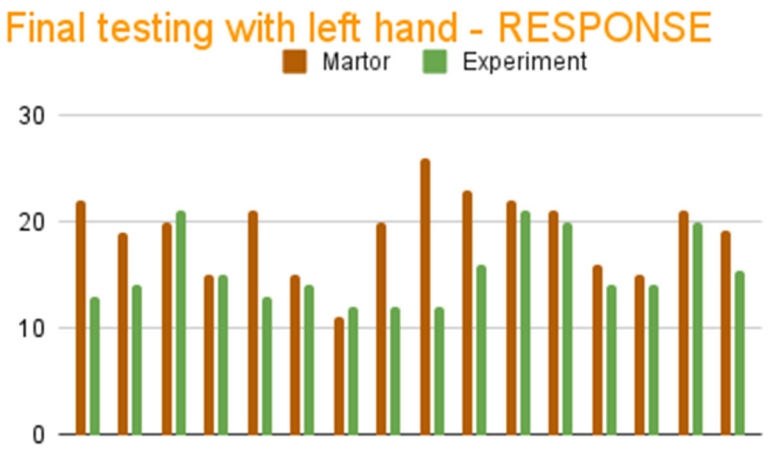

Fig. 8 Representation of the results of the final test on the clumsy hand

The differences I have mentioned are not only between individuals, but also between segments of the same body, significant being the distance between the Central Nervous System and the targeted segment, as well as the quality of analysis or the speed at which the white myelin, myelin, transmits the nerve impulse. [11]

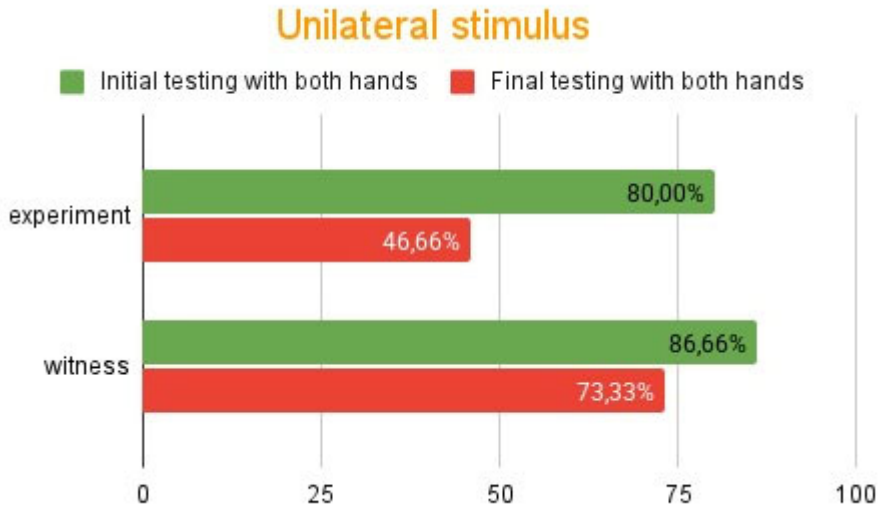

Fig. 9 Representation of the errors of the initial and final test with unilateral stimulus

In the testing we conducted with subjects having only a stimulus on one string, while the other was inactive, we noticed something extremely interesting. The tested subjects acted with both hands even though the stimulus was only for one segment, which we considered to be an error. Figure 9 illustrates in percentages how many errors there were in the two tests with both groups.

4. Discussion

Reaction speed is extremely important for both competitive athletes and people in general because of the implications it can have in everyday life [12] (p.3). The differences that often occur between members of a team mean that positions of varying importance in attack or defense are occupied. When unforeseen situations arise, it is certainly important to have the best possible reaction speed in order to make

timely decisions per time unit [13], [14]. In addition to performance sports, we are also referring to military activities or driving or other more or less ordinary situations.

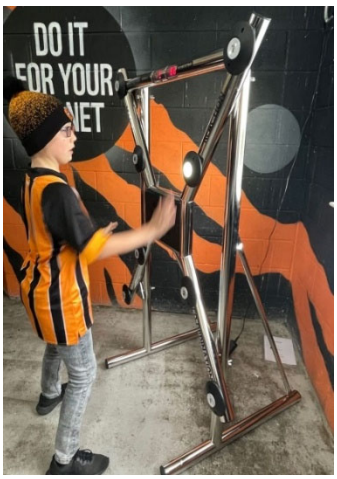

Fig. 10 Batak reaction speed test machine [15]

The differences that this device, see Fig. 10, compared to standardized tests, such as the ruler test, are that the tested athlete analyzes the trajectory of a ball, of a familiar object with which he is used to interact and which he follows even during the game, which brings the test closer to his own experiences, causing the subject to have a pre-programmed reaction, certainly useful in the subsequent training process.

Some devices are known that test the execution speed of the elan [16] combined with high-speed cameras to capture subtle mechanisms that influence the vault off the vault, such as short contact time caused by high execution speed. The need for electronic devices is obvious for the realization of modern apparatus in order to obtain additional data, otherwise impossible to harvest without their help.

The apparatus in Fig. 10, which causes the upper limbs to move in different planes to press a switch that turns on randomly controlled by a microprocessor system. What is interesting to note is that this apparatus not only tests reaction speed, as it involves moving segments through skeletal muscles, but also execution speed, and dissociating these two becomes extremely difficult to do. The RESPONSE apparatus designed by us and presented at the beginning of the study stands out in addition to accurately determining the reaction speed following a simple motor gesture such as closing the fist when the stimulus occurs, but it can also be included in the sphere of those apparatuses that have a regulatory role due to the fact that when the graded string grasp was operated with both hands, if the stimulus was unilateral and the execution was aimed at grasping both strings, the value was declared error and the subject was stimulated to channel his attention dissociatively to give a correct response.

Further studies on human subjects using the RESPONSE machine may shed new light on brain activity when stimulating the central nervous system, as well as when deciding to make a fist or perform other imposed tasks.

5. Conclusion

The device we designed validated its efficiency by correlating it with the ruler test which obtained values of 11 cm in the left hand and 13 cm in the right hand, and at first glance we were a bit disappointed. When we analyzed the data, however, we noticed that the same inter-segmental difference was maintained as in the test with the device we designed - Response, with a better time obtained by the upper clumsy segment. At the same time, because the volleyball, which weighs 260g -280g, was attached to the end of the string, its acceleration was higher than that of the plastic ruler, which explains the results and validates our test.

The values obtained by the two groups in the final test unequivocally illustrate, as we can see in the graphs in Figures 8 and 9, that the use of the Response apparatus in the preparation of the experimental group contributed to lower values of their reaction times. It is hoped that the realization of the electronic version of this apparatus will facilitate its widespread use both in educational establishments and in the framework of sports clubs and associations.

6. Patents

Following the tests and the results obtained, we considered it appropriate to obtain protection for the presented device, for which reason we addressed to the Romanian State Office for Inventions and Trademarks an application for a patent with the number: 00111/2025.

Author Contributions: "Conceptualization, Cîrdei Albert-Sebastian; Moroșan-Larionescu Virgil-Adrian; and Leuciuc Florin-Valentin; methodology, Leuciuc Florin-Valentin; Moroșan-Larionescu Virgil-Adrian; software, Cîrdei Albert-Sebastian; Moroșan-Larionescu Virgil-Adrian; validation, Cîrdei Albert-Sebastian; Leuciuc Florin-Valentin; formal analysis, Cîrdei Albert-Sebastian; investigation, Cîrdei Albert-Sebastian; Moroșan-Larionescu Virgil-Adrian; resources, Cîrdei Albert-Sebastian; data curation, Moroșan-Larionescu Virgil-Adrian; Leuciuc Florin-Valentin; writing—original draft preparation, Cîrdei Albert-Sebastian; Moroșan-Larionescu Virgil-Adrian; writing—review and editing, Leuciuc Florin-Valentin; visualization, Moroșan-Larionescu Virgil-Adrian.; supervision, Leuciuc Florin-Valentin; project administration, Cîrdei Albert-Sebastian and Moroșan-Larionescu Virgil-Adrian ; funding acquisition, Cîrdei Albert-Sebastian; Moroșan-Larionescu Virgil-Adrian and Leuciuc Florin-Valentin. All authors have read and agreed to the published version of the manuscript."

Funding: „This research received no external funding."

Institutional Review Board Statement: „The study was conducted according to the guidelines of the Declaration of Helsinki."

Informed Consent Statement: All participants consented to involvement in this research.

Conflicts of Interest: „The authors declare no conflict of interest."

References

1. CÂRSTEA, G. Teoria şi metodica educaţiei fizice şi sportului. Bucureşti, 2000: AN-DA. p. 17, p. 52-66.
2. SANDOR, Iosif. Bazele generale ale teoriei educației fizice și sportului, suport de curs, Cluj-Napoca,2008 , p. 68-72.
3. Atan, T., Akyol, P. Reaction times of different branch athletes and correlation between reaction time parameters, Procedia - Social and Behavioral Sciences 116 2886 – 2889, Turkey, 2014.
4. Hagovska, M. & I. Nagyova, The transfer of skills from cognitive and physical training to activities of daily living: a randomised controlled study. In: European Journal of Ageing, 2017, 14(2), 133-142.
5. Menevşe, A. Examination of the relationship between muscle palmaris longus and reaction time. World Applied Sciences Journal, 2011, 12 (1), 114-118.
6. Cojocaru, A.M. și Cojocaru, M., Optimizarea vitezei în jocul de volei prin mijloace specifice, Universitatea Spiru Haret București, Romania, 2015, Jurnal of Sport and Kinetic Movement. Vol. II, No. 26/2015.
7. Obetko. M., Peráček. P., Šagát. P., Mikulič. M. Impact of age and agility performance level on the disjunctive reaction time of soccer goalkeepers, Saudi Arabia, 2019, p. 226.
8. Tudor A. Eficientizarea pregătirii în volei și baschet prin utilizarea problematizării, 2024, Riso Print, 116 p.
9. CARP, I. Teoria și metodica culturii fizice - note de curs. Chișinău, 2019: UFEFS, p. 14.
10. Magill, R. A., Motor Learning and Control: Concepts and Applications. McGraw-Hill Education., San Francisco 2011 ISBN 978-0-07-802267-8, p. 2-14.
11. Oancea B.M, Badau D., Badau A., Joksimović M. , Manescu C.O. , Graur C., Cornea G. G. , Ene-Voiculescu V., Cojanu F. , Stefanica V., Cojocaru A., Mocanu G., Silisteanu S.C. The effects of 6-weeks program of physical therapeutic exergames on cognitive flexibility focused by reaction times in relation to manual and podal motor abilities. Balneo and PRM Research Journal. 2023;14(3):570. DOI 10.12680/balneo.2023.570.
12. Reynaud, C. Coaching volleyball technical and tactical skills, American Sport Education Program, Human Kinetics, 2011. p.3 ISBN-13: 978-0-7360-5384-6

13. Badwe, N., Patil, K.B., Yelam, S.B., Vikhe, B.B., Vatve, M.S. A comparative study of hand reaction time to visual stimuli in students of 1 st MBBS of a rural medical college. Pravara Med Rev, 2012, 4(1):3-6;
14. Gorgan C.M., Graur C., Milon A. G., Puni R. Study regarding the reaction time levels in Physical Education and Sports, Gymnasium Scientific Journal of Education, Sports and Health, Bacău, 2023, DOI: 10.29081/gsjesh.2023.24.2.08.
15. https://www.streetwisesoccer.co.uk/interactive-games/batak-reaction-game/
16. Veličković P., Stanković D., Paunović M., Đorđević D., Bubanj S., Kocić M., Marović B., Bjelica B., Stanković V., Aksović N. Does the Impact Force Depend on Arm Position and Run-up Speed during Forward Handspring on the Vault in Elite Gymnasts? A Pilot Study. Balneo and PRM Research Journal 2024, 15(2): 685. DOI 10.12680/balneo.2024.685