

# Study on the Influence of Physical Effort on the Mental Processes of Preteen Students

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**Abstract**—The physiological effects of physical exercise on human body are relatively well known in literature, which describes in detail the changes that occur in the cardiovascular system, the respiratory one, in bones and other systems, both during exercise and after its delivery. However, the effects of exercise on mental processes are less treated. From the literature reviews discussed in this study, it can be detached the idea that we can not exactly say that physical exercise has beneficial effects on mental processes, but neither that it would have potentially negative effects. This uncertainty, reflected in the inability to indicate precise and unequivocal meaning, favorable-unfavorable physical effort in acting on mental processes, is a prime reason to undertake a study of the phenomenon influence effort administered physical education classes on the dynamics of mental processes like attention and memory.

**Keywords**—management, exercise, mental process, lesson.

## I. INTRODUCTION

WHILE the school activity has an obviously intellectual nature, with students placed in a position to gain an increasingly high volume of theoretical and practical knowledge, school physical education must ensure and improve performance of their mental processes or maintain them at an optimal level. Preteen age (from 10/11 to 14/15 years) is one of the most important periods of human development, in which changes lead to a mature organism. At this stage we meet a combination of features related to elementary schools with additional ones, which, in one form or another, prefigure those of adolescents. The child finds his creativity, but he plays too, he reasons. However, he does not excel in logical subtleties while having greater autonomy, thus remaining sensitive to suggestions from the group he is part of. He is able to put some distance between him and the parents, but is far from closing itself [2, 18], thus making preteen age a difficult subject in many ways.

At the age of 10/11 years, which marks the end of the small schooling age, and the beginning of the middle one, the cortex topography becomes finalized, intellectual capabilities approach a high level, while all higher nervous activity is growing rapidly. Psychologically, the child has a good mental balance, combining successfully school tasks with extracurricular activities.

*Attention and memory - fundamental psychological processes in human activity.* Along with thinking, attention and memory are processes that provide mental approach addressing both the didactic training and the education of individuals, which are considered the organizing functions of mental life that exert a great influence on the noted process.

*Attention* is the ability of the human psyche to orient and focus on a phenomenon or activity. Any act of attention is characterized by the indissoluble unity between the positive and the negative side, between focus and distraction, an establishment which, physiologically speaking, is based on an outbreak of optimal excitability between certain points of the cortex while decreasing the excitability of other points of the body. Attention is classified as a mental phenomenon that energetically supports activity; it is a psychological process of adjustment [4, 12]. It is not homogeneous and unidimensional, but instead it presents a complex picture, piecemeal, which is manifested in three main forms:

a) *Involuntary attention* which occurs spontaneously, being the one that manifests itself as long as education and artificial means have not been in action [12, 23]. The main function of this type of attention is the investigation-exploration of something new and preparation for the voluntary attention [7].

b) The second form is *voluntary attention*, which is not spontaneous but deliberate and consciously self-regulated. There are certain conditions that may encourage voluntary attention, namely: to establish clear goals, highlighting the significance of the activity, establishment of work moments, intentional creation of friendly ambiance, eliminating or reducing disturbances [7, 12].

c) *Post-voluntary attention*. Initial volunteer effort is reduced as the operating schemes of cognitive processes and work consolidate and become automatic [7]. However, the quality of attention is not reduced, still retaining at the optimum level.

*The features of attention on preteens.* Preteen period is characterized by greater intensity, concentration and stability of attention. In school activities, increased attention to performance is driven by the emergence of knowledge interests. Preteens have a desire to solve some problems independently, to know more about certain areas, which will lead them to spend more time studying the atlases or encyclopedias, thereby his attention gaining both a quantitative and qualitative advantage. Characteristic for this age period is the development of voluntary attention, while involuntary attention changes appearance, becoming more

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efficient. Preteens can concentrate and be attentive for a longer time (2 hours), can make frequent efforts of self-correcting and self-improvement on the quality of attention [4]. So, amid the general psycho-physiological development, the preteen attention acquires new qualitative and quantitative values.

*Memory* is the mental mechanism that ensures the acquisition of knowledge and skills, updating them with every opportunity in different situations, but also the mechanism through which the individual orientates in space and time, through the selective update experience [13, 24]. It is in close interaction with other mental processes, but has some features which distinguish this report; it can be: *active* - making the changes and transformations that saves both subject and material needed to be saved; *selective* - only some of the requests coming to the individual are brought up to date; *situational* - it is in accordance with the particularities of time and place of the situation, but also with the internal state of the subject; *relatively accurate*, which means that no information is retained in exactly the form in which it is presented to the subject, *mediate* - to be able to better remember and reproduce easier, we use a series of instruments which serves the function of authentic memory means; *intelligible* - as it involves the understanding the stored memories and the organization of the stored material, saved after significance criteria.

After the presence or absence of intent to save, there are two types of memory generally accepted, namely:

a) *Unintentional*, that seems simple at first glance, random, inefficient. In fact it has a complex structure, competitive with the voluntary memory. But the fact remains that sometimes it is less organized and systematic than the voluntary memory. This covers a vast memory of our daily existence and provides us daily, without any effort, with information and experiences that can later be helpful [7].

b) *Voluntary* - organized, systematic, productive, going into action especially in complex, uninteresting activities. Very important in this case are the aware establishment of the goals, making a voluntary effort to achieve the goal, use of special procedures to facilitate memorization. Basically, voluntary memory is an essential form of organization and expression of human memory capacity; it is closely related to the reasons and goals of activities, from gaming activities to the end of the creative work based on the presence or absence of voluntary memory which can be thought in turn, mechanical (made without understanding) or logical [7, 24].

*Characteristics of the memory of preteens.* From this perspective, the preteen age is characterized by an increased capability to logically process stored material, to systematize, in order to establish the logical links between parts of such material. So, logic is the central memory storage, while the style of learning for each person's memory is outlined. Compared to the previous stage, in the preteen age there is a yield curve that changes the memory, both in terms of duration in time of the memorization and in terms of maximum quantity of information material that may be

incorporated. In this period, memory changes from a qualitative point of view: the preteen begins to consider the very faithful memory saving as "grind", and tends to retain the essential [4, 13, 17]. Specific for beginning of this period is also the fact that the pubescent can easily save also what he does not understand. Another aspect in the changing intellectual activity is the increase in saving capabilities of the abstract sides of the knowledge and being relatively easy to control.

This change increases the volume of concepts, validation, accessibility and their status, but also increases the quality of the thinking operations and the quality and capacity of understanding.

## II. BASIC FEATURES OF THE PHYSIC EFFORT AND ITS INFLUENCE ON PHYSICAL AND PSYCHOLOGICAL PROCESSES

Effort is generally defined as a conduct of mobilization, concentration, physical and mental acceleration force in a conscious and unconscious self-regulating system to detect an obstacle, defeat the resistance from the environment and oneself [14]. In physiological terms, effort is an accentuated strain of an organ or the whole organism, to obtain a higher yield than normal. This tension is achieved by mobilizing under the control of the cortex, the body's energy reserves.

In the case of physical activity, we call effort the magnitude of the exercise on the body and the level of overcome objective and subjective difficulties. Physical effort involves, by its action, the muscular system, energy transmission and information processing and causes a degree of strain of the body, which has the effect of developing physical capacity, thereof functional, biochemical and psychological.

*Basic features of preteens' physical effort.* The children's need and desire to move and their motor activity are important incentives for the harmonious development of their body. Satisfying the need for movement, especially in physical education courses, must take into account the different functional and morphological features visible at this age, requiring compliance with certain principles regarding the dosage of effort, so that it has a positive effect on the children's body.

In this context, preteens can perform strength, force or velocity efforts, in agreement with the conditions specified and explained by physiologists.

*Fatigue - a limiting factor of human performance.* In organizing the formative-education activity of students in the classroom, in general, and in physical education - in particular, and beyond, one must take into account not only what to do, but what can be done. The working capacity of the body, both in physical appearance and psychologically, is not unlimited, it depends on several factors such as age and gender features, size and complexity of knowledge etc. Even if one strictly takes into account such factors, daily, weekly or yearly school work is frequently followed by natural phenomenon of fatigue [4, 14]. The most obvious forms of

fatigue are muscle fatigue (peripheral) - caused by unilateral application of muscle - and mental fatigue - caused by intellectual work.

*Influence of physical exercise on mental performance of the attention process.* The fact that attention is an important and complex psychological process of interest made many researchers move with interest in this direction. Among other steps, they have questioned whether or not the physical effort disturbs attention and they have tried to solve some specific problems, carrying out a series of studies on this subject.

Various researches have been conducted on the effect of running to exhaustion on a treadmill on performing long meetings to assess the relationship between effort and problem solving [20]. The results showed that "numerical accuracy" has been reduced by hard effort, though only for a short period. Other research designed for boys aged between 9 and 11 years old [20] has pointed out that immediately after physical effort (pedaling on an ergometer bicycle at different loads), accompanied by administration of a numerical task, such performance does neither decrease, nor grow at low or high levels of fatigue. However, when children make an effort they get almost the speed and numerical accuracy of those achieved by making a low effort.

T. Stockfelt, in 1972 [20] examined the effect of exhausting effort on solving problems. He tested 40 boys of 12 years, which he divided into three groups according to their bag of knowledge. Subjects underwent three mental tests: the first two while they pedaled on an ergometer bicycle at different loads, and the third after the above mentioned work was completed. The conclusion was that the exhausting effort reduced mental capacity while at the same time the strength of the effort increased.

In turn, B. Heckler, R. Croce, in 1992 [20] conducted a study using trained and untrained men as subjects, subject to sub-maximal effort with a variable duration. The authors evaluated the accuracy and speed of making simple mathematical operations, immediately after physical exercise, after 5 and 15 minutes. The conclusion showed that in the following 20 minutes after the effort, the speed of execution of mathematical operations increased significantly, whether subjects were trained or not. Regarding the accuracy of calculations, after minutes 20 and 40 of the exercise sessions, there were no significant differences between groups.

D. Mc Naughten and C. Gabbard, in 1993 [11] examined the potential influence on the concentration of attention of the physical effort which varied in terms of duration and the fact that it occurred at different times of the day. They tested 120 students of 6<sup>th</sup> grade: 60 girls and 60 boys. The mental test consisted in solving easy mathematical operations whereas the physical one consisted of walking at a moderate intensity for a certain period of time (25, 30 and 40 minutes). The results of this study showed that the physical activity of moderate intensity lasting from 30 up to 40 minutes did not affect concentration. Obvious differences between sexes were not recorded.

*Influence of physical exercise on mental performance of memory process.* In sport, memory as well as attention play an equally important role. This was not overlooked by various researchers who have dedicated themselves to study the effects that physical exercise has on memory and said that, after physical education classes, retention of numbers were appreciably improved.

It was concluded, among other things, that some positive or negative effects of exercise on memory depend on the motivation of the subject. Thus, individuals with a good physical fitness see effort as an enjoyable activity and are convinced that it produces beneficial effects, while those who do not have a good physical condition tend to see it as stress and believe that it decreases their memory performance.

Y. Zervas and his colleagues in 1991 [21] examined the effect of exhausting effort on short-term memory in boys aged 10 to 14 years old. The experimental group ran a training program, whereas control groups did not. Results showed no significant differences between the two groups and showed that exhausting effort does not adversely affect memory.

J.R. Thomas and D.M. Landers, after reviewing a number of studies have concluded that physical exercise has beneficial effects on the subjects' memory capacity [19].

For example, during recovery after swimming training, the effort that affects memory function is either positive or negative, in conjunction with the training experience of subjects, the ability to save and memorize being the most sensitive to the effects of fatigue caused by physical efforts.

Y.A. Fery and A. Ferry, in 1997 [6], conducted a study in which the mental task was a short-term memory one and the physical one was of two types: constant effort, 30% maximum aerobic power, and progressive effort - the load increased by 35 W every three minutes. Their conclusion was drawn from the following: the extent to which physical effort affects short-term memory depends on the intensity of the effort and the magnitude of the task performed.

### III. RESEARCH ORGANIZING

*Hypothesis.* Directing and regulating the physical effort during physical education lessons are an effective way to improve attention and memory processes of students, which may influence the specific behavior of the program next time devoted to other educational disciplines.

*Subjects of the study.* Longitudinal research was conducted over two school years, during 2007-2009, and comprised 53 students of similar age all on the sixth grade (11/12 years) - 26 girls and 27 boys students randomly selected from two urban schools. Of these, half were the reference group (code B) and half were the experimental one (code A) which has been applied to a particular work program.

*Methods used:* documentation, pedagogical observation, questionnaire-based survey, testing, somatic and psychic driving, pedagogical experiment, data processing and statistical mathematical interpretation of data, graphical representation.

Mathematical and statistical parameters used for calculating the analysis results are the arithmetic mean, standard deviation, mean error, coefficient of variation and significance of differences between environments. For uncorrelated, independent samples, with a number of subjects less than 30, the criterion of "t" - student, the minimum threshold of significance (p) was considered at  $p = 0.05$  after Fischer's board.

Teachers' questionnaire had a total of 9 items relating to: physical education and its place in the formative-educational approach, the relationship between this discipline and others contained in the national educational curriculum, the training materials available for the creation of skills and competencies specific for physical education and sport compared to the approach of other disciplines, the time approach of the daily educational process after doing an exercise.

Each item had multiple choice responses (between 3 and 5), for example:

"When deployed in a classroom whose students have performed previous efforts of different intensities during physical education lessons", you find that they are:

- a) totally careless;
- b) careless;
- c) moderate careful;
- d) careful;
- e) very careful.

However, in order to obtain information about the students' adaptation to the efforts required by the objectives and content of physical education lessons, they applied to them a questionnaire with 11 items that concerned the following aspects: the presence of physical education classes, how their memory capacity and attention were challenged after submission of an conducted exercise, while performing an exercise how much they are able to do without fatigue appearing, what are the favorite lessons after physical education, etc., for example:

Immediately after physical education lessons they think there is a need for one hour like:

- a) Romanian or Foreign Language;
- b) Biology or Geography;
- c) Mathematics, Chemistry, Physics;
- d) History;
- e) Another (to be named).

Each item of the 11 had, like the above model, five different valid response (a, b, c, d, and e), the applicant had to choose only the option they considered appropriate to their own convictions. Pedagogical observation was used to track the students' response to exercise at different periods of time and at different moments during the school program, the volume and intensity of the training during physical education lessons, how to organize and conduct educational activities.

*Subjective estimate of the volume and intensity of physical effort* was made by using Borg Scale (quotes from 6 to 20) - Table 1 - which provides information about whether that person is equipped to assess the intensity of effort. The subject must indicate a figure on the scale, a figure which more accurately describes the feeling of fatigue generated by that effort [1, 3].

TABLE I  
BORG SCALE

Content		
No.	Quote	Effort perception
1	6	Too easy
2	7	
3	8	Very easy
4	9	
5	10	Easy indeed
6	11	
7	12	Relatively difficult
8	13	
9	14	Difficult
10	15	
11	16	Very difficult
12	17	
13	18	Too difficult
14	19	
15	20	

Psychological tests applied during the research to the subjects were:

a) for attention - Krepelin test - arithmetic calculation method (sample addition), consists of making the subjects do some simple operations of addition and subtraction, with numbers from 0 to 9, for 5 minutes, concentrated attention test - underline of method letters, consisting of crossing out vowels "a" and "e" and "i" and "o", a series of Romanian words with meaning. Working time was 60 seconds.

Example: library, desire, ferret, dynamite, chopper, museum, aquarium, philately, reptile, housing, color, clouds, crocodile, dahlia, fichus, scallops, humming, hut, old men, broken, doctors, waistcoat, stove, binoculars, solfeggio, books, pens, lime, gun, residential, church, line, linoleum, tile, world, cat, pen, petite, monthly, hospital seal, milk, sword, light, mouse, robe, cherry plum, icon, iodine, duck-bill, omnivorous, ideally shrunk, miniature, magnifying glass, paths, waste, colleague, stockings, bone, rail, violets, coconut cart, fried, eggs, oil, decreased, recovery, tool, fungus, trolley, coaches, waistcoat, kettle, heater, dandelion, lizard, sand, hypnotic, science, shock, celebrity, skirt, childhood, elegant movement, lion, bat, stove, label, button, located, shoes, history, geography, sports, monkey, forest.

b) Memory - method of memorizing numbers and words. For the first time, subjects were presented for 10 seconds a plate on which there were written in a certain order, the numbers from 0 to 9, after which they must write the numbers in the order they were on the plate. Working time was 60 seconds.

*Word memorization* was assessed using auditory word memory test, which consists of a list of 30 words read aloud by the experimenter, at an interval of 2 seconds. These words were chosen from the usual vocabulary so that they might not seem to have an apparent connection. At the end of listening, subjects were asked to reproduce in writing as many words, in the order that they recalled. Working time was 90 seconds.

Example:

a) *Variant administered before exercise*: cardboard, wagon, cloth, bell, basket, old man, bee, tray, hunter, piano, stick, flower, bowl, poplar, coal, trees, cookies, ink pot, lemon, book, jacket, vinegar, mouse, nipple, soup, working bunch, knife, barrier, match.

b) *Variant administered after exercise:* tree, hunter, tray, match, coach, book, cookies, board, poplar, basket, flower, soup, bee, working, piano, cloth, old, ink pot, mantle, lemon, mice, barrier, bouquet, stick, charcoal, knife, nipple, bowl, vinegar.

In what concerns drive ability the goal was to test the speed of moving subjects - race against time on a distance of 50 m, the explosive force of the legs - long jump and strength of the abdominal muscles - lifting of the torso while lying back, for 30 seconds.

From the functional standpoint, the following parameters were concerned: heart rate, vital capacity and aerobic exercise capacity ( $VO_2\max$ ).

Indirect assessment of  $VO_2\max$  test was performed using a "shuttle" (method of Leger and Lambert, 1980), on 20 meters. The sample consisted of running without interruption, back and forth on a path of 20 m, at the speeds required, which increased minutely, according to a stereo sound reproduction. Sounds recorded on tape started at a pace adequate for speed of 8.5 km/h. Speed increased (minutely) by 0.5 km/h. Subjects ran as much as possible, until they can no longer maintain the pace required by tape. At the end of the 20 m route the subjects did not change the direction by going round, but by stopping and turning 180°. Aerobic exercise capacity ( $VO_2\max$ ) is measured in ml  $O_2$ /kg body/min. [1, 3].

The experiment consisted in applying a program specifically designed for the experimental group. This was not aimed to develop new methods and means which lead eventually to a new approach to physical education content for training skills and abilities.

Therefore the program was based on the use of those already known and widely used in physical education lessons, the novelty consists in the fact that their effort dosage ensured that such acts and actions during lesson were possible, requiring a moderate effort (CF between 120-150 beats/min - b/m).

Starting from those mentioned above, the main objective of the program used in the experiment was: effort during physical education lessons to help improve or maintain performance level of cognitive mental processes responsible for learning (attention, memory). The purpose of this effort is to maintain the heart rate of students between 120 and 150 b/min. - CF values corresponding to moderate effort as established in the literature [6, 16, 21].

#### IV. OTHER DOMAINS TEACHERS' AND STUDENTS' CONCEPTIONS REGARDING PHYSICAL EDUCATION IN SECONDARY SCHOOLS.

Effort to assess the influence on the ability to concentrate in lessons and the return of students to apply a questionnaire to 146 teachers from other specialties, of which 34 teach mathematics, 32 - Romanian, 34 - Languages, 15 - History, 9 - physics and/or chemistry, 8 - arts education, 6 - Biology, 10 - Geography, 2 - Religion, 2 - Music education.

The following are the most significant responses to the questions of the teacher questionnaire.

In the item "When deployed in a classroom whose students have performed previous efforts of different intensities during physical education lessons, you find that they are totally careless, careless, moderately observant, careful, very careful" - 4% replied that all students are inattentive, and 18% considered that they are careless, while 43% believed that students are attentive and 5% - very attentive to the requests time. 30% of teachers who have applied to the questionnaire chose moderate alert variant (Fig. 1).

The first two types of responses are 22% of teachers considering that, after the time of physical education, students can no longer focus on the requirements of the next hour.

The percentage of teachers who argue that after the effort of physical education time, students do not face any difficulty to focus on teaching situations and to solve the following tasks in time is 48%. Those undecided believe that they have chosen the answer "moderate".

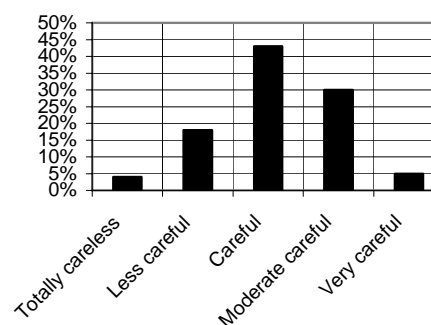


Fig. 1. Distribution of responses to the item regarding the perception by teachers of students' behavior after doing effort

From the perspective of teachers in the group of domain experts that real human were obtained the following results: the actual profile (mathematics, physics, chemistry), of 43 respondents, 25% showed response option "careless", 47% variant "careful" and 28% are undecided, and the humanist profile (Romanian language, foreign languages, history, biology, geography, religion, art and music education), in 100 subjects, 21% showed variant "careless", 48% version "alert", and 31%, variant "moderate" (Fig. 2-3).

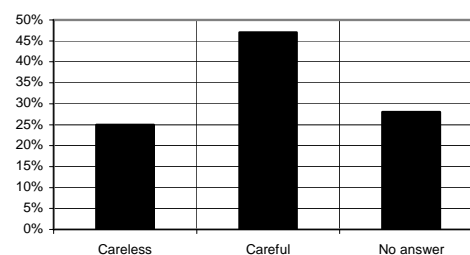


Fig. 2. Distribution of responses given by science professionals

Analysis of responses to this item led us to conclude that regardless of the area of specialization, teachers consider that

students do not have difficulty focusing on tasks and required classroom immediately following the physical education.

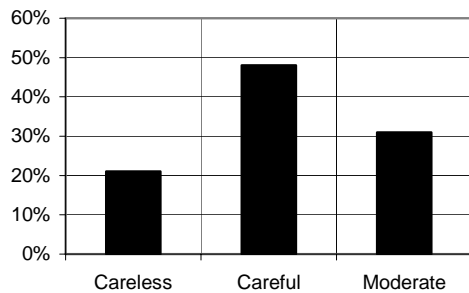


Fig. 3. Distribution of responses given by humanist professionals

Similarly, the students were given a similar question on focus. 523 students from fifth grade to eighth grade, from several schools, responded, of which 272 girls and 251 boys. Since the ability to focus attention can be determined both by specific evidence (established psychological tests) and based on subjective assessments, covering the subject's resistance to distractions, the survey contains a series of questions which refer to this second way of determining the degree of concentration of attention.

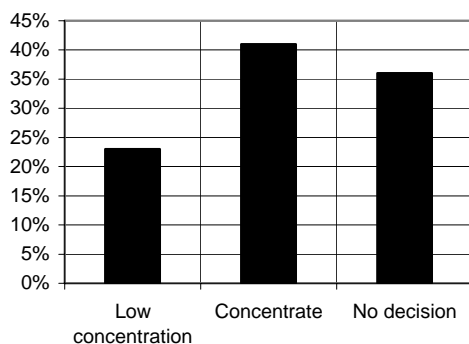


Fig. 4. Distribution of responses to the item on the students ability to concentrate after physical education (PE) lesson

When asked: "At the activity immediately following the physical education, you are: very little concentrated less concentrated, moderately concentrated, focused, very focused", 23% of all students surveyed believed that they showed poor concentration, 41% that they are concentrated and 36% are undecided (Fig. 4).

On how they are perceived in being able to concentrate by the teachers (Fig. 5), students' responses were distributed as following: 22% argued for option "careless", 45% for option "careful", while 33% are undecided.

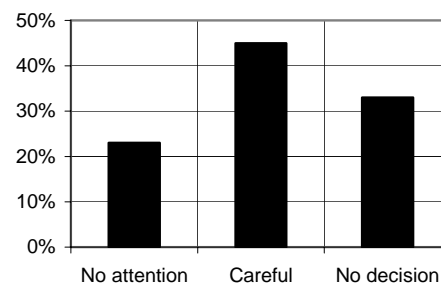


Fig. 5. Distribution of teacher responses to students' ability to focus on after PE lesson

Comparative analysis of student responses to those offered by teachers surveyed, findings show that almost all of them coincide.

Both students (45%) and teachers (41%) say that at the class right after physical education the students' focus capability is not disturbed. This means, according to both categories of respondents, that students are able to focus and successfully solve the tasks to be undertaken.

The conclusion drawn above shows that after effort, the recovery occurs the same, even after moderate effort or very difficult exercise. This means that they are quickly able to perform the cognitive tasks proposed.

Quick Recovery after exercise is important not only for physical education time, but for other subjects because it means that students are not adversely affected by the effort made for other courses during physical education lessons.

One of the objectives of our research was that attention and memory performance or mental processes of students can be influenced by what immediately follows the activity profile of physical education. That is why we made the analysis leading to popular belief items concerning the placement of classes in the school program immediately after physical education lessons.

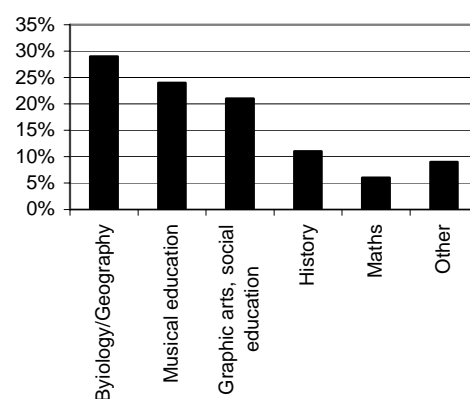


Fig. 6. Teacher responses to the item assignment "What educational and formative activity you think should follow immediately after the physical education one?"

Thus, the question “What educational and formative activity you think should follow immediately after the physical education?”, of all teachers surveyed, 29% believe that physical education lesson should be followed by an hour of biology and geography, 24% opted for music education, 21% chose arts education, civic culture, 11% answered “history”, 6% opted for mathematics, chemistry or physics, 9% of teachers surveyed felt that physical education lessons can be followed by any object of study (Fig. 6).

Grouping of responses led to the following conclusions: 7% of teachers surveyed opted for specific activities, real profile, 9% are undecided, 84% indicated adequate human activities profile.

Analysis of students’ responses to the same subject, shows that 17% of them opted for classes with real profile, and 83% for materials with humanistic profile.

According to the analysis of data obtained, the class that should follow immediately after the physical education is preferable to have humanistic profile. These data further intend to confirm the results in specific psychological tests administered to subjects under research.

Analysis of responses to questions aimed at how the request is felt in physical education lessons shows that students perceive this request as mild or very mild, 10% of 272 girls responded that physical education lessons are difficult, while 41% of them say otherwise. On the same issue, 7% of boys considers that the efforts in physical education lessons is one of high level, and 69% of them say that the same indicator is at an acceptable level, easy to bear.

When asked “How fast does fatigue install during physical education lessons?” 20% of girls considered that during physical education lessons they get tired quickly, while 38% stated that they do not fatigue quickly, the rest being undecided. 9% of girls as opposed to boys argue that the appearance of fatigue occurs sooner than their peers, while 63% of them say otherwise. Analyzing the answers respondents (Fig. 7), results show that 9% say that because of their content, that physical education lessons are difficult, compared with 63% who consider that they are mild and the remaining 28% of respondents are undecided.

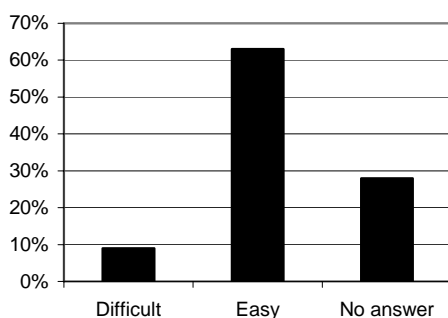


Fig. 7. Distribution of responses to the item: “How fast is fatigue installed during physical education lessons?”

Of the students surveyed, 10.5% say that they tire quickly during physical education lessons, as opposed to 49% of them that have stated otherwise (Fig. 8), the remaining 40.5% say that the degree of fatigue that you perceive at the end of physical education lesson borders between “fast”, “hard” and “moderate.”

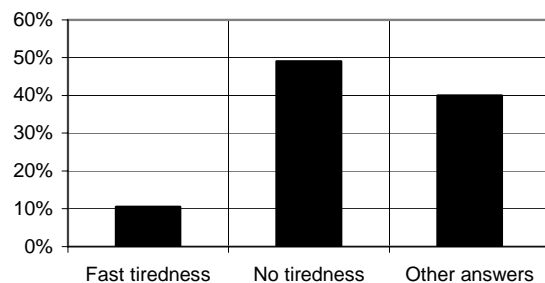


Fig. 8. Distribution of responses on the installation of fatigue during effort submission

Given the percentage of students who argue that physical education lessons are hard and those who say that during the course of those hours, fatigue does not occur quickly, we conclude that, at least from the subjective point of view, the effort of physical education lesson is not perceived by students as being very difficult. Rather, it is considered to be an easy one.

In support of this assertion, heart rate values (CF) recorded during physical education lessons (the more so as it is known that CF is one of the parameters that give an objective and fair relationship with the intensity of effort), values which are around  $144.97 \pm 4.28$  b/min. (beats per minute) for girls and  $139.49 \pm 4.09$  b/min. for the boys and confirmed that the intensity of effort in physical education lessons is medium.

However, in terms of subjective estimation of intensity of effort, according to Borg Scale, we can conclude that students of 11-15 years are unable to self-assess properly the intensity of effort, our results indicating that all subjects under-appreciate the intensity of effort performed during physical education lesson.

As such, regardless of age and gender, they do not perceive the effort performed during physical education lessons as very difficult, but they undervalue its intensity.

#### V. PARAMETERS OF THE PHYSICAL EFFORT EFFECTS ON ATTENTION AND MEMORY PERFORMANCES FOR 10/11-14/15 AGED STUDENTS

For each type of intensity of effort - minimum (CF between 100 b/min. and 120 b/min.), average (CF between 120 b/min. and 150 b/min.) and maximum (CF over 151 b/min.) there have been executed tests which lasted two different days: a performance evaluation process and psychological care, another day for the mental process memory.

Established psychological tests were applied to subjects both before and after physical education lessons to capture the effect of physical exercise of a certain intensity upon mental focus performance and memory processes. Reference group subjects were not included in the experimental program.

The results presented in Table 2 show that the experimental group performance on tests of memory, both girls and boys are not significantly different statistically from group B ( $p > 0.05$ ), so the tests carried out before the lesson and thereafter regarded to three levels of effort used: minimal effort (CF between 100 b/min. and 120 b/min.), average effort (CF between 120 b/min. and 150 b/min.) and maximum effort (CF over 151 b/min.).

This allows us to maintain that low-intensity effort does not significantly improve student performance on tests of memory, but neither significantly reduce its lesson by participating in physical education.

In other words, low-intensity effort has zero effect on memory performance for the students aged 10/11-14/15 years.

The test results that recorded moderate effort are presented in Table 3.

TABLE II  
PERFORMANCE OF THE PSYCHOLOGICAL PROCESS OF MEMORY,  
MADE UNDER MILD EFFORT TEST

Parameter tested		Girls (26)				Boys (27)			
		Group A	Group B	t	p	Group A	Group B	t	p
Humanist memory (no. of words memorized)	Before effort	8.43 ± 0.91	8.84 ± 1.54	0.24	$p > 0.05$	8.90 ± 3.03	8.32 ± 1.82	0.15	$p > 0.05$
	After effort	9.82 ± 1.51	8.96 ± 1.51	0.41	$p > 0.05$	9.76 ± 1.52	8.66 ± 0.91	0.59	$p > 0.05$
Mathematical memory (no. of numbers memorized)	Before effort	5.59 ± 2.44	5.18 ± 2.44	0.11	$p > 0.05$	5.06 ± 2.12	5.01 ± 2.70	0.02	$p > 0.05$
	After effort	6.42 ± 2.13	5.29 ± 2.74	0.33	$p > 0.05$	6.13 ± 1.52	5.65 ± 0.90	0.24	$p > 0.05$

Analysis results showed that, regardless of the type of memory test before the lesson of physical education, student performance is not significantly different from group A compared with the reference ( $p > 0.05$ ), neither girls or boys. In contrast, when tested after physical education lessons, the whole group A results were significantly different from the reference groups ( $p < 0.05$ ).

This result enables us to appreciate that individuals who make moderate efforts have a greater storage capacity, compared with those who rest at the same time, ie, 50 minutes, as during a physical education lesson.

TABLE III  
PERFORMANCE OF THE PSYCHOLOGICAL PROCESS OF MEMORY,  
MADE UNDER MODERATE EFFORT TEST

Parameter tested		Girls (26)				Boys (27)			
		Group A	Group B	t	p	Group A	Group B	t	p
Humanist memory (no. of words memorized)	Before effort	9.47 ± 1.08	9.69 ± 1.77	0.10	$p > 0.05$	9.13 ± 1.66	9.35 ± 2.97	0.07	$p > 0.05$
	After effort	14.77 ± 2.10	8.46 ± 1.60	2.39	$p < 0.05$	13.86 ± 1.06	8.01 ± 1.80	2.79	$p < 0.01$
Mathematical memory (no. of numbers memorized)	Before effort	6.12 ± 1.47	6.47 ± 2.38	0.10	$p > 0.05$	5.64 ± 1.67	6.05 ± 2.97	0.12	$p > 0.05$
	After effort	9.71 ± 0.57	6.06 ± 1.40	2.38	$p < 0.05$	9.95 ± 1.18	6.01 ± 1.46	2.13	$p < 0.05$

The assertion is confirmed by comparing the results obtained before and after moderate effort, for group A, which shows that student performance on memory tests improves significantly ( $p < 0.05$ ). Thus, moderate effort, performed for 50 minutes, has significant positive effects on students' memory performance, regardless of profile (science or humanist).

Therefore, the effort in physical education lessons in which its volume is controlled and does not exceed the average intensity has beneficial effects on memory of students aged 10/11-14/15 years.

With the same parameters the third test was performed, during which subjects made an effort with great intensity. Comparison and analysis of the results from subjects in group A with those obtained from subjects in Group B demonstrated no significant differences in performance ( $p > 0.05$ ), prior to the lesson of physical education (Table 4), which was not also true after the completion of the physical education, group B subjects achieved significantly better performance than those of group A.

Also, the analysis of results achieved by the subjects in group A shows that the differences between performances on memory tests before starting the lesson of physical education are not significantly better than those from its end ( $p > 0.05$ ). In contrast, performance is significantly reduced by participation in the physical education lesson ( $p < 0.05$ ), for both girls and boys.

Analysis of the results obtained by testing the subjects entitles us to say that the intensive effort and duration of 50 minutes decreases memory performance for 10/11-14/15 years aged students.

Moreover in the literature is noted that intensive effort has negative effects on cognitive tasks of individuals, whether they are memory tasks, attention, problem solving, reaction time etc. [10, 21, 22].



TABLE IV  
PERFORMANCE OF THE PSYCHOLOGICAL PROCESS OF MEMORY,  
MADE UNDER BIG EFFORT TEST

Parameter tested		Girls (26)				Boys (27)			
		Group A	Group B	t	p	Group A	Group B	t	p
Humanist memory (no. of words memorized)	Before effort	11.36 ± 1.34	10.09 ± 2.33	0.46	p>0.05	11.91 ± 1.45	11.12 ± 2.02	0.30	p>0.05
	After effort	7.21 ± 1.16	10.74 ± 1.24	2.11	p<0.05	8.01 ± 1.14	11.47 ± 1.23	2.03	p<0.05
Mathematical memory (no. of numbers memorized)	Before effort	7.90 ± 1.03	7.80 ± 2.04	0.04	p>0.05	7.67 ± 1.13	7.61 ± 1.74	0.02	p>0.05
	After effort	5.07 ± 0.78	7.90 ± 1.13	2.08	p<0.05	5.03 ± 0.37	7.74 ± 1.30	2.02	p<0.05

Whatever the intensity of effort scheduled physical education lessons, which served as a model for the analysis of the experiment beforehand, memory performance does not differ significantly from group A to the witness group regarding tests administered before the effort (ie the lesson of physical education).

Regarding the psychological results of the attention testing process, carefully analyzing the results of Table 5 show that the performance of the experimental group, both girls and boys, are not significantly different from control group (p>0.05), nor tests carried out before the lesson of physical education, nor those afterwards.

Even comparing the results obtained only from group A, regardless of genre subjects, they lead us to the same result: the difference is statistically insignificant (p>0.05), although the recorded performance after physical education lessons is higher (as numerical value) than the one recorded in previous testing.

This allows us to conclude that low-intensity effort does not result in significant reduction in performance of attention, regardless of type (mathematical or human), but no marked increase in them either.

As with performance on tests of memory, low-intensity effort has negligible effect on memory performance of the students aged 10/11-14/15 years.

Comparison and analysis of results obtained after submitting the subjects to a moderate effort, indicate that, irrespective of the type of attention tested before addressing the content of physical education lesson, student performance did not differ significantly in group A than that of group B (p > 0.05), this is true for both girls and boys (Table 6).

In contrast, when it was tested after physical education lessons, Group A (boys and girls) recorded significantly

different from the reference groups (p < 0.05). This means that subjects that are doing actions characterized by a moderate effort have a greater capacity to focus attention than those who rested over the same period of time, in our case during a lesson physical education.

TABLE V  
PERFORMANCES OF PSYCHOLOGICAL PROCESS OF ATTENTION  
REGISTERED IN THE MILD EFFORT TEST

Parameter tested		Girls (26)				Boys (27)			
		Group A	Group B	t	p	Group A	Group B	t	p
Humanist attention (no. of vowels correctly selected)	Before effort	72.65 ± 4.32	70.14 ± 2.46	0.50	p>0.05	63.55 ± 3.26	62.48 ± 2.7	0.25	p>0.05
	After effort	73.48 ± 3.86	69.01 ± 3.78	0.81	p>0.05	60.48 ± 5.32	60.05 ± 4.17	0.06	p>0.05
Mathematical attention (no. of correct operations)	Before effort	88.73 ± 2.72	87.48 ± 2.61	0.30	p>0.05	83.23 ± 2.69	82.74 ± 2.30	0.15	p>0.05
	After effort	86.56 ± 2.05	84.48 ± 3.36	0.52	p>0.05	80.64 ± 3.17	81.73 ± 3.19	0.25	p>0.05

This result is confirmed by the fact that comparative analysis of results obtained before and after submission of moderate effort, the group A, shows that student performance on tests of attention are improved significantly (p<0.05).

Statistical parameters obtained lead us to say that moderate effort, made during the 50 minutes, has positive effects on maintaining the attention of the students to high parameters. This means that the volume of effort in conducting physical education lessons, conditioned by threshold intensity, has beneficial effects on the attention of students aged 10/11-14/15 years, it leads to a significant increase in performance. Our results come in agreement with other research that showed that performances on tests of attention (human) are not affected by physical effort performed before testing. It turned out that an average effort has positive effects on task assembly in male subjects, 20 ± 0.8 years.

With regard to test results applied before and after the subjects did acts and actions based on sustaining a high intensity effort, these results showed that subjects in Group A compared to Group B had no significant differences in performance (p>0.05) before the lesson of physical education (Table 7).

In the testing done after the scheduled lesson, group B showed significantly better performance than group A. Regarding the gender or the type of the subjects tested and the analysis of the achieved results by the subjects in group A,

performance tests applied after physical education lessons are significantly reduced compared to those taken before the lesson ( $p < 0.05$ ), both girls and boys.

TABLE VI

PERFORMANCES OF PSYCHOLOGICAL PROCESS OF ATTENTION REGISTERED IN THE MIDDLE EFFORT TEST

Parameter tested		Girls (26)				Boys (27)			
		Group A	Group B	t	p	Group A	Group B	t	p
Humanist attention (no. of vowels correctly selected)	Before effort	72.03 ± 2.00	71.90 ± 2.55	0.03	$p > 0.05$	64.05 ± 3.66	63.93 ± 2.58	0.03	$p > 0.05$
	After effort	97.66 ± 4.51	68.16 ± 2.79	5.52	$p < 0.001$	90.76 ± 3.08	61.20 ± 3.18	7.18	$p < 0.001$
Mathematical attention (no. of correct operations)	Before effort	11.20 ± 2.21	109.43 ± 2.12	0.46	$p > 0.05$	89.15 ± 1.94	88.46 ± 2.85	0.20	$p > 0.05$
	After effort	135.54 ± 3.08	106.44 ± 2.51	7.82	$p < 0.001$	122.46 ± 2.35	89.04 ± 3.03	8.72	$p < 0.001$

TABLE VII

PERFORMANCES OF PSYCHOLOGICAL PROCESS OF ATTENTION REGISTERED IN THE BIG EFFORT TEST

Parameter tested		Girls (26)				Boys (27)			
		Group A	Group B	t	p	Group A	Group B	t	p
Humanist attention (no. of vowels correctly selected)	Before effort	79.95 ± 2.36	72.21 ± 3.43	1.86	$p > 0.05$	78.82 ± 3.02	73.92 ± 2.67	1.21	$p > 0.05$
	After effort	62.26 ± 3.07	72.64 ± 3.42	2.26	$p < 0.05$	63.04 ± 3.00	76.21 ± 3.26	2.97	$p < 0.01$
Mathematical attention (no. of correct operations)	Before effort	109.57 ± 3.95	101.07 ± 2.89	1.73	$p > 0.05$	108.71 ± 2.98	103.14 ± 2.94	1.33	$p > 0.05$
	After effort	86.57 ± 2.12	100.12 ± 2.85	3.81	$p < 0.001$	84.05 ± 2.12	106.35 ± 3.00	6.07	$p < 0.001$

A conclusion of the analysis results obtained by students in applying tests entitles us to say that intensive effort for the duration of 50 minutes diminishes the attention performance of students 10/11-14/15 years confirming the discussion in specialized studies [5, 10, 15].

At the conclusion of the tests it can be affirm that, to achieve a positive action on mental performance in attention

and memory processes, the effort to achieve the objectives and content of physical education lesson should be one of medium intensity. This is because, as demonstrated by the submission of high intensity effort and low intensity effort, high intensity effort over a long period determines a significant decrease in performance and low-intensity effort does not have any effect on the attention and memory of students aged 10/11-14/15 years.

#### VI. EVALUATION OF THE DINAMIC OF MOTRIC AND FUNCTIONAL INDICATORS AFTER THE APPLICATION IN TIME OF RESEARCH FROM THE PROGRAM DESTINATED TO GROUP A

Comparative data of initial and final tests' results are as follows:

##### a) functional indices

Vital capacity (VC) of the girls, at the final testing increased in the average value of 133.33 cm<sup>3</sup> air from 2615.38 cm<sup>3</sup> of air in initial testing, comparing to 2748.71 cm<sup>3</sup> of air in final testing. However, calculation of the significance of the difference between the averages shows that  $t_{\text{calculating}} (t_c) = 0.40 < t_{\text{tabelat}} (t_t) = t_{p, f} = t_{0.05; 26} = 2.06$ , which means that the final testing results are not significantly different from those of the initial testing ( $p > 0.05$ ). Boys recorded an increase of 154.57 cm<sup>3</sup> of air at the final test from the original, but it is insignificant ( $p > 0.05$ ) in statistical terms:  $t_c = 0.26 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ .

*Maximum oxygen consumption (VO<sub>2max</sub>):* For the girls, the maximum value recorded in the initial test is 44.06 mlO<sub>2</sub>/Kg body/min. and that of the final test is 44.96 mlO<sub>2</sub>/Kg body/min. According to statistical calculation, the difference between the two tests is not significant ( $p > 0.05$ ):  $t_c = 0.03 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ . For the boys, this parameter value recorded at initial testing 49.05 mlO<sub>2</sub>/Kg body/min., and in final testing it increases to 50.94 mlO<sub>2</sub>/Kg body/min. However, as in the case of girls, the difference between the results of initial and final testing is not statistically significant ( $p > 0.05$ ):  $t_c = 0.30 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ .

##### b) indices of speed and strength

Standing long jump (SLL) for the girls, this parameter improves performance in the final testing, compared to the original, from 178.75 cm (originally) to 184.12 cm in final testing. Calculation of significance between values obtained from initial and final testing is expressed as  $t_c = 0.50 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ , which means that the final testing results are not significantly different from those of the initial testing ( $p > 0.05$ ).

For the boys situation it can be noticed the same way: the initial test result is recorded at 181.25 cm and the final is 190.24 cm, but the observed growth is not statistically significant ( $p > 0.05$ ):  $t_c = 0.91 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ .

Speed run on 50 meters: the girls recorded a decrease in the final mean to the initial mean, 0.08 hundredths of seconds, which is not statistically significant ( $p > 0.05$ ):  $t_c = 0.10 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ .

Boys also recorded a decrease in the mean average time from initial to end, 0.25 hundredths of seconds, but it is insignificant ( $p > 0.05$ ) in statistical terms:  $t_c = 0.45 < t_t = t_{p, f} = t_{0.05; 26} = 2.06$ .

Crunches in 30 seconds: the girl average is of 24.50 crunches in the initial testing and in the final testing it is of 26.79. Statistical treatment of data revealed that the difference recorded between the results obtained from initial and final testing is not significant ( $p > 0.05$ ):  $t_c = 0.69 < t_t = t_p$ ;  $r = t_{0.05; 26} = 2.06$ .

Regarding the boys, the situation is similar: the initial test was an average of 28.58 ups and crunches and 33.29 at final testing, but the difference between the two tests is not statistically significant ( $p > 0.05$ ):  $t_c = 1.09 < t_t = t_p$ ;  $r = t_{0.05; 26} = 2.06$ .

## VII. CONCLUSIONS

*Initial hypothesis is confirmed.* Using exercise systematically and continuously, in a special program features age-appropriate, on which physical effort made during the course of physical education lessons is maintained at medium, led subjects in group A to obtain results better than those in Group B of attention and memory tests and on the functional type. Responses obtained by applying the two questionnaires showed that both categories of respondents chose (84% and 83%) immediately after physical education classes to attend classes of Romanian language, biology, history, etc. It was also revealed that 41% of teachers surveyed and 45% of students considered that the latter do not face any difficulty to concentrate and perform cognitive tasks that are required immediately in the class following the physical education. According to student responses, we find that 51% of subjects perceive no effort during physical education lessons as very difficult: a fact confirmed by Borg index values ( $104.60 \pm 0.51$  b/min. for the girls and  $103.80 \pm 0.51$  b/min. for the boys), values which, according to Borg Scale, characterize the effort is perceived as "really easy". However, students do not consider that the effort of physical education time as very difficult is contradicted in reality by the physiological reaction ( $CF = 133.95 \pm 5.26$  b/min. for the girls and  $126.39 \pm 5.08$  b/min. for the boys), which shows that students underestimate the intensity of physical exercise in PE class. Following the organization of physical education lessons and the conveyance of the intensity of physical effort put into them, during a semester, maintaining a moderate effort ( $CF = 120-150$  b/min.) throughout the lesson may have beneficial effects on attention and memory performance mental processes for students undergoing research.

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