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ASSESSING THE EFFECTIVENESS OF LEARNING A COMPLEX MOTOR ACTIVITY IN CHILDREN AGED 9-10 YEARS

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Abstract

Introduction

Learning is a complex and multi-dimensional process that depends on cognitive and emotional processes and the development of functional systems of the human body. One type of learning is motor learning. Its course and effects depend on many factors, one of the factors may be gender. Differences between intellectual and motor learning tend to be blurred when learning a complex motor activity takes place.

Purpose

The cognitive aim of the study is to assess the effectiveness (speed, efficiency, durability) of learning a complex motor activity in a selected group of girls and boys.

Materials and methods:

The study was conducted among 73 children (44 boys and 29 girls) aged 9 - 10 years. The teaching experiment method consisting of three stages was used. The research tool is a program of learning to juggle with three tennis balls. Learning speed was assessed using the Learning Speed Rate (LSR); efficiency was based on the results of subsequent stages as part of the experiment, whereas durability was evaluated on the basis of the effect compliance between stages of the experiment.

Results:

The speed, efficiency and durability of learning a complex motor activity in children participating in the study showed similar levels. Slow learning was dominant among both

girls and boys. Yet, boys achieved better learning effects than girls, but these differences were not statistically significant. The subjects showed high durability of learning effects.
Conclusions:
The effectiveness of learning a complex motor activity is characterized by inter-subject variability. Gender makes distinction in terms of speed, efficiency and durability of learning a complex motor activity.

Keywords: motor learning; complex motor activity.

INTRODUCTION

The oldest definitions of *learning* date back to ancient times when ways of learning, teaching or exercising memory started to be developed and described [1]. In literature there is still a lack of consistency between the meanings of these concepts. Different definitions that vary according to the view taken occur [2, 3, 4, 5, 6].

Until 20th century the behavioural view was predominant. It defined the relationship between an external event and behaviour of the body. Thorndike, Skinner, Tolman investigated the reactions of the body to a given stimulus (stimulation – reaction: S-R) [7, 2, 8, 9, 6]. Two types of response conditioning were highlighted: the *classic* one - is a form of learning based on reactions to biological stimuli, whereas the *instrumental* one is a form of learning based on the consequences of behaviour. In instrumental conditioning, reinforcements - which may be negative or positive [4] - play a major role. At the end of 20th century, a cognitive approach began to prevail in the psychology of *learning*. Emphasis was put on the fact that *learning* is about building and designing knowledge and interpreting the incoming data using one's experiences. Humans should be active participants in the learning process. This approach occurred as a result of the criticism of behaviourism [1]. Today, the above-mentioned theories of learning benefit from their respective discoveries and are not mutually exclusive. When analysing the literature on the concept of *learning* [10,11, 12, 13, 14, 15] definitions by Włodarski [2] and Anderson [7] are most likely to be found. According to Włodarski [2], *learning is* 'the process leading to changes in the individual's behaviour which do not depend solely on the function of their receptors and effectors; it occurs on the basis of individual experiences and, if they are not of a lasting nature, rely on the occurrence of new elements as compared to the behaviour preceding them'. Anderson [7] states that 'learning is a process through which, as a result of experiences, there are relatively permanent changes in the behaviour potential'. One type of human learning is *motor learning*. The term *motor learning* takes into account changes in the internal processes of the body and the external level of changes when performing movements. *Motor learning* refers not only to movements (visible), but above all to their control processes [16,17]. Osiński [3] states that in motor learning the key roles are played by: the intellect, awareness and anticipation processes. Also, Raczek [5] points out that *motor learning* requires an interaction between motor, sensory, cognitive and emotional aspects. Differences between intellectual and motor learning tend to be blurred when learning a complex motor activity takes place. According to Raczek [5] *motor learning* refers to 'some internal processes resulting from exercises or experience acquired which lead to relatively permanent changes in motor activity skills." Raczek [5] lists

the criteria used for assessing motor learning effectiveness: *speed* is the amount of time taken to complete tasks which results in fewer attempts; the learning level (*efficiency*) is a dimension that determines the level of practice and performance; *durability is* memory retention, resistance to fatigue and disruption. Among these criteria, *quantitative indicators* can be identified, for example: a number of correct actions, time needed to reach the target, resistance to oblivion and *qualitative indicators*, e.g. *learning curves* with growth, stagnation and regression phases [18].

Effective *learning* is conditional on a number of factors. Włodarski [2] finds that learning effects depend on generic, developmental and individual characteristics. Czabański [19] considers physical and social environment where students collect information as the most important factors in the learning process. Osiński [3] lists two groups of internal (endogenous) factors: genetic ones - determinants of development and paragenetic ones, i.e. stimulators of development. The same scholar also identifies three groups of exogenous factors: socio-economic (cultural modifiers), bio-geographical (natural modifiers) and factors related to lifestyle, the type of work and leisure and sleep time. Ledzińska et al. [1] claim that the course and effects of *learning* are driven by intelligence and abilities, individual qualities, a style of thinking and cognitive styles, personality and temperament, as well as the *learning* style.

Learning is a complex and multi-dimensional process that depends on cognitive and emotional processes and the development of functional systems of the human body (e.g. visual, auditory, osteoarticular and muscular systems). Petriński [20] stresses that the learning process involves the whole body and personality, i.e. the bio-psycho-social unity. In *motor learning* of complex motor activities, determinants coincide with intellectual learning. However, the specific role of learners' physical characteristics of development is emphasized. According to Osiński [3] these include both physical fitness and genetic, morphological and environmental conditions of motor predispositions and abilities.

Purpose

With regard to the content of the theoretical introduction, the cognitive objective was to identify the effectiveness of learning a complex motor activity in a selected group of girls and boys. The results obtained and described in the article can be taken into account in order to better identify and implement the learning and teaching process of complex motor activities. The following research questions were formulated:

1. What is the speed, efficiency and durability of learning a complex motor activity in girls and boys participating in the study?
2. What are the differences in terms of speed, efficiency and durability of learning a complex motor activity in girls and boys participating in the study?

MATERIAL AND METHODS

The study was carried out in the Koźminek Primary School in Wielkopolska Province. The study group consisted of 73 pupils (44 boys and 29 girls) aged 9 to 10 years (these were all pupils of this school who attended 4th grade). This age group is called the "golden age of the child". This period of life is conducive to the development of all motor abilities, in particular coordination abilities [19, 3, 21, 5].

Teaching experiments in natural conditions were used for the purpose of analysing the speed, efficiency and durability of learning a complex motor activity [22]. One group technique was applied. The teaching experiment was conducted during the school year and comprised three stages: Stage I – October – six physical education lessons that took place within three weeks; Stage II – January – four lessons over two weeks; Stage III – April – two lessons over one week. The study was carried out by the author of the paper who then worked at this school as a PE teacher. The complex motor activity was juggling with three tennis balls. In the teaching process, the curriculum developed by Wieczorek was used as a tool [23]. In this program learning to juggle three balls was divided into six phases (so-called steps).

The effectiveness of learning is determined by its efficiency, speed, and durability. The Learning Speed Rate (LSR) [23] was applied to assess the speed. Any higher Learning Speed Rate (LSR) value signifies faster learning. For stage I of the study (6 lessons) LSR (LSR1) could vary between 0 and 36. For stage II of the study (4 lessons) LSR (LSR2) could range between 8 and 24. For stage III of the study (2 lessons) LSR (LSR3) could fluctuate between 4 and 12. The effectiveness was determined based on the effect (mastered step) achieved at the final lesson of a given stage as part of the study. According to the methodology used for the purpose of learning to juggle, the achievement of step 4 is considered to be the mastering of this complex motor activity at an elementary level [24]. Durability was determined by comparing the final effects of a repeated series of classes after three months and then following the next three months (triple determination of learning effects). The durability assessment was expressed as a percentage of the result consistency between stages II – I and III – II.

RESULTS

The comparison of learning speed rates obtained by girls and boys at stage I of the study shows similarities. For most of the subjects LSR varied between 13 and 24, so they learned the activity at a medium pace (girls 86,2%, boys 93,2%). The number of those who were learning slowly (LSR between 0 and 12) corresponded to 13,8% and 6,8%, respectively. None of the subjects learned at a fast pace. Girls and boys participating in the study differ only in terms of the number of persons learning at a slow pace – there were twice as many girls as boys in this respect (fig. 1).

When comparing the learning speed rate shown by girls and boys at stage II, it seems to be more varied than in stage I. There were more girls who learned at a medium pace (31%) than boys (20,4%). The highest number of girls and boys were those who learned at a slow pace (69% and 75% respectively). Among boys, there were those who learned fast (4,6%). At this point none of the girls learned fast. As regards both girls and boys, learning speed rates decreased with respect to stage I (fig. 1). At stage III of the study, low-speed learning was dominant in both boys (79,5%) and girls (75,9%). Among boys, the number of those who learned quickly increased (6,8%). Also girls who began to learn quickly (10,3%) appeared (fig. 1). In conclusion, all stages of the study showed that boys and girls were learning in a fastest way at the start of the teaching experiment. At stage II and subsequently at stage III the learning speed rate decreased (fig. 1).

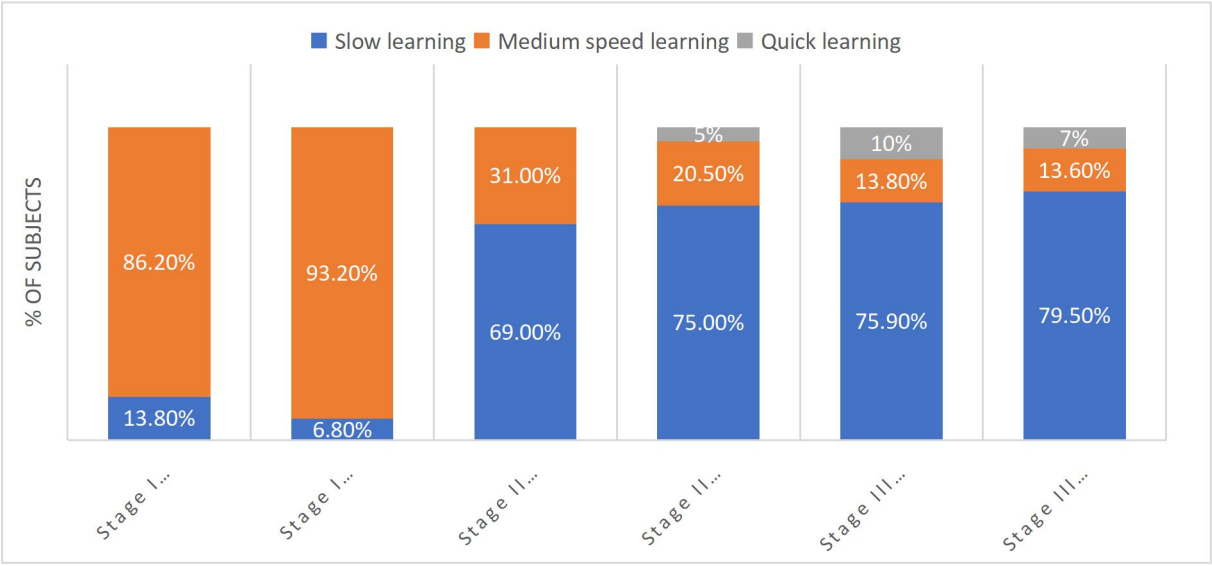

Fig. 1. Speed of learning a complex motor activity in girls and boys based on LSR in subsequent stages of study (stage I, II, III of study)

Stage I GIRLS – speed of learning by girls at stage I of study, Stage I BOYS - speed of learning by boys at stage I of study, Stage II GIRLS — speed of learning by girls at stage II of study, Stage II BOYS — speed of learning by boys at stage II of study, Stage III GIRLS – speed of learning by girls at stage III of study, Stage III BOYS – speed of learning by boys at stage III of study

The learning effects, i.e. the final achievements at each stage of the study were further analysed. Comparing the learning efficiency among girls and boys at stage I of the study, it can be said that both boys and girls largely completed their learning at step 3 (girls 62,1%, boys 70,5%). However, boys learned more efficiently than girls, as more of them mastered step 4 and further steps. None of the girls mastered steps 5 and 6, and 13,9% remained at step 1 and 2. Among boys were those who mastered steps 5 and 6 (6,8%) and only 6,8% of them remained at juggling skills corresponding to step 1 or 2 (fig. 2). When comparing learning efficiency among girls and boys at stage II of the study, it can be said that both boys and girls largely completed their learning at step 3 (girls 65,5%, boys 75%). None of the girls remained at step 1, but also none of them mastered step 6. Among boys no one remained at step 1 but one of them mastered step 6. In total, 20,4% boys mastered step 4 and above, which means they learned juggling at an elementary level and so was the case among girls but in 31% (fig. 2). At stage III of the study, most girls and boys (75,9% and 79,6% respectively) completed their learning at step 3 again. In total, 20.3% and girls 16,7% boys mastered step 4 and step 5, which means that they learned to juggle at an elementary level. 3,5% of girls mastered step 6 for the first time and among boys so was the case in 4,6% of them. Effectiveness of learning in girls and boys at stage III was most similar (fig. 2).

The durability of learning was assessed on the basis of the consistency analysis with regard to learning effects between specific research stages. Between the second and the first stage of the study, the effects were more consistent in girls (83%) than in boys (66%). The

average consistency of results was 71%. However, between the third and the second stage, the effects were more consistent in boys (93%) than in girls (90%). The average consistency of results was 92%. In conclusion, durability of learning among the investigated groups was high and increased, especially among boys (fig. 3).

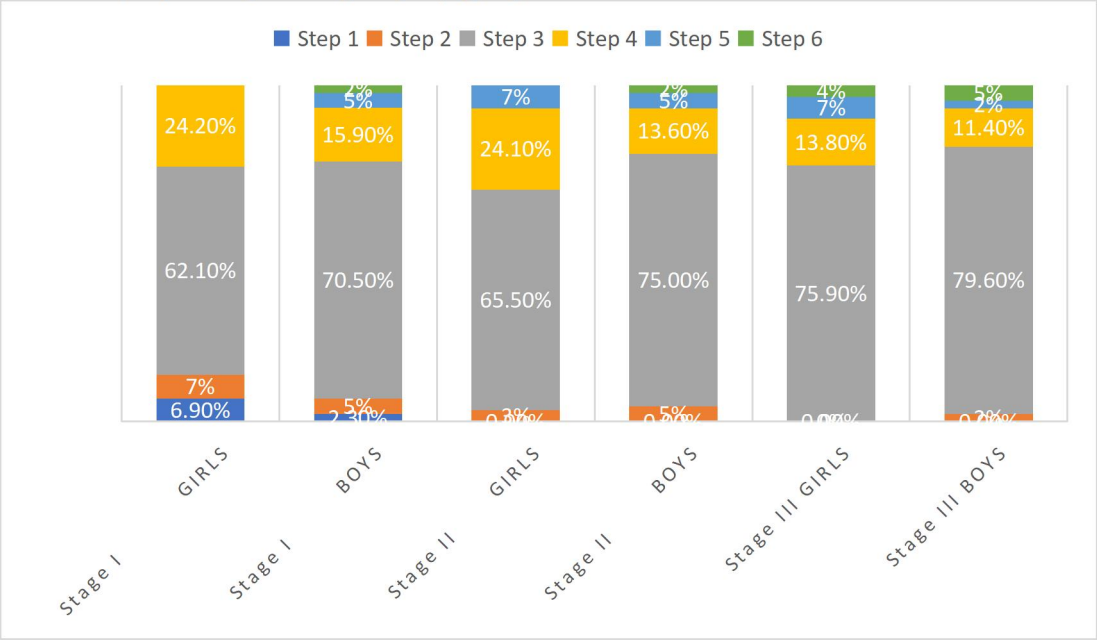

Fig. 2. Learning effects (percentage of girls and boys who mastered individual steps) after stages I, II and III of study.

Stage I GIRLS– speed of learning by girls at stage I of study, Stage I BOYS — speed of learning by boys at stage I of study, Stage II GIRLS — speed of learning by girls at stage II of study, Stage II BOYS — speed of learning by boys at stage II of study, Stage III GIRLS – speed of learning girls at stage III of study, Stage III BOYS –speed of learning by boys at stage III of study

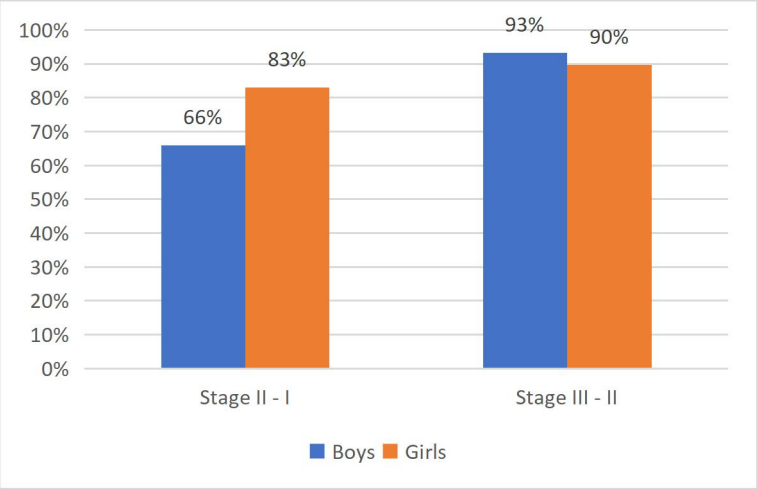

Fig. 3. Percentage of learning effects consistency between different stages of study

DISCUSSION

More and more often progressive changes in the development of civilization cause people to face new tasks that force them to constantly adapt in every area of life [25, 11, 15, 26, 27]. *Learning* is one way to prepare humans for changing daily requirements. *Learning* is the subject of research in many fields of science, including physical culture sciences [28, 19, 29, 12, 30]. By developing multiple approaches (e.g., behavioural and cognitive), styles (e.g. kinesthetic, visual, auditory) and learning definitions, it is easier to understand the conditions, the course, and effects of this process [31, 32, 33, 34, 35, 36, 37, 38]. One type of *learning* is *motor learning* [39, 40, 41].

In this work, the effectiveness of learning a complex motor activity was assessed on the basis of selected aspects: speed, efficiency and durability. The speed of learning a complex motor activity between girls and boys shows inter-subject variability. However, these results are considered quite common and typical for school age subjects [19, 42, 43, 44, 45]. The process of motor learning can take place at a different pace. There are moments of high and rapid skill growth, stagnation or even decline regarding skills already acquired [33]. Both girls and boys were learning in the fastest way at the beginning of the teaching experiment. This may be due to children's interest in a new motor activity that they had not yet known. During the subsequent stages the learning speed decreased, which may be due to the difficulty in mastering any higher (subsequent) step. In 1997 [24] Wieczorek first developed and applied LSR and a method of programmed learning to juggle with three balls. The author analysed the speed of learning a complex motor activity in young boys and girls aged 10. Gender was not a variable differentiating the speed of learning a complex motor activity. This study also showed no difference between learning speed rates for boys and girls. Similar conclusions were made by Ostrowski [46]. The author assessed the speed of learning to swim by young children aged 9 to 10. In order to assess the speed of skill acquisition,

Ostrowski carried out 8 swimming skill tests every 5 weeks. In these results, the scholar took into account the division of children taking part in the study into 5 groups: non-swimmers, swimmers adapted initially, elementary level swimmers, backstroke swimmers, two-style swimmers. The speed of learning swimming skills in girls and boys was similar. Identical conclusions were made by other authors who examined gender-to-learning speed relationship with regard to motor activity learning [2, 47]. According to Włodarski [2]: 'at present there are no grounds to believe that learning is gender-dependent'. Czyż [48] conducted a study on speed and durability of learning a complex motor activity, namely juggling two and three balls, thus allowing for a further reference to this scholar's own studies. The author analysed the relationship between learning conditions and forms (integrated and variable) and the speed and durability of motor learning under discussion. The participants were boys aged 16 years. The learning speed rate was measured 10 minutes after each lesson. The learning durability was reviewed 5 days after the last, i.e. fourth lesson. Testing learning durability and speed was based on juggling three balls for one minute. The author found that out of the two forms: random and variable, the random form had a more positive impact on the consolidation of this motor activity. However, the random approach is based on the fact that the learning process was the slowest. As regards the results of the studies described in this work, it can be concluded that durability of learning a complex motor activity was high. Girls achieved more lasting learning effects between stage I and II of the study. In contrast, between stage II and stage III of the experiment, the durability of learning was comparable in both groups.

Learning effects, i.e. the final achievements at each stage of the study were further analysed. Boys acquired slightly higher skills during the first stages of the study, but girls completed their learning at a slightly higher level. The learning process in the group of girls and boys was very similar. In the investigation carried out by Wieczorek [24], the process of motor learning in girls and boys was also similar. The author noted that boys were more effective in terms of learning, but these differences were not statistically significant. The majority of persons completed learning at step 3, just like in the author's own research. Ostrowski [46] also noted that the learning process in girls and boys was similar, but boys learned more effectively. The research to be referred to in view of the similarity of the group under examination are further studies by Wieczorek [43] dating back to 2003. The aim of these studies was once again to evaluate the learning process of a complex activity, such as juggling with three balls. This time, the investigated group consisted of girls aged 13 years. Most girls completed their learning a t step 3, whereas step 6 was mastered by 10% girls only, and step 4 and above was achieved by 33% female subjects in total, which shows that the basic ability to juggle with three tennis balls was mastered. With regard to the author's own research, 22,8% girls also mastered juggling at an elementary level. Fewer female students remained at step 1 and fewer girls completed learning at step 6. (3.5%).

A similar subject matter of study - although the research group differed from the one described in this article - was undertaken by Koszczyc et al. [49]. The scholars carried out studies in the area of learning a complex coordinated motor activity among women over 60 years of age. The activity consisted in juggling with three balls as well. The authors' aim was to evaluate the learning process and its effects among the investigated women. In the paper, LSR was used to assess the speed of mastering the ability to juggle with three balls. The method of programmed learning was also applied. The results achieved after three classes were interpreted and on the basis of these, the effectiveness of learning - that could be low, medium or high - was estimated. The authors observed, as in their own findings, that the best progress was achieved by senior subjects during their first classes. In the group of children

investigated by the author of the present paper, as in the case of investigated senior female subjects, most persons completed learning at step 3 (77,7%, average efficiency). However, a higher percentage of senior female subjects remained at step 1 and step 2 (22,2%,) while among children only 2,3% of pupils completed learning at step 2. Step 6: was mastered by 4% of the investigated children, while none of the women-subjects was able to master this level of skills. In summary, children aged 9-10 years learned more effectively but at a slower rate than senior female subjects. The speed and effects of motor learning depend on a number of factors, such as maturity of the learner's body (e.g. morphological development), diversity of motor predisposition (which depends on the body's intrinsic properties), or the overall mental attitude [50, 49].

CONCLUSION

As a result of the study and development of its results the cognitive objective was achieved, namely - assessing the effectiveness (speed, efficiency, durability) of learning a complex motor activity in a selected group of girls and boys. The author of the present paper hopes that the results will also be applicable and will help teachers of physical education to achieve more effectively the process of learning and teaching complex motor activities.

On the basis of the results obtained from the author's own studies, it can be concluded that the speed, efficiency and durability of learning to juggle three balls among the investigated children were at a similar level. Slow learning predominated among both girls and boys participating in the study. The highest number of subjects completed learning a complex motor activity in the middle of the task. Boys achieved better learning effects than girls, but these differences were not statistically significant. The subjects showed high durability of learning effects.

On the basis of the results obtained, it can be concluded that the learning process of a complex motor activity is varied between individuals and gender does not significantly differentiate the speed, efficiency and durability of learning a complex motor activity.

Taken together, the data collected from own research and results of investigation by other authors, the need for further research projects in this field should be highlighted. In order to verify the issues addressed in the present paper, different teaching methods, varied motor activities and age groups should be used.

DISCLOSURE

The authors report no conflict of interest.

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