MOTOR LEARNING IN RHYTHMIC GYMNASTICS: INFLUENCE OF FUNDAMENTAL MOVEMENT SKILLS

Ana Kezić[1], Đurđica Miletić[2], Ivana Kujundžić Lujan[3]

[1]*Faculty of Kinesiology, University of Split, Croatia,*

[2]*University of Split, Croatia,*

[3]*Faculty of Science and Education, University of Mostar, Bosnia and Herzegovina*

Original scientific paper

Abstract

The main aim of this research was to determine the influence of fundamental movement skills on the performance of specific rhythmic gymnastics skills in different stages of motor learning in 6-year-old children. Seventy preschool children participated (30 girls and 40 boys; mean age 6±0.5y; height 122.5±5.0 cm, weight 24.49±3.78 kg). A battery of 20 rhythmic gymnastics skills tests (5 tests with each of the apparatus: rope, hoop, ball and ribbon) was constructed and evaluated by experienced judges. Fundamental movement skills were measured using the Bruininks-Oseretsky Test of Motor Proficiency, second edition (short form). Children exercised for approximately 6 months, three times a week for 35 minutes. Three measurements of specific rhythmic gymnatics skills were carried out: initial (first week), transitive (ninth week) and final (nineteenth week). The level of fundamental movement skills was tested in the first week of the treatment. The results of multiple regression analyses indicate the existence of statistically significant influence of fundamental movement skills on the degree of specific rhythmic gymnastics skills acquisition for all apparatus and all measurement points (p value ranging from 0.00 to 0.02). Partially, the verbal-cognitive phase of learning specific rhythmic gymnastics skills is characterized by the influence of precise motor skills. In the motor phase of learning, hand coordination, as well as bilateral coordination, becomes more and more important. Finally, at the advanced motor stage of learning, the influence of significant predictors is changed. These changes are reflected in the increasing influence of bilateral coordination, hand coordination and strength, and also the same, or somewhat smaller, impact of precise motor skills.

Key words*: motor skills, preschool, beginners, BOT-2*

Introduction

Speaking of rhythmic gymnastics (RG) as a competitive sport, it can be said that it requires two diametrically opposite features: 1) power and explosiveness, and 2) flexibility and rhythm. In addition, it is precisely optimal relationship between these parameters what makes this sport complex, but interesting. In complete contrast to the competitive sphere is the beginner's RG program. This program is equally focused on entertainment, active participation and enjoyment. In such environment, this sport is not determined by gender, and both girls and boys are equally involved (Pollatou, Karadimou, & Gerodimos, 2005; Bozanic & Miletic, 2011) as coeducational programs become more advocated by the experts. It attracts children of different ages and of all levels of motor skills since it is an effective mean for the enhancement of motor proficiency in early childhood (Karachle, Dania & Venetsanou, 2017). Mostly, children are involved in this program, from the age of 4 to greatly increase their training volume (Jastrjembskaia & Titov, 1999) by the time they enter the first competitions. As training volume includes all technical elements that an individual can perform, it's still pretty modest in the preschool age, and the problem of selecting the appropriate tests to assess the specific movement skills of RG at that age arises. Although there are validated measurement instruments for assessment of RG skills in school children (Miletic, 2003), they have not been studied in a sample of preschool children. The importance of finding such measuring instruments is increased by the fact that children are involved in the program of RG in preschool age already. The problem that almost always occurs in the assessment of such skills is specific sport evaluation. The complexity of the problem manifests as severe ponderability of specialized skills. Specifically, the assessment of isolated technical elements with clearly defined levels of skills often leads to discrepancies among judges. Far greater problem occurs in official competitions where the judges have much more complex task and where impartiality is highly questionable (Seltzer & Glass, 1991; Ste-Marie, 2000; Liviotti & Hökelmann, 2012). This prominent problem in the assessment of specialized skills authors tried to solve in a number of ways: using the Likert scale evaluation (Miletic, Katic & Males, 2004), using the extended grading scales or with a "managed "/"failed" principle. What is common to all approaches are specific, exact assessment criteria which must be explicitly defined and identifiable to provide the most objective assessment. From the above it is clear that the

assessment of specialized RG motor skills requires a qualitative approach of evaluation. Such approach focuses on the form and/or the quality of the performance technique. In other words, it emphasizes the performance of the skill itself. Unlike the quantitative approach, its ultimate goal is not the result, but the performance. It is based on strictly defined criteria that are scored in a certain way.

The term movement skill refers to development of motor control, precision, and accuracy in the performance of both fundamental and specialized movements (Gallahue & Donnelly, 2007). The most common classification of movement skills defines them as fundamental and specialized movement skills. Although mostly used in the same context, terms *fundamental* and *specialized* movement skills have different meanings. Fundamental movement skills are a specific set of skills that involve different body parts such as feet, legs, trunk, head, arms and hands. They can be subdivided into categories: stability, locomotion and manipulation (Gallahue & Donnelly, 2007). On the other hand, specialized movement skills are considered as a combination of fundamental skills directly applied to the performance of a specific sport-related activity. Mastering fundamental movement skills is a prerequisite to the successful introduction of specific sport activities (Burton & Miller, 1998; Gallahue, Ozmun & Goodway, 2006; Jurimae & Jurimae, 2001; Karabourniotis, Evaggelinou, Tzetzis & Kourtessis, 2002; Schmidt, Lee, Winstein, Wulf & Zelaznik, 2018) with practice being crucial to their development (Gallahue et al., 2006). The period of life from age 2 to age 7 authors describe as a period of greatest development of fundamental movement skills (Gallahue, 1982; Sanders, 1992; Gabbard, 2002) which can be divided into three distinctive developmental phases: initial, elementary and mature. According to this categorization, preschool children in the age of 6 belong to mature fundamental movement skills developmental phase. This phase is characterized by integration of all previously learned components of movement structures into a coordinated, accurate and efficient performance. Starting from this phase of development, the quality of motor performance is growing rapidly and begins to move in the first phase of specialized movement skills development - transition phase, characterized by the increasing interest for a particular sport.

Gallahue and Donelly (2007) consider that individuals who have not developed a mature phase of development in fundamental movement skills have limited ability to progress in acquiring specific motor skills. The question is whether this assumption is founded and justified when we talk about certain sports and sports disciplines, in the case of this research, about RG. Although Burton and Miller (1998) define specific movement skills as a combination or different manifestation of one or more fundamental movement skills that are at the service of solving specific motor tasks, they consider that a certain level of fundamental skills is not a precondition for learning specific skills. This is explained by the fact that a child at age of two, for example, can master specific movement skills such as skating or rolling even though his fundamental skills are not yet on an optimal level. But could this be confirmed in a sport in which, apart from the technique of the body, manipulation with different apparatus predominates? Is a certain level of fundamental skills a prerequisite for learning specific skills in preschool children or are children whose fundamental skills are not at a high level capable of adopting basic techniques with different apparatus? And in the end, are the same fundamental movement skills important for success in all learning phases?

The main aim of this research was to determine the influence of fundamental movement skills on the performance of specific RG skills in different stages of motor learning in 6-year-old children.

Methods

Participants

Seventy preschool children participated (30 girls and 40 boys; mean age 6±0.5y). All of them were chosen randomly and they all gave their informed consent, as their parents gave official written consent. The study included children with no health problems or significant motor disorders. Their average body height was 122.5±5.0 cm, with average body weight of 24.49±3.78 kg, average body mass index being 16.28±1.71. Those children who were involved in RG outside the preschool institution were not included in the investigation.

The Ethical Committee of the Institution verified that this investigation complied with all ethical standards for scientific investigations involving human participants. Also, the study conformed to the declaration of Helsinki.

Measures

Selection of tests for specific rhythmic gymnastics skills assessment was done according to existing techniques of the sport in such way that 5 tests for each apparatus was designed (one test for each technique of the four apparatus). Overall, 20 rhythmic gymnastics skills tests were constructed. Qualitative approach that was based on fundamental movement skills assessment (Test of Gross and Motor Development-2) (Ulrich, 2000) was used for evaluation of each skill. Thus, each test was divided into three phases (segments) and each stage had to meet certain criteria. If the respondent met the criteria he was assigned the score 1, and if he did not meet the criteria, he received a score 0. The maximum number of points that the respondent could get on a single test was 6 because each test was repeated twice. Based on primary rope techniques the following tests were constructed: rope swings, front scale rotation, jumping through the rope, throwing and catching and rope winding. The following tests were used for hoop skills assessment: jumping into the hoop, hoop swings, floor roll, throwing and catching in front scale,

passing through the hoop. For assessment of ball skills we used the following tests: throwing and catching the ball, hand roll, floor roll, bouncing in the front scale, circling the ball around the body. Based on primary ribbon techniques the following tests were constructed: swings and skips, circling in the front scale, horizontal snake, spirals and figure eights. To get a complete insight in the total proficiency of rhythmic gymnastics skills all tests with each apparatus were summed up.

For the evaluation of fundamental movement skills, the short form of ″Bruininks-Oseretsky Test of Motor Proficiency″, second edition (BOT-2) was used (Bruininks and Bruininks, 2005). The test covered 8 different motor areas: fine motor precision (FMP), fine motor integration (FMI), manual dexterity (MD), upper-limb coordination (ULC), bilateral coordination (BC), balance (B), running speed and agility (RSA) and strength (S).

Procedures

The investigation was a part of a long-term study which main research phase referred to a six-month beginner's RG experimental program conducted in two preschool institutions. The six-month treatment included the retention period also, which was not a part of this paper. The program itself was constructed of a regular preschool program with addition of RG elements (frequency was 4-6 RG elements per class). Children exercised three times a week for 35 minutes in the preschool gym, led by an experienced teacher. Three measurements of specific RG skills were carried out: initial (first week), transitive (ninth week) and final (nineteenth week). It is important to emphasize that children were tested on their 3rd class, when they got familiar with all the specific tests. The level of fundamental movement skills was tested also in the first week of the treatment. Each child was tested throughout one session and all participants were tested in the range of one week. All RG skills were videotaped (GoPro Hero 4, H.264-1920x1080-120 fps) and later assessed individually by three experienced RG teachers and coaches according to the set criteria.

Data analysis

Data were analyzed using the Statistica for Windows 13.0 package and statistical significance was set at $P < 0.05$. Basic descriptive statistics were calculated for total skills for each apparatus and each measurement point (mean values and standard deviations, minimum and maximum result), and for BOT-2 variables. For determining the between-subject reliability of the specific skills tests Cronbach's alpha coefficients (α) were calculated; for determining the normality of the distributions Kolmogorov-Smirnov test was calculated for all variables in all measurement points. T test for dependent samples was used to check the differences in the RG skills between the measurements. Finally, the influence of fundamental movement skills on the performance of specific RG skills in each measurement point was tested using multiple regression analyses.

Results

Analyzing Table 1 and the results of basic descriptive parameters, it is clear that participants had the lowest results in the initial measurement point in all applied apparatus. Also, a progress of developing specific RG skills is visible throughout mean values in transitive and final measurement points. Values of minimum and maximum results show that there were children who demonstrated the RG technique on the highest level in the final measurement point (30.00).

According to the results of between-subject reliability, Cronbach alpha coefficients are ranging from 0.91 up to 0.97 which indicates a very high correlation value. The values of this coefficient indicate a satisfactory correlation between the judges in all the analyzed tests for assessing the degree of specific RG skills.

T test for dependent samples revealed significant differences between the measurement points for all applied apparatus and skills, proving the existing learning process.

The analysis of the distribution of results through the K-S test for each applied specific skill, as well as for BOT-2 variables (Table 2), confirms that there is no significant difference in the distribution of the results of the aforementioned skills relative to the theoretical normal distribution of the result at the error level of 0.05, and the obtained variables can be used in further analyzes.

The results of multiple regression analyses (Table 3) indicate the existence of statistically significant influence of fundamental movement skills on the degree of specific RG skills acquisition for all apparatus and all measurement points (p value ranging from 0.00 to 0.02). The set of predictors explain from 25% (transitive measurement point for ribbon) to 51% (final measurement point for hoop) of common variability.

When observing only rope techniques, fine motor integration seemed to be significant predictor in initial and transitive measurement and bilateral coordination in transitive and final measurement point, with the addition of upper-limb coordination in the final point.

Fine motor integration was significant for hoop skills in transitive and final point as well. Manual dexterity proved to be the only predictor of importance in the initial measurement point for this apparatus. As in the case of rope, bilateral coordination is needed to perform hoop skills in the transitive and final measurement. In the final stage of learning hoop skills it is also important to be skilled in running speed and agility and strength.

The dominant predictor of ball performance seemed to be the upper-limb coordination which dominated in all points of measurement. Manual dexterity was also important in the initial and running speed and agility in the transitive point of measurement.

Significant predictor of ribbon performance was the fine motor integration, with the addition of bilateral coordination in the initial and final, and running speed and agility only in the final point of measurement.

Table 1. Results of between-subject reliability and normality of distribution for all specific skills in three measurement points (Mean – mean value, SD – standard deviation, Min – minimum result, Max – maximum result, α – Cronbach alpha coefficient, K-S – Kolmogorov-Smirnov test for normality); results of t test for dependent samples between measurement points (t – t-value, p – level of significance)

		Mean ± SD	Min	Max	α	K-S	t	p
Rope	I	5.32±3.04	0.33	13.66	0.91	0.07	-27,93	0,00
	T	18.86±4.37	9.00	27.33	0.97	0.09	-15,21	0,00
	F	23.97±3.54	16.00	29.67	0.96	0.13		
Hoop	I	5.90±3.33	0.00	21.00	0.95	0.08	-27,08	0,00
	T	18.85±3.86	8.00	27.00	0.94	0.08	-13,68	0,00
	F	24.07±3.28	14.33	29.67	0.96	0.12		
Ball	I	8.90±3.29	2.00	17.00	0.91	0.08	-21,96	0,00
	T	19.48±3.98	8.33	28.00	0.95	0.07	-13,09	0,00
	F	24.06±3.21	16.00	30.00	0.97	0.08		
Ribbon	I	11.98±3.80	3.66	22.66	0.91	0.09	-17,49	0,00
	T	20.43±4.83	9.67	29.67	0.96	0.09	-12,68	0,00
	F	24.80±3.70	15.00	30.00	0.95	0.10		

Legend: I – initial measurement, T – transitive measurement, F – final measurement, d=0.16 for N=70 ($p<0.05$)

Table 2. Descriptive statistics and normality of distribution for BOT-2 variables (Mean – mean value, SD – standard deviation, Min – minimum result, Max – maximum result, K-S – Kolmogorov-Smirnov test for normality)

	Mean ± SD	Min	Max	K-S
FMP	8.70±2.74	2.00	14.00	0.12
FMI	6.53±2.23	0.00	10.00	0.12
MD	3.93±1.15	1.00	6.00	0.15
ULC	5.70±2.80	1.00	12.00	0.11
B	6.94±1.21	4.00	8.00	0.15
BC	6.23±1.05	2.00	7.00	0.15
RSA	4.30±2.19	1.00	9.00	0.14
S	3.70±2.21	0.00	8.00	0.11

Legend: fine motor precision (FMP), fine motor integration (FMI), manual dexterity (MD), upper-limb coordination (ULC), balance (B), bilateral coordination (BC), running speed and agility (RSA) and strength (S); d=0.16 for N=70 ($p<0.05$)

Table 3. Results of regression analyses between four groups of skills as criterion and fundamental movement skills as predictors through three measurement points (I – initial measurement, T – transitive measurement, F – final measurement)

	Rope			**Hoop**			**Ball**			**Ribbon**		
	I	T	F	I	T	F	I	T	F	I	T	F
	Beta			Beta			Beta			Beta		
FMP	0.05	0.00	0.05	0.10	-0.02	-0.06	0.21	0.07	0.14	0.18	0.19	0.05
FMI	0.25*	0.28*	0.17	-0.05	0.23*	0.33*	-0.09	0.08	0.03	0.29*	0.24*	0.27*
MD	0.14	0.19	0.16	0.38*	0.18	0.10	0.26*	0.11	0.17	-0.08	0.22	0.09
ULC	0.10	0.05	0.23*	0.05	0.18	0.15	0.25*	0.30*	0.34*	-0.14	-0.06	0.04
B	0.19	0.09	0.10	-0.02	0.05	0.17	0.11	0.05	-0.03	-0.11	-0.08	-0.08
BC	0.15	0.35*	0.26*	0.13	0.30*	0.21*	-0.15	0.13	0.16	0.25*	0.12	0.25*
RSA	0.09	0.20	0.16	0.22	0.21	0.27*	0.07	0.30*	0.22	0.22	0.10	0.28*
S	-0.10	0.07	0.11	0.20	0.07	0.20*	0.16	-0.04	-0.02	-0.10	0.01	0.10
R	0.53	0.68	0.65	0.64	0.65	0.71	0.55	0.60	0.62	0.52	0.50	0.60
R2	0.28	0.46	0.42	0.41	0.42	0.51	0.30	0.36	0.39	0.27	0.25	0.36
p	0.01*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.01*	0.02*	0.00*

Legend: fine motor precision (FMP), fine motor integration (FMI), manual dexterity (MD), upper-limb coordination (ULC), balance (B), bilateral coordination (BC), running speed and agility (RSA) and strength (S); *R – coefficient of multiple correlation, R^2 – coefficient of determination, p – level of significance, * - significant predictors.*

Discussion

The results clearly indicate the existence of statistically significant influence of fundamental movement skills on the degree of specific rhythmic gymnastics skills acquisition for all apparatus and all measurement points. Partially, different phases of learning specific rhythmic gymnastics skills are characterized by the influence of different fundamental movement skills.

Theories of motor learning are generated on a daily basis. Given that this is an extremely complex phenomenon that can be seen from a large number of perspectives (biochemical, psychological, biomechanical, sociological, kinesiological, etc.), a massive number of theories have been created so far to analyze a unique phenomenon - movement. From the kinesiological point of view, the most interesting fact is that the idea of a movement is created in the initial stages of learning (Gentile, 1972). The initial idea and the motor structure are performed at the basic level. This stage is called verbally-cognitive stage (Fitts & Posner, 1967), and is characterized by maladministration, insecurity, slowness and frequent errors. By time and training, as well as increasing the level of motor abilities and skills, the error elimination process begins and the performance becomes safer and more accurate. This phase is called the associative phase of learning (Fitts & Posner, 1967; Anderson, 1982; Anderson, 1995), or the motor phase of learning (Adams, 1971, Gentile, 1972). Since the automation phase of learning (Schmidt & Wrisberg, 2000) requires long-lasting training and experience, it is to be assumed that the motor phase of the learning process is retained for a long time.

If we define the initial point of measurement as a verbal-cognitive learning phase, we conclude that at this stage the motor skills have a significant influence on the performance of specific skills with all apparatus. Thus, it is possible to confirm the conclusions of many authors (Burton & Miller, 1998; Gallahue, Ozmun & Goodway, 2006; Jurimae & Jurimae, 2001; Karabourniotis, Evaggelinou, Tzetzis & Kourtessis, 2002) about the necessity of mastering fundamental movement skills for successful introduction to specific skills. This necessity was mostly reflected in hoop skills, since the predictor set has explained the highest percentage of the variance of the criteria (41%). It is possible that the majority of the tests required a certain body technique besides the manipulation of

the hoop, which generated the complexity of the tests themselves, so that respondents with a higher level of basic motor skills could easily master these skills. Furthermore, significant Beta coefficients show an important influence of motor integration in the performance of rope and ribbon. Motor integration, or visual-motor integration, is defined by authors as the ability to reproduce visual stimuli (Bruininks & Bruininks, 2005). This skill belongs to the area of precision motor control (along with motor precision). The test of motor integration itself is characterized by the drawing of certain geometric shapes, that is, reproduction based on the sight. Given the fact that the participants saw the specific skills in the initial measurement for the first time, it is apparent that they experienced the rope and ribbon visually as non-rigid apparatus having a shape change characteristics, and tried to reproduce their form with their own motion. Unlike non-rigid apparatus, the ambidexterity (skill of being equally adapted in the use of both the left and the right hand) has shown to be a significant predictor for hoop and ball skills. The important role of ambidexterity is confirmed by research on older populations (Bozanic & Miletic, 2011). However, its significant influence is evident even at early ages in children who are introduced to rhythmic gymnastics for the first time. Because of the frequent shifting of the hoop and the ball from one hand to the other, those respondents who could equally well handle the left and right hand, had better performance in the tests. Hand coordination with the BOT-2 test is measured by throwing, catching, and dribbling the ball. For success in this test, coordinated work of arms and hands is required. Therefore, the significant influence of hand coordination on the performance of ball skills is not incidental. Bilateral coordination has been shown as a second significant predictor for the performance of the ribbon skills in the verbal-cognitive phase of learning. This skill requires control and simultaneous coordination of the upper and lower extremities. Significant impact of this skill is most evident in the swings and skips, which requires precisely the coordinated movement of the arms and legs.

According to the significant increase in the level of specific RG skills and decreasing number of errors in performance, the transitive point of measurement can be defined as the motor phase of learning. As in the verbal-cognitive, the applied movement skills have a significant influence on the performance of specific RG skills with all apparatus. At this stage, the largest percentage of the explained variance of 46% is found in the rope skills. So, at this stage of learning, it is necessary to have very good fundamental movement skills in order to make visible progress in acquiring specific RG skills. Motor integration still appears to be a significant predictor in rope and ribbon, but at this stage it is also important for the performance of the hoop elements. So, we can conclude that the children in this stage started to perceive the hoop through a visual perspective. Unlike initial measurement, ambidexterity no longer appears as a significant predictor in any group of skills. It is possible that this is a consequence of sufficient training but also of the fact that skills are probably not complex, requiring a relatively "rough" patterns and therefore are easily to master (after initial information acquisition and information processing through the verbal-cognitive learning phase). Hand coordination, except in the verbal-cognitive learning phase, appears to be a significant predictor for ball skills in the motor phase of learning, but now accompanied by speed and agility. If the ball skills are thoroughly analyzed we come to the fact that neither a single test requires a significant speed or a rapid change in direction of movement, so we can talk about an unexpected result. The only velocity that could be of such importance in such constructed tests is the speed of reaction, given the need for timely reaction when catching the ball, rejecting it from the ground and rolling on the hands. However, the author is of the opinion that the speed and agility test from the BOT-2 battery test did not measure the required response rate. On the contrary, given the very nature of the test, its inclusion in the area of speed and agility can be considered, at least, doubly. The task of this test was to make as many one-legged skips as possible in a time of 15 seconds with a free leg bent at 90 degrees and hands placed on the hips. Some participants performed with minimal separation from the ground and thus achieved a better result in the test, while others considered that it was necessary to jump as high as possible, and thus have reached a weaker score. This omission most likely occurred due to the insufficiently explained measurement procedure, but also due to the possible favoring of the girls. Namely, girls in our region spend their outdoor time in playing the traditional game with elastic tape and this is probably the reason they had better results in the test. Ultimately, the author's opinion is that this test is likely to be valid, but not for our region, and it would be advisable to replace it with another test that would better assess the area of speed and agility, as recommended by Venetsanou, Kambas, Aggeloussis, Fatouros and Taxildaris (2009). Bilateral coordination is shown to be an important motor skill in the motor phase of learning. Namely, high Beta coefficients have been found in rope and hoop skills. Therefore, timely, accurate, and synchronized upper and lower extremity movements are responsible for troubleshooting and safer and more accurate performance with rope and hoop.

It is clear that the participants were still in the motor phase of learning at the final checkpoint since the automatization phase only takes place after about 40,000 - 50,000 repetitions of a certain motion (Coh, Jovanovic-Golubovic & Bratic, 2004), which is a time period of several years. Of course, the skills applied in this research do not represent a complex movement that would require so many repetitions. However, it is clear that we still cannot speak about the automatization stage. There is a statistically significant influence of a set of predictors on all four sets of skills in this phase, which is probably a slightly higher but still motor-based learning phase. Also, this time we come to the highest percentages of the explained variance,

which reaches over 50%. Obviously, during the learning process, acquired fundamental movement skills become increasingly important. So, children who have a higher level of fundamental movement skills can easily eliminate the performance mistakes and achieve stability of performance sooner.

By inspecting significant Beta predictors, we also notice the further significant influence of motor integration on the success of ribbon skills, but also hoop skills. Children, who are able to visualize the apparatus path, are more successful in manipulating of the apparatus. Hand coordination is still important for the performance of ball skills, but at this stage and for the performance of the rope skills. So, as the children progressed in their rope skills and made fewer mistakes, their movements were more accurate, precise and coordinated so that they could, for example, catch a thrown rope with success. As for the bilateral coordination, we can say that it has the biggest influence on the performance in the final stage of the learning process, because its significant impact was noted in all groups of skills, excluding the ribbon. We might say that tests of bilateral coordination are most similar to the tests for rhythm coordination. Namely, both the synchronized hops and the synchronized taping of the feet and hands, require a certain rhythm of the performance from the participants. Otherwise, it is not possible to achieve a high test result. This would suggest that the applied tests of bilateral coordination, apart from the coordination of the upper and lower extremities, measure rhythm coordination as well. It is well-known (Miletic, Katic and Males, 2004) that rhythm coordination is one of the important abilities needed for success in rhythmic gymnastics. The emergence of speed and agility as a significant predictor in hoop and ribbon can be explained by the very nature of the tests with these apparatus. However, because of the obvious measurement error and possibly favoring of the girls, this significant impact cannot be interpreted correctly. What is very important for this stage of learning is the emergence of strength as a significant prediction in hoop skills. Since in this research strength was presented solely through the repetitive power of hull and arms, the result can be interpreted with the dimensions and weight of the apparatus itself. Hoop is an apparatus of the biggest dimensions and weight, since the ball was much less weight than prescribed. For the proper handling of large and, for preschoolers, heavy equipment one requires a significant amount of body and arm strength.

Conclusion

Summarizing the results of regression analyses at all stages of skill acquisition, it is generally possible to assert that the verbal-cognitive phase of learning specific RG skills is characterized by the influence of precise motor skills. At this learning phase, or the emulation phase, participants do not have movement control; their only goal is to do the most faithful reproduction of what they have seen. At this stage, children are not focused on the body technique, but only on the apparatus technique. For this reason, the significant influence of the predictors has been limited mainly to precise motor skills of the hand, the ability to use equally good left and right hand, and general hand coordination.

The transitive measurement point (the motor learning phase) is the point at which progress in performance is most visible. Motor integration continues to have a very significant impact on success. However, at this stage, the impact of ambidexterity is lost to a degree, which is a consequence of training. Hand coordination continues to be an important factor in the good performance of the technique with a ball, and bilateral coordination becomes more and more important.

The final point of measurement (probably higher level of the motor learning phase) yields slightly lesser progress in performance, but also brings some changes in the structure of significant predictors. These changes are primarily reflected in the increasing influence of motor skills, such as bilateral coordination, hand coordination and strength, and also the same, or somewhat smaller, impact of precise motor skills. This is due to an increasing focus on the body technique, since the error concentration was higher in these elements.

It is possible to conclude that fundamental movement skills and specific motor skills of rhythmic gymnastics cannot be separated at all stages of learning. The influence of individual variables varies with respect to the learning phase; however, certain legacies are noticeable, which are certainly appropriate to respect, both when designing plans and programs for pre-schoolers, and in selecting gifted children.

References

Adams, J.A. (1971). A closed-loop theory of motor learning. *Journal of motor behavior*, 3, 111-150.
Anderson, J. R. (1982). Acquisition of cognitive skill. *Psychological Review*, 89, 369-406.
Anderson, J. R. (1995). *Learning and Memory.* New York: Wiley.
Bozanic, A., & Miletic, D. (2011). Differences between the sexes in technical mastery of rhythmic gymnastics. *Journal of Sports Sciences, 29*(4), 337-343.
Bruininks, R. H. (2005). *Bruininks-Oseretsky test of motor proficiency* (pp. 27-28). Circle Pines, MN: AGS Publishing.
Burton, A. W., & Miller, D. E. (1998). *Movement skill assessment*. Human Kinetics.
Coh, M., Jovanovic-Golubovic, D. & Bratic, M. (2004). Motor learning in sport. Physical Education and Sport, 2(1), 45-59
Fitts, P.M. & Posner, M.I. (1967). *Human performance*. Belmont, CA: Books/Cole.
Gabbard, C. (1992). *Lifelong motor development* (pp. 259-275). Dubuque, IA: Brown & Benchmark.
Gallahue, D. L. (1982). *Developmental movement experiences for children*. Wiley.

Gallahue, D. L., & Donnelly, F. C. (2007). *Developmental physical education for all children*. Human Kinetics.
Gallahue, D. L., Ozmun, J. C., & Goodway, J. (2006). *Understanding motor development: Infants, children, adolescents, adults*. Boston.
Gentile, A.M. (1972). A working model of skill acquisition with application to teaching. *Quest Monograph*, 17, 3-23.
Jastrjembskaia, N., & Titov, Y. (1999). *Rhythmic gymnastics*. Human Kinetics 1.
Jurimae, T., & Jurimae, J. (2001). *Growth, physical activity, and motor development in prepubertal children*. CRC Press.
Karabourniotis, D., Evaggelinou, C., Tzetzis, G., & Kourtessis, T. (2002). Curriculum enrichment with self-testing activities in development of fundamental movement skills of first-grade children in Greece. *Perceptual and motor skills*, *94*(3_suppl), 1259-1270.
Karachle, N., Dania, A., & Venetsanou, F. (2017). Effects of a recreational gymnastics program on the motor proficiency of young children. *Science of Gymnastics Journal*, *9*(1), 17.
Liviotti, G., & Hökelmann, A. (2012). Quantitative choreography analysis of the group competition medallists at the Rhythmic Gymnastics World Championship 2011. *International Journal of Performance Analysis in Sport*, *12*(2), 246-257.
Miletic, D. (2003). Analiza usvajanja motoričkih znanja u ritmičkoj gimnastici [Analysis of acquisition of rhythmic gymnastics motor skills. In Croatian.]. *Doctoral disertation, Zagreb: Faculty of Kinesiology*.
Miletic, D., Katic, R., & Males, B. (2004). Some anthropologic factors of performance in rhythmic gymnastics novices. *Collegium antropologicum*, *28*(2), 727-737.
Pollatou, E., Karadimou, K., & Gerodimos, V. (2005). Gender differences in musical aptitude, rhythmic ability and motor performance in preschool children. *Early Child Development and Care, 175*(4), 361-369.
Sanders, S. W. (1992). *Designing preschool movement programs*. Human Kinetics Publishers, Box 5076, Champaign, IL 61825-5076.
Schmidt, R. A., Lee, T., Winstein, C., Wulf, G., & Zelaznik, H. (2018). *Motor Control and Learning, 6E*. Human kinetics.
Schmidt, R.A. & Wrisberg, C.A. (2000). *Motor learning and performance*. Champaign, IL: Human Kinetics.
Seltzer, R., & Glass, W. (1991). International politics and judging in Olympic skating events: 1968-1988. *Journal of Sport Behavior*, *14*(3), 189.
Ste-Marie, D. M. (2000). Expertise in women's gymnastic judging: An observational approach. *Perceptual and Motor Skills*, *90*(2), 543-546.
Ulrich, D. A. (2000). TGMD 2–Test of gross motor development examiner's manual. *Austin TX: PRO-ED*, *2*.
Venetsanou, F., Kambas, A., Aggeloussis, N., Fatouros, I. & Taxildaris, K. (2009). Motor assessment of preschool aged children: A preliminary investigation of the validity of the Bruininks-Oseretsky test of motor proficiency-short form. *Human Movement Science*, 28, 543-550.

MOTORIČKO UČENJE U RITMIČKOJ GIMNASTICI: UTJECAJ BAZIČNIH MOTORIČKIH ZNANJA

Sažetak

Cilj ovog istraživanja bio je utvrditi utjecaj bazičnih motoričkih znanja na izvedbu specifičnih znanja ritmičke gimnastike u različitim fazama motoričkog učenja kod 6-godišnje djece. U istraživanju je sudjelovalo 70 djece predškolske dobi (30 djevojčica i 40 dječaka). Konstruirana je baterija od 20 testova specifičnih znanja ritmičke gimnastike (po 5 testova za svaku od sprava: vijaču, obruč, loptu i traku), a izvedbu su procijenila 3 iskusna suca. Bazična motorička znanja procjenjivana su baterijom testova „Bruininks-Oseretsky Test of Motor Proficiency, second edition" (kratka forma testa). Djeca su sudjelovala u eksperimentu 6 mjeseci, 3 puta na tjedan po 35 minuta. Specifična znanja testirana su u 3 navrata: inicijalno (prvi tjedan), tranzitivno (deveti tjedan) i finalno (devetnaesti tjedan). Razina bazičnih motoričkih znanja provjerena je u prvom tjednu tretmana. Rezultati provedenih regresijskih analiza ukazali sun a statistički značajan utjecaj bazičnih motoričkih znanja na razinu izvedbe specifičnih znanja za sve sprave i u svim točkama provjeravanja, tj. učenja (p vrijednosti kretale su se od 0.00 do 0.02). Parcijalno gledajući, početna verbalno-kognitivna faza učenja specifičnih znanja ritmičke gimnastike okarakterizirana je utjecajem preciznih motoričkih znanja. U motoričkoj fazi učenja dominiraju koordinacija ruku i bilateralna koordinacija. U finalnoj fazi učenja, odnosno, višoj motoričkoj fazi, mijenja se utjecaj značajnih prediktora. Ove se promjene ogledaju u povećanom utjecaju bilateralne koordinacije, koordinacije ruku i snage, ali i nešto manjem utjecaju preciznih motoričkih znanja.

Ključne riječi: *bazična motorika, vrtić, početnici, BOT-2*

Corresponding information:

Received: 08.11.2018.
Accepted: 01.12.2018.
Correspondence to: Associate professor Ana Kezić
University: University of Split, Croatia
Faculty: Faculty of Kinesiology
Phone: +385 21 302 440
E-mail: anakezic@kifst.hr