Analysis of the structural feature of rhythmicity in 8-10 year-old children with Down syndrome

M.V. Kosheleva

Togliatti State University, Togliatti, Russia.

Abstract. The paper substantiates the idea that the set rational rhythm of movements creates favorable conditions for the organization of motor activity. The insufficient level of its formation affects the activity of physiological systems, and results in significant energy expenditure with minimal results. A promising approach for solving the problem of developing rhythmicity in 8-10 year-old children with Down syndrome is to form the following varieties of the ability: individual rhythm; collective rhythm; rhythm in exercises with musical accompaniment. The paper analyses the results of testing the structural feature of rhythmicity in children with developmental disabilities. The change in the level of rhythmicity in children with Down syndrome of the experimental group was registered. The best results were achieved for the rhythmic exercises performed with musical accompaniment, the difference in the arithmetic mean values between the stages of the experiment was 1.37 points. In the control group with mental retardation (CG (MR)) the difference between the rhythmicity indicators in the exercises performed with musical accompaniment was less significant, only 0.17 points. The average index of rhythm in collective activities in the experimental group of children with Down syndrome (EG (DS)) increased by 1.33 points. Particular attention is paid to the results of the development of individual rhythm between the groups studied, at the beginning of the experiment the difference between the scores of CG (MR) and the EG (DS) was 0.83, at the end it decreased by 0.18 points. The scores of children with Down syndrome almost reached the results of children with MR. Such a positive result indicates the influence of rhythm on the motor areas of the brain of children with Down syndrome.

1 Introduction

The concept of inclusive education is now being actively discussed. Children with special educational needs face difficulties in accessing and participating in basic educational services. The system of inclusive education must be able to respond to changes in the development and adaptation of children with disabilities in society.

This category of children has repetitive pattern behavior, which creates a significant burden on the family. Weak social development of children with disabilities hampers their integration into society.

Various studies show a negative trend in the personal and social development, self-determination, and socialization of elementary school-age children who attend special (remedial) schools [1].

Palmer et al. note that "communication difficulty in adulthood is associated with small social network size, fewer positive social exchanges, less frequent participation in social activities, and higher levels of loneliness" [2]. Therefore, it is vital to create activities that support the child's development of communication skills and increase his or her social competence until adulthood.

Early intervention has a major impact on a child, allowing him to reach full potential, and sometimes timely interventions will help reduce the need for services later in life [3,4].

When developing corrective measures for children with disabilities, it is important to consider motor activity, which is the basis of psycho-physical development.

L.V. Tokarskaya states that "The severity of intellectual defect, comorbidities, secondary disorders, peculiarities of the mental and emotional-volitional sphere of children affect the physical development, motor abilities, learning ability and adaptability to physical activity of children" [5].

M.V. Budarin, A.Y. Keiko note that "The development of basic physical abilities (strength, speed, endurance) is subordinated to the general laws of age development, but mentally retarded schoolchildren have a lower rate of development and the sensitive periods come 2-3 years later" [6].

I.V. Fedotova and M.A. Bykova pointed out that "The motor coordination disorder is considered to be the main motor disorder of children with intellectual disabilities" [7].

The scientific literature considers coordination as a motor theory. The neurological maturation of motor coordination is important in determining movement outcomes. The basis is formed by the rhythmic characteristics of motion.

L.P. Matveev, L.D. Nazarenko, V.I. Lyakh, S.P. Evseev highlight rhythmicity as a manifestation of coordination abilities having temporal characteristics of movements.

The rhythmicity of motor actions is a fundamental property of the organism. It determines the formation of a dynamic stereotype, as a result of which the motor act is characterized by more accurate spatial-temporal and spatial-force parameters.

M.V. Kosheleva reveals rhythmicity from several points of view. It is considered as various processes of biological nature, such as breathing, inhibition and excitability of the cortex of the large hemispheres, pulse rate readings; processes occurring in the external environment (alternation of day and night, seasons, etc.); processes of social life and labor activity [8].

Thus, the establishment of a rational rhythm of movements creates favorable conditions for the organization of motor activity. The optimal level of development of rhythmicity determines the quality of performance of many motor actions. An insufficient level of formation causes a decrease in the efficiency of movements, mismatch in the activity of physiological systems, which leads to significant energy expenditure with minimal results.

So, it is relevant to study the level of formation of rhythmicity in children with disabilities to maintain a neurological condition. This study is aimed to determine the level of development of rhythmicity according to its varieties in 8-10 year-old children with Down syndrome.

The work has the following tasks:

1. Theoretical justification of the developed tests for 8-10 year-old children with Down syndrome in accordance with the structural features of rhythmicity as one of the basic motor actions.

2. Experimental validation of the feasibility of the proposed tests and means of adaptive physical education with predominant content of tempo-rhythmic characteristics.

2 Materials and Methods

The experimental study lasted 10 months in 2020-2021 on the basis of the state budgetary educational institution "Boarding school for students with disabilities". The control and experimental groups were composed of 12 people each. The control group (CG) consisted of 8-10 year-old children with mental retardation (MR), and the experimental group (EG) consisted of 8-10 year-old children with Down syndrome (DS). Classes were conducted three times a week according to the educational program of the Boarding school. The musical phrases of 4/4, 2/4 time signatures were widely used in the program for the formation of rhythmicity for EG (DS). Children learned to move to music with changes in the tempo and rhythm of steps, hops and other ways of movement.

The results obtained were processed using Student's t-criterion. Statistical processing included calculation of statistical parameters of the output: mean values (X), standard deviation (δ) and arithmetic mean error (t). Significance of differences of sample averages was determined by Student's test.

3 Results

Analysis of scientific research has shown that it is promising to develop the rhythmicity in 8-10 year-old children with Down syndrome according to the following varieties:

- individual rhythm;
- collective rhythm;
- rhythm in exercises with musical accompaniment.

Such an approach makes it possible to individualize and differentiate the process of perception of movements, the level of motor activity of children with developmental disabilities.

Three tests were used to determine the level of rhythmicity of motor actions. Test 1 was used to identify the level of development of individual rhythm. The student took a 2-meter long ribbon and, repeating the movement of the teacher's hand, performed 5 strokes of the ribbon up and down. The amplitude and cohesion of movements and the participation of the whole body were assessed. Test 2 was used to determine the level of development of the rhythm of collective action. Standing in a circle, a group of children performed a ducking step to the right with a half crouch. The width of the step, the speed of the other leg, the tempo of the squat, and the movement cohesion were assessed. Test 3 was used to assess rhythmicity in exercises performed with musical accompaniment. Children walk in a circle with a half-crouch for each 4th step under the amplification of the measure of musical accompaniment. The coincidence of the tempo and rhythm of the steps with the nature of the musical accompaniment, the timeliness of the half-sitting on the 4th step to the corresponding sound of the melody were assessed.

The test exercises were assessed using a five-point system. Before the experiment, testing was conducted to determine the initial level of development of individual, collective rhythm and with musical accompaniment in children of the control and experimental group (Table 1).

Table 1: Empirical values of the level of development of rhythmicity in children at the beginning of the experiment.

№	Indicators	Statistical indicators (X±σ)		Significance of differences (P) CG and EG
		CG MR	EG DS	
1.	Level of development of individual rhythm (points)	4.083±0.9	3.25±0.452	<0.01
2.	t - estimated	3.4		
	Level of development of the rhythm of collective action (points)	4±0.853	3.25±0.452	<0.05
	t - estimated	2.28		
3.	Level of rhythmicity in exercises performed with musical accompaniment (points)	3.83±0.718	3.33±0.651	<0.10
5.	t - estimated	1.79		

At the beginning of the experiment, there were statistically significant differences between the control and experimental groups in the development of individual rhythm, t = 3.4 ($p<0.01$). The average value was X = 4.08 in the control group (MR) and X = 3.25 in the experimental group (DS). Indicators of the level of development of collective actions also had reliable differences. Significant differences were found between the CG (MR) group and the EG (DS), t = 2.28 ($p<0.05$). The mean value of X=4 in the CG (MR) is greater than X = 3.25 in the EG (DS). The empirical data indicate a low level of development of varieties of rhythmicity in children with Down syndrome in contrast to the control group with mental retardation.

The analysis of the level of rhythmicity in the exercises performed with musical accompaniment did not reveal a reliable difference between the studied groups, a weak variation in values was observed. But the average values in the tested groups testified to an insignificant formed ability to reproduce rhythm with musical accompaniment in the control group with mental retardation. The average value was 3.83 in the CG and 3.33 in the EG (figure 1).

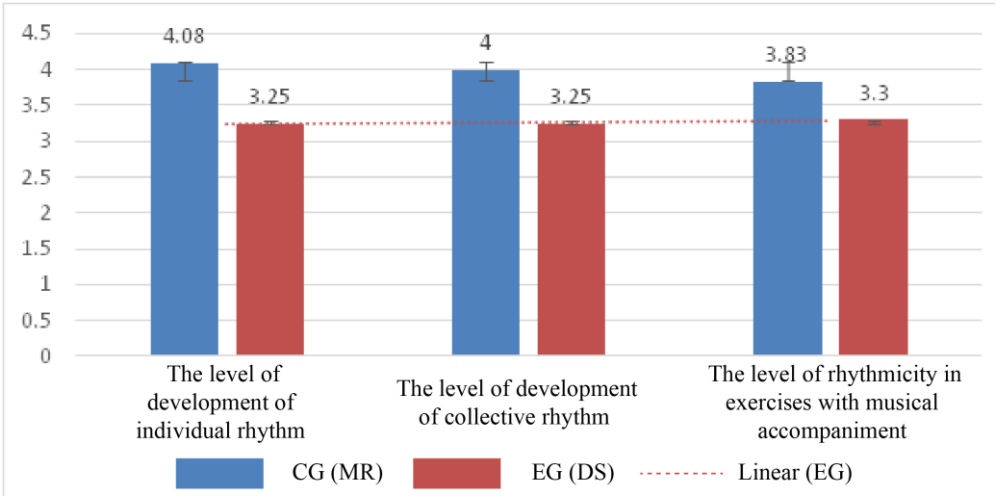

Fig.1. Empirical values of the level of development of rhythmicity in the subjects at the beginning of the experiment.

For 10 months, children with Down syndrome were engaged in an experimental program based on rhythmic exercises, sketches, and physical games with movement tasks for the directional development of rhythmicity.

In the control group classes were held in accordance with the program of the primary school. In the experimental group, the physical education and rhythmics classes were supplemented by an additional set of experimental motor tasks for directed development of rhythmicity. Children with Down syndrome performed exercises requiring different amplitudes of movements of the upper and lower limbs and torso accompanied by a metronome, rhythmic recitatives, a phonogram of drumming and other musical signals. To develop individual rhythm, at the beginning of the experiment, children with the help of a teacher, tapped the 4/4, 2/4 time signature with sound accompaniment.

For the development of collective rhythm, we also used the exercise for reproduction of the musical time, but only in roundelays, movements in columns, rows, with strokes, grooves, objects, focusing the attention of children on the moment of application of muscular effort. During the exercises, children in the experimental group had difficulties in rearrangement and change of direction of movements. This problem confirms studies of adaptive physical education on underdevelopment of coordination abilities, reaction to changes in motor task, motor-spatial characteristics of movement. In order to fully reproduce the pattern of the collective rhythm, we had to learn it by individual elements and then combine them. Motion games were developed taking into account the motor task and were accompanied by recitation or inclusion of an auxiliary object in the game. All movements in the task were accompanied by additional marking with a signal or sound.

The stage of formation of rhythmic exercises with musical accompaniment was the final stage in the experiment, as children learned to move to music with changes in tempo and rhythm of steps, hops and other ways of movement. Techniques of change of amplitude of movements caused by the nature of musical accompaniment were used. The easiest exercises to reproduce were those with music accompanied by words; children with DS at this moment were the most emotionally expressive, movements were less constrained and conformed to musical time.

After 10 months of regular exercise, rhythmicity was retested in the studied groups (Table 2).

Table 2. Empirical values of the level of development of rhythmicity in the subjects at the end of experiment.

№	Indicators	Statistical indicators (X±σ)		Significance of differences (P) CG and EG
		CG MR	EG DS	
1.	Level of development of individual rhythm (points)	4.25±0.45	4.42±0.51	<0.1
	t - estimated	0.84		
2.	Level of development of the rhythm of collective action (points)	4.17±0.72	4.58±0.52	<0.10
	t - estimated	1.63		
3.	Level of rhythmicity in exercises performed with musical accompaniment (points)	4±0.74	4.67±0.49	<0.05
5.	t - estimated	2.60		

Processing of the obtained data showed that children with Down syndrome (EG) gained an increase in the level of rhythmicity in its varieties. In the control group, an improvement in the results was insignificant. In EG, the greatest increase in scores was registered for rhythmic exercises performed with musical accompaniment, the difference in the arithmetic

mean values between the stages of the experiment was 1.37 points. The difference between the data of rhythmicity in exercises performed with musical accompaniment was less significant, only 0.17 points. The same increase in indicators of the level of development of rhythm of collective actions in the EG was 1.33 points. The special attention was paid to differences in results of development of an individual rhythm between the groups: the indicators increased in two groups, but in EG it increased by 0.92 points, and in CG it increased by 0.09 points. At the beginning of the experiment, the difference between the scores of CG and EG was 0.83, at the end it decreased by 0.18 points. The scores of 8-10 year-old children with Down syndrome almost reached the results of children with MR. Such a positive result indicates the influence of rhythm on the motor areas of the brain of children with DS (Figure 2).

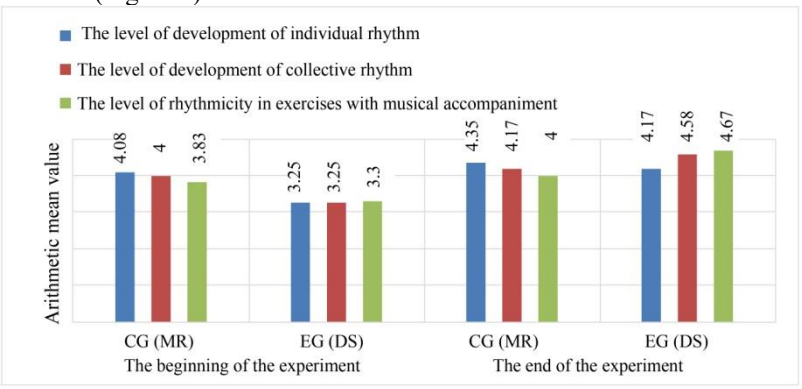

Fig. 2. Empirical values of the level of development of rhythmicity by varieties in the subjects at the end of the experiment.

Mental retardation is a borderline state between normality and pathology, so it is incorrect to speak of a pronounced mental deviation in this category of children. If correctional process is arranged correctly, children with mental retardation pass into a group without pathological findings. The distinctive characteristic between children with DS and MR are more severe congenital disorders of mental and physical development, so the results of the EG were compared with that of the CG with MR to determine the effectiveness of the correctional process.

Thus, the results of the pedagogical experiment showed the feasibility of targeting the development of rhythmicity in children with Down syndrome.

4 Discussion

The registered statistically significant results at the end of the experiment between the indicators of the studied groups are reliable. Positive dynamics of growth of levels of rhythmicity specifies influence of changes in mental and motor activity. This conclusion was confirmed by other studies. Thaut & Volker state that "...Music influences change in brain and behavior" [9]. Hardy & Lagasse note that "The use of music, primarily supported by rhythm, can promote motor skills because rhythm activates motor areas of the brain and facilitates motor responses in people with and without disabilities" [10].

The development of rhythm depends on musical accompaniment, purposeful working through rhythm-movement tasks. Individual and group forms of work with 8-10 year-old

children with Down syndrome helped the participants better understand how to control their movements in combination with the rhythmic size of the action.

Tempo-rhythmic characteristics of motor action contribute to the development of movement coordination skills, increase the ability of children with developmental disabilities to interact with the world and other people, as they are closely related to their socio-emotional and cognitive development. For example, according to H.C. Leonard and E.L. Hill, "Most of the social skills that children develop depend on movement practices that enable them to understand social-emotional cues and fine motor skills that help them properly manipulate objects" [11]. Wang et al. pointed out that “The control of strength and timing of movements is essential for manipulating objects and performing everyday tasks that require manual dexterity, such as writing, feeding, and playing" [12].

Motor deficits in children with Down syndrome are among the main symptoms of the disease, so the potential for rhythm of motor actions is important for the development of movement control skills.

5 Conclusion

This study examines the practical relevance of tests aimed at determining the level of development of rhythmicity by varieties in 8-10 year-old children with Down syndrome. The experimental results demonstrate the effective influence of the application of means aimed at the development of rhythmicity. Means with the predominant content of rhythmic motor tasks were studied by 8-10 year-old children with Down syndrome for 10 months. At the initial stage, the ability to determine an individual rhythm was formed, classes were conducted both individually and in groups. The next stage was the formation of rhythm in collective activities and the final stage was the development of rhythm accompanied by musical productions. For this stage, musical fairy tales, sketches were used, all movements were supplemented with emotional displays, it was necessary to control the unification of movements with feelings and musical accompaniment. It should be noted, that this kind of rhythm was most quickly mastered by children with Down syndrome, unlike the individual rhythm, as the classes were conducted in the form of a game. When learning an individual rhythm, we had to give the children more tasks for tapping out the size of the rhythm and this lesson was not always emotionally colored.

Thus, the proposed tests allowed us to objectively assess the levels of development of rhythmicity in its varieties, and the results obtained confirmed the effectiveness of the introduction of rhythmic tasks in the correctional and educational process of 8-10 year-old children with Down syndrome.

References

1. M.A. Pravdov, E.A. Shmeleva, A.V. Kornev, Methodology of development and correction of psychofunctional and physical abilities of children with disabilities. Proceedings of the VIII All-Russian Forum "Health of the nation is the basic prosperity of Russia”, 269 (2014).
2. A.D. Palmer, J.T. Newsom. K.S. Rook, How does difficulty communicating affect the social relationships of older adults? An exploration using data from a national survey. J Commun Disord (2016)
3. R. Jordan, G. Jones, D. Murray, Educational Interventions for Children With Autism: A Literature Review of Recent And Current Research. Crown Copyright, 168 (1998)
4. J. L. Matson, R.J. Rieske, K. Tureck, Additional considerations for the early detection and diagnosis of autism: Review of available instruments. Research in Autism

Spectrum Disorders, Volume 5, Issue 4, October–December 2011, Pages 1319-1326. https://doi.org/10.1016/j.rasd.2011.03.006

5. L. V. Tokarskaya, N. A. Dubrovina, N. N. Babiychuk Peculiarities of teaching physical education to children and adolescents with moderate and severe mental retardation: tutorial. Yekaterinburg: Ural Federal University,190 (2015) ISBN 978-5-7996-1578-9.
6. M.V. Budarin, A.V. Keino, Impact of swimming on the motor program of children 8-12 years old with mental retardation. Bulletin of Tambov University. Series: Humanities, 4(120), 276-283 (2013).
7. I. V. Fedotova, M. A. Bykova. Peculiarities of mental and physical development of children with intellectual disabilities. International Student Scientific Herald, 3, 50 (2017).
8. M.V. Kosheleva, The formation of rhythmic motor actions in the process of adaptive physical education of children 6-7 years with mental retardation: thesis for the degree of candidate of pedagogical sciences. Volgograd, 165 (2012)
9. M. Thaut, V. Hoemberg, Handbook of neurological music therapy. -Oxford University Press, USA, (2014).
10. A.B. LaGasse, M.W. Hardy, Consideration of rhythm for sensorimotor regulation in children with autism spectrum disorders. Perspectives on Music Therapy, 31(1), 67-77 (2013).
11. H.C. Leonard, E.L. Hill, The impact of motor development on typical and atypical social cognition and language: A systematic review. Child and Adolescent Mental Health, 19(3), 163-170 (2014).
12. Z. Wang, M. Kwon, S. Mohanty, L.M. Schmitt, S.P. White, E.A. Christou, M.W. Mosconi, Increased Force Variability Is Associated with Altered Modulation of the Motorneuron Pool Activity in Autism Spectrum Disorder (ASD). International Journal of Molecular Sciences, 18(4), 698 (2017); https://doi.org/10.3390/ijms18040698.