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Original Article

Characteristics of the psychomotor system in preschool children with mental disabilities

VIKTORIA PASICHNYK[1], MARYAN PITYN[2], VALERYI MELNYK[3], ZORYANA SEMERYAK[4], IVAN KARATNYK[5]
[1 2 3 4 5]:Lviv State University of Physical Culture, Lviv, UKRAINE

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Abstract.
The health of the nation is primarily determined by the health of children, which is the most significant resource of any society. Health conditioning in preschool children, physiologically valuable development of all organs and systems of the body is of great importance in the preschool educational institutions. In Ukraine special attention is paid to children with various disabilities. Hence, the research dedicated to the study of psychomotor characteristics of children became of special value for working out pedagogical actions aimed at remodeling psychophysical development of preschool children. The purpose of the study was to describe characteristics of psychomotor system of preschool children with psychophysical abnormalities, as well as find out the main features of their manifestation. Material: the study involved 118 children aged 5 - 6 years (N=118). Out of the total number of the study participants 54 children (25 girls and 29 boys) were in need of psychophysical development correction. Thus, 9 of them suffered from musculoskeletal disorders (MSD), though they did not display visual motor impairments (like gross gait, running, jumping or walking disorders); other 15 children had disturbances of speech development (SDD); in 16 children were diagnosed as mental deficients (MD); 5 kids had Down syndrome (DS); 9 children suffered from the disturbances of the autistic spectrum (ASD). A group of 64 kids (30 girls and 34 boys) had normative level of development. *Results* of the study: Developmental retardation of children with psychophysical abnormalities as compared to their peers with normative development on average by 22.5% to 35% was established. This backwardness was observed in the data, which characterized the psychomotor system formation (development of dynamic and static coordination, movements' rate, fine motor activity, motor memory, a sense of rhythm, ability of simultaneous movements execution, expressiveness of movements etc.) *Conclusions.* The level of psychomotor system organization in children with psychophysical abnormalities requires differentiated approach in physical education in the context of inclusive education.
Key words: psychomotor system, preschool age, abnormalities, psychophysical development.

Introduction

The health of the nation is primarily determined by the health of children, which is the most significant resource of any society (Prystupa, 2013; Yefymenko, 2013; Romanchyshyn, 2015). Health conditioning in preschool children, physiologically valuable development of all organs and systems of the body is of great importance in the preschool educational institutions (Engle, 2007; Grantham, 2007; Iedynak, 2017; Pasichnyk, 2012, 2015).

It is the preschool education mainly that is optimal for inclusion of children, who are in need of psychophysical development remodeling, in the educational environment, since this particular age period is the most conducive time to easily and quickly generate various personal manifestations. In particular, preschool children cease to make interindividual differences among people much faster than adults; kids actively master cultural skills, capabilities etc. (Artyushenko, 2010;, Budyak, 2009; Kuzava, 2015). Besides, the development of preschool children who require remodeling of psychophysical development can, under certain conditions, equal or approximate the level of development of the apparently healthy peers. The currently existing educational systems enable the management of this process (Kuzava, 2015).

In Ukraine special attention is attached to the issues of education of children with various disabilities. According to the studies of different authors quite a big number of preschool children possess insufficient psychomotor qualities. To a large extent, it applies to children with psychophysical backwardness due to the disturbances of different or several analyzers (i.e. visual, hearing), with organic nervous system disorders, mental retardation, speech impairments, locomotive system abnormalities, behaviour deviations, emotional disorders and severe multiple disturbances(Gvozdec'ka, 2005; Hlushchenko, 2013; Shlapachenko, 2012).

That is why the development of motor sphere, which is one of the most significant characteristics of children's health and physical perfection, is considered to be the task of paramount importance in preschool educational institutions (Shmaley, 2007; Volovyk, 2007; Walker, 2007; Stebliy, 2008; Wilczkowski, 2012).

Corresponding Author MARYAN PITYN, E-mail: pityn7@gmail.com

The significance of studying and remodeling of disordered motor functions in children with psychophysical abnormalities is determined primarily by the role of motor analyzer in the development of brain functions, of higher nervous activity and mental functions. Hence, the research aimed at the study of psychomotor characteristics of children became of special value for working out pedagogical actions for remodeling psychophysical development of preschool children.

Purpose of the study was to identify psychomotor characteristics of preschool children with psychophysical abnormalities, as well as to elucidate the peculiarities of their manifestation.

Material and methods.

Following methods of research were used in the study: general scientific (analysis, generalization of literary sources data); educational ascertaining experiment, observations.

Participants: the study involved 118 children aged 5 - 6 years (N=118). Out of the total number of the study participants 54 children (25 girls and 29 boys) were in need of psychophysical development remodeling. Thus, 9 of them suffered from musculoskeletal disorders (MSD), though they did not display visual motor impairments (like gross gait, running, jumping or walking disorders); other 15 children had abnormalities of speech development (SDA); in 16 children were diagnosed as mentally deficient (MD); 5 kids had Down syndrome (DS); 9 children suffered from the disturbances of the autistic spectrum (ASD). A group of 64 kids (30 girls and 34 boys) had normative level of development (apparently healthy).

Organization of the study. The research was carried out on the basis of preschool educational institutions of the city of Lviv and Lviv region where compensatory and inclusive groups are operating.

A special examination scheme, including 8 tests, has been elaborated for quantitative and qualitative assessment of children psychomotor development (Rogovik, 2005; Herasymenko, 2016). The tests administration enabled to simultaneously assess both components and levels of movements' organization. The tasks were given to the subject in the form of verbal instructions and demonstration. The child was allowed 1-2 attempts, after which the result was recorded. A 4-point evaluating scale was proposed to estimate test results. According to this scale 4 points were given to a child who understood verbal instruction, performed the task independently and properly, fully adhering to the instruction, without any faults; 3 points were given to a child who understood verbal instruction, performed the task independently and properly, fully adhering to the instruction, making sometimes minor errors; 2 points was given to children who comprehended verbal instruction only after multiple repetitions, the task was performed with mistakes commitment and with an adult assistance; 1 point was given to children who could hardly apprehend the verbal instruction, who performed the task, committing a lot of significant mistakes, adult's assistance was used rarely or was not used at all; and 0 points meant that a child failed to cope with the task.

1. Static coordination test: to keep standing position on one leg (right and left alternately) with eyes open for 10 sec., left/right leg is bent orthogonally at the knee joint, the hip is slightly drawn aside, arms at one's sides.

2. Test for dynamic coordination of movements requires a concerted activity of a large number of muscle groups. It displays agility, kinetic flexibility, state of general dynamic coordination. The test includes a standing leap over the rope stretched at the height of 15-20 cm from the floor.

3. Test for the speed of movements' detection: one has to quickly sit on the floor after hearing the appropriate instruction and get up unassisted by the hands.

4. Test for hand and fingers micromotion coordination: the subject is given a square sheet of thin paper (5x5 cm) and is asked to roll it into a ball as soon as possible with the fingers of one hand. It is forbidden to use the second hand while the procedure.

5. Test for rhythmicity of movements: alternation of the strokes – the adult produces 2 strokes, the child responses with 1 stroke , then equally the adult produces 2 strokes, the child responses with 1 stroke (for 10 sec.)

6. Motor memory test: the experimenter performs sequential movements lagging by one movement (hands forward, up, sideways, down).

7. Test for movements' precision (syncinosis detection): tapping with a pencil on the table (pencil in the right/left hand, the subject has to tap with a pencil several times on the table). Make sure the subject does not produce any unnecessary movements.

8. Test for movements' simultaneity: arms straight, stretched in front of the chest. The tested simultaneously clenches his right hand into a fist and simultaneously unclenches his left hand, then the other way round.

Statistical analysis. The data were staticized by means of Microsoft Excel standard software package.

Results

Psychomotor activity of a child appears as an integrated result of interaction between central nervous (mental) and locomotor (muscular) systems. Characteristic feature of the first stages of ontogenesis is its syncretism, when psyche and motility are in indissoluble unity. That is why the assessment of child's development should be accomplished according to his/her psychomotor development characteristics instead of certain processes or functions estimation as it occurs at an adults age, when those characteristics gradually get

disconnected and attain relative self-sufficiency (Mussen, 1990; Ozerov, 2002; Rogovik, 2005). Analysis of the ascertaining educational experiment results made it possible to estimate the condition and degree of maturity of central mechanisms organization in children's psychomotor system (Table 1). According to the data obtained it is possible to claim that all children with psychophysical developmental disorders suffer from psychomotor retardation. Thus, the quality of tasks performance by the group of children with disorders in psychophysical development was lower as compared with apparently healthy children. On average, the achievements of children with disorders in psychophysical development made up 1.95 points for girls and 1.96 points for boys, which amount to 48.8% and 49.0% respectively. The efficiency of the tasks performance by the group of children with normative development was higher and averaged 3.11 points for the girls and 3.17 points for the boys that made 78.0% and 79.3% respectively. In particular, the difference in psychomotor system general development of the girls with psychomotor disorders as compared to their peers with normative development could be observed on the assumption of average results achieved by the girls (the difference made 29.2%) and by the boys (30.3%). According to Table 1 the results of psychomotor characteristics in the group of children with normative development were quite homogeneous (mean fluctuation of the coefficient of variation V=13.62– 28.66 %). Significant dissipation of psychomotor development characteristics was observed in children with psychophysical disorders (large fluctuation of the coefficient of variation V>30 %). Significant heterogeneity of the studied contingent of children could be accounted for different types of abnormalities. The most pronounced retardation of psychomotor development was found in children with various mental disorders, like mental retardation or disturbances of the autistic spectrum. The execution of motor tasks presented significant difficulties for those children regardless of the type of psychomotor functions (general motor skills or fine motor skills), and even despite the actual absence of motor functions.

Apparently this situation is related to the peculiarities of brain structures maturation in children with mental retardation and autistic spectrum disturbances, which denotes the lower level of voluntary movements control. Such results give evidence of developmental retardation of spatial representation integral index, starting with body image, which is regarded as the very basic level of spatial representation (Volovyk, 2007; Frolova, 2009; Korovyna, 2010).

Children with musculoskeletal system disorders, Down syndrome and speech development abnormalities displayed better results. Performing test tasks children experienced certain difficulties, inconveniences; they made some errors; slowness of movements and lack of coordination were characteristic of most of them. Nevertheless, the test tasks were quite realizable for children. Summarizing the results it should be noted that pronounced immaturity in children with MSD, DS and SDA, or distortion of emotional and volitional sphere in children with MD and ASD considerably inhibits psychomotor system development (Volovyk, 2007; Frolova, 2009). Comparative analysis of psychomotor qualities manifestation in girls with psychophysical abnormalities and their apparently healthy peers has shown a decrease of task success for all the characteristics in the group of girls with psychophysical abnormalities (Fig.1).

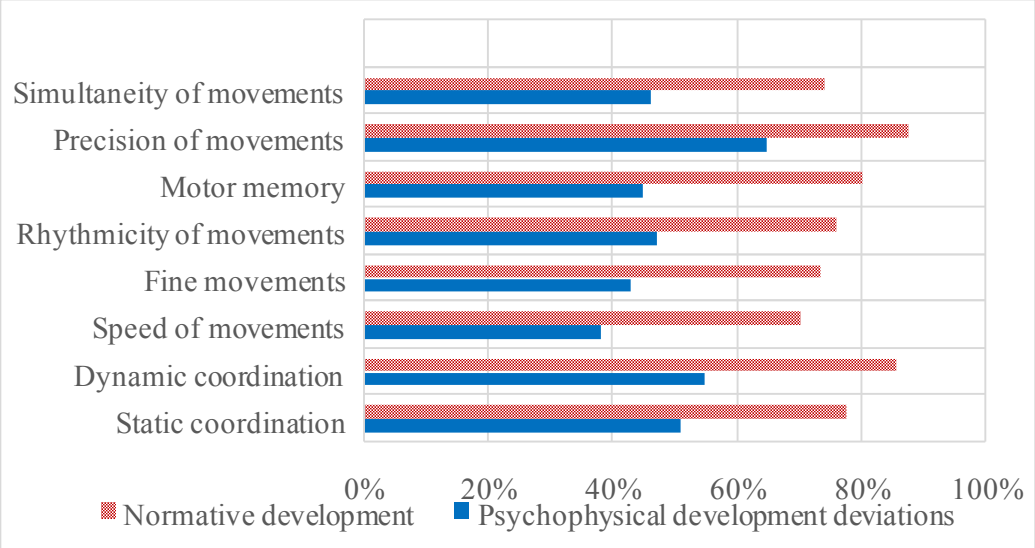

Fig. 1. Comparison of psychomotor tests characteristics in girls with psychophysical abnormalities and girls with normative development

The following retardation in girls with psychophysical developmental abnormalities as compared to their apparently healthy peer has been observed: in static coordination – by 26.5%; dynamic coordination – by 30.7%; speed of movements – by 32.0%; hands and fingers fine movements coordination – by 30.3%; sense of rhythm – by 28.8 %; motor memory – by 35.0%; precision of movements – by 22.5%; ability to perform movements simultaneously – by 28.0%.

Table 1

Characteristics of psychomotor development in children aging 5–6 years

Tests	Children who require remodeling of psychophysical development, n=54																Children with normative development, n=64					
	Girls, n=25								Boys, n=29								Girls, n=30			Boys, n=34		
	Psychophysical development disorders					Statistical characteristics			Psychophysical development disorders					Statistical characteristics			Statistical characteristics					
	MSD	SDA	MD	DS	ASD	$\bar{x}$	S	V, %	MSD	SDA	MD	DS	ASD	$\bar{x}$	S	V, %	$\bar{x}$	S	V, %	$\bar{x}$	S	V, %
1	2,60	2,00	1,80	2,30	1,50	2,04	0,67	33,12	2,00	2,00	1,70	2,55	1,20	1,89	0,72	38,19	3,10	0,60	19,59	2,91	0,62	21,33
2	1,80	2,10	2,00	3,00	2,00	2,20	0,70	32,14	3,00	2,65	2,20	3,00	1,00	2,37	0,86	36,24	3,43	0,62	18,23	3,55	0,56	15,76
3	2,10	1,30	1,00	2,20	1,00	1,52	0,87	57,35	2,01	2,25	1,34	2,00	0,50	1,62	0,82	51,59	2,80	0,76	27,18	3,02	0,67	22,23
4	2,15	1,60	1,30	2,15	1,40	1,72	0,73	42,85	2,80	1,40	1,66	1,79	0,75	1,68	0,76	45,02	2,96	0,85	28,66	3,05	0,64	21,20
5	2,75	1,55	1,65	2,10	1,35	1,88	0,88	47,87	2,01	2,07	1,67	2,00	1,00	1,75	0,63	36,13	3,03	0,71	23,68	2,97	0,67	22,67
6	2,65	1,95	1,35	2,05	1,00	1,80	0,76	42,43	3,00	1,72	1,88	2,50	1,20	2,06	0,65	31,45	3,20	0,66	20,76	3,11	0,64	20,53
7	3,85	2,85	2,15	2,15	2,00	2,60	0,77	30,56	3,40	3,03	2,22	2,00	1,40	2,41	0,77	32,31	3,50	0,50	14,52	3,61	0,49	13,63
8	2,55	1,90	1,50	2,25	1,00	1,84	0,89	48,81	3,00	1,62	1,33	2,50	1,20	1,93	0,84	43,61	2,96	0,61	20,72	3,14	0,70	22,30

Footnote: 1. Static coordination, point. 2. Dynamic coordination, point. 3. Speed of movements, point. 4 Coordination of fine movements of the hand and the fingers, point. 5. Rhythmicity of movements, point. 6 Motor memory, point. 7. Precision of movements, point. 8. Simultaneity of movements, point.

MSD – musculoskeletal disorders, SDA – speech development abnormalities, MD – mental deficiency, DS– Down syndrome, ASD – autistic spectrum disturbances.

Comparison of average results of test tasks success that depicted actual state of boys' psychomotor system, in much the same way as girls' characteristics, has displayed retardation for all the investigated components (Fig. 2).

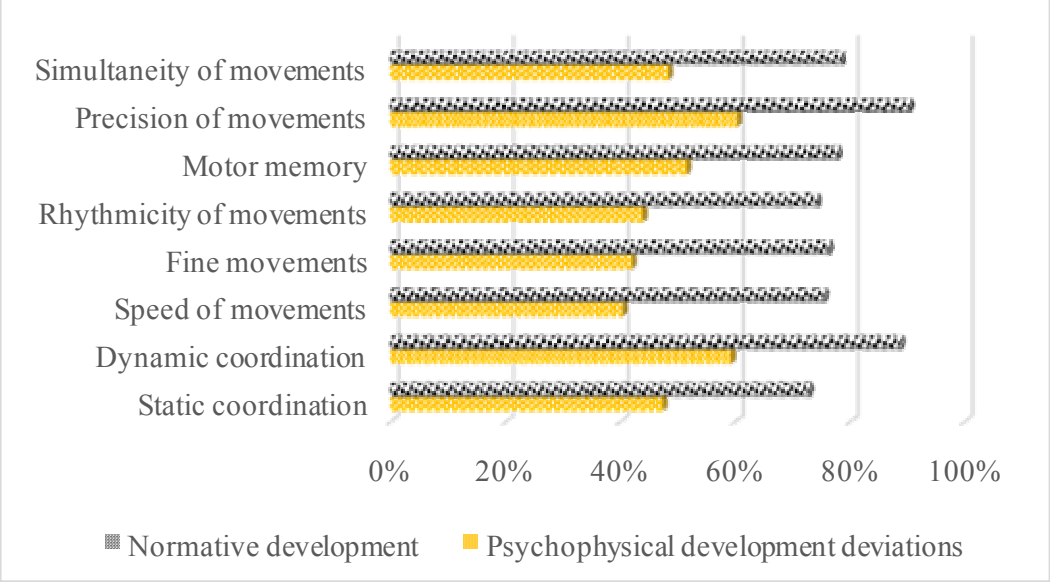

Fig. 2. Comparison of psychomotor tests characteristics in boys with psychophysical abnormalities and boys with normative development

The following retardation in boys with psychophysical developmental abnormalities as compared to their apparently healthy peer has been observed: in static coordination - by 25.5%; dynamic coordination – by 29.5 %; speed of movements - by 35.0%; hands and fingers fine movements coordination – by 34.3%; sense of rhythm – by 30.5%; precision of movements – by 30.0%; and in the ability to perform movements simultaneously – by 30.2%. Retardation of psychomotor components in children with psychophysical developmental impairments as compared to their apparently healthy peers was found to be fairly even for both sexes. It should be noticed that gender differences did not affect the psychomotor characteristics either of children with disabilities or of those apparently healthy ones. Psychomotor tests accomplishment by children with psychophysical developmental deviations allowed us to reveal certain peculiarities of these abnormalities manifestations. Thus, certain difficulties have been observed on part of children with disabilities while performing the static coordination test. In particular, children most frequently failed to maintain the equilibrium, stepping backwards or aside from their starting position; they were balancing on one leg trying to lower the other

leg bent in the knee; tremor of the bent extremity could be observed. Most children were looking for adults' assistance. Boys displayed more violations of static equilibrium than girls. The ability to maintain equilibrium is stipulated by a combined mobilization of visual, auditory, vestibular and somatosensory systems. Henceforth, it is possible to assume that malfunction of one of the functional systems is one of the reasons for impairing the equilibrium skills. In reference to the results obtained during dynamic coordination of movements test, we have observed insufficiently consistent activity of various muscle groups in children with psychophysical abnormalities. Incorrect starting position with legs insufficiently bent in the knees, head stooped down, nonsimultaneous take-off with two legs, rigid and unstable landing on the heels, falling on the floor in some cases have been observed during test execution. It is quite obvious that the lack of dynamic coordination in children with disabilities as opposed to their healthy peers is due to disorders of intramuscular and intermuscular coordination. It should be noticed that the dynamic test performance was more successful than the static one.

Execution of the test for speed of movements caused considerable difficulties in the vast majority of children with psychophysical disorders. Almost all the children performed the task slowly, asking for assistance. They were capable to sit on the floor according to the task requirements, but not a single child was able to raise himself from the floor unassisted by at least one hand. In some cases children couldn't cope with the task. It should also be noticed that substantial proportion of the apparently healthy children failed to properly perform this task as well. Analysis of the results of testing fine movements of hand and fingers suggests that most children performed the task in a slow and strenuous manner, not to the full capacity, with a low level of precision. Accompanying synkinesis, i.e. additional supportive movements of the other hand and fingers, in some cases refusal to perform the task were observed. The results of the sense of rhythm study in children with mental and physical disorders showed that the perception and reproduction of the given rhythm by the majority of the testees was slowed down. We can assume that reception and processing of sensory information in children with psychophysical disorders occurs with deceleration. While performing the task on motor memory children could hardly remember and accomplish the transition from one movement to another. The pace of the task was slowed down. Only small number of children coped with the task at the first push.

While testing the precision of movements special attention was paid to synkinesis movements' detection, i.e. accompanying involuntary movements. Most children coped with this task without difficulties. Some of kids accompanied their actions with supportive movements, like nose or forehead wrinkling, head flexion, lifting the eyebrows, sticking tongue out, involuntarily moving lips etc. Some children demonstrated lack of control over facial muscles relaxation. The task for movements' simultaneity turned rather complicated for children with mental and physical disabilities. The execution of each movement separately caused no difficulties, but when the right and the left hand performed alternating movements, a malfunction arose in keeping the same pace for both hands. It is possible to assume that underdevelopment of inhibitory processes in the cerebral cortex could be one of the reasons for reducing the ability to accomplish movements simultaneously. In order to provide more detailed analysis, we distributed children by the level of successfulness in their psychomotor development according to the assessment criteria (Table 2). As we can see, a number of boys and girls from the group of children with psychophysical disorders did not cope (0 points) with the tasks for speed of movements, hand and fingers fine movements and movements simultaneity. Nevertheless, some children displayed a high level (4 points) of dynamic coordination and movements precision.

Table 2

Distribution of children aging 5-6 years according to the level of successfulness of psychomotor tests performance, %

Test		Children with psychophysical disorders, n=54					Children with normative development, n=64				
		Points									
		0	*1*	*2*	*3*	*4*	*0*	*1*	*2*	*3*	*4*
Static coordination	g	0,0	20,0	56,0	24,0	0,0	0,0	0,0	12,3	63,3	24,6
	b	0,0	24,2	58,6	17,2	0,0	0,0	0,0	20,0	65,7	14,3
Dynamic coordination	g	0,0	12,0	60,0	24,0	4,0	0,0	0,0	6,6	43,4	50,0
	b	0,0	20,7	58,6	55,2	3,5	0,0	0,0	2,9	40,0	57,1
Speed of movements	g	12,0	36,0	40,0	12,0	0,0	0,0	0,0	33,3	50,0	16,7
	b	10,3	27,6	55,2	6,9	0,0	0,0	0,0	20,0	57,1	22,9
Fine movements of the hand and fingers coordination	g	4,0	40,0	40,0	16,0	0,0	0,0	0,0	30,0	40,0	30,0
	b	3,5	27,6	58,6	10,3	0,0	0,0	0,0	17,1	60,0	22,9
Rhythmicity of movements	g	0,0	36,0	36,0	28,0	0,0	0,0	0,0	20,0	53,3	26,7
	b	0,0	37,9	48,3	13,8	0,0	0,0	0,0	20,0	65,7	14,3
Motor memory	g	0,0	40,0	40,0	20,0	0,0	0,0	0,0	16,6	50,0	33,4
	b	0,0	34,5	55,2	10,3	0,0	0,0	0,0	14,3	60,0	25,7
Movements precision	g	0,0	8,0	32,0	52,0	8,0	0,0	0,0	0,0	66,7	33,3
	b	0,0	10,3	48,3	34,5	6,9	0,0	0,0	0,0	40,0	60,0
Simultaneity of movements	g	4,0	40,0	36,0	20,0	0,0	0,0	0,0	20,0	63,3	16,7
	b	4,5	30,0	44,9	20,6	0,0	0,0	0,0	17,1	51,4	31,5

Footnote: g – girls; b – boys.

Discussion

According to numerical studies the process of physical education of preschool children with mental and physical disorders should provide maximum conditions for their full development, as well as the remodeling of their malontogenesis manifestations (Kozibroda, 2006; Korovyna, 2010; Kozina, 2014; , Yefymenko, 2012, 2013). It is indisputable that the assessment of a preschool child's development should be determined according to his psychomotor developmental characteristics, since the first stages of ontogenesis are characterized by its syncretism, when the psyche and motor skills are in inseparable unity (Rogovik, 2005; Ozerov, 2002; Pasichnyk, 2012, 2015). In the course of studies we have found that psychomotor development of children with mental and physical disorders was due to their retardation in all parameters as compared to the normative ones (Gvozdec'ka, 2005, Shmaley, 2007; Yefymenko, 2012; Hlushchenko, 2013; Petrenko, 2016), which leads in its turn to the functional dysfunction of certain physiological systems. The authors managed to supplement the studies on the deviations in the development of speed and simultaneity of movements in children with psychophysical disorders, as well as fine movements development in mentally and physically disabled children (Gvozdec'ka, 2005; Stebliy, 2008; Korovyna, 2010; Redle, 2015).

The obtained experimental material supplements the data of other authors about the most pronounced retardation in psychomotor development of children with autistic spectrum disorders and with mental retardation. The revealed abnormalities indicate the existence of motor disorders caused by organic lesions of the central nervous system, as well as by the disorders of intellectual and volitional sphere, by low level of perception and motor material processing (Huebner, 1998; Dmytryev, 2002; Volovyk, 2007; Korovyna, 2010).

The study complements and confirms the scientific information about the necessity of a natural and purposeful pedagogical remodeling process aimed at the development of psychomotor system of children with disabilities (Gvozdec'ka, 2005; Kozibroda , 2006; Yefymenko, 2012; Kozina, 2014; Iedynak, 2017).

Conclusions

The comparative analysis of psychomotor functions of children with developmental psychophysical disorders and their apparently healthy peers showed a significant retardation in the development of static and dynamic coordination, speed of movements, fine movements, motor memory, sense of rhythm, ability to perform movements simultaneously, precision of movements by 22.5 % to 35.0 %. It was noticed that children with developmental psychophysical disorders experienced considerable difficulties while performing the tasks for speed and simultaneity of movements' detection, as well as fine movements coordination. On the assumption of the abovementioned, it could be argued that the development of psychomotor system of children with mental and physical disabilities requires a differentiated approach in the process of physical education in the context of inclusive education.

Competing interests. The authors declare no competing interests.

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