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THE IMPORTANCE OF PSYCHO-SOMATIC FACTORS IN THE DYNAMICS OF DYSGRAPHIA

Abstract. The article deals with the problems of teaching writing to junior schoolchildren with dysgraphia who study at a general education school. The results of a longitudinal study of pupils show that dysgraphia in some pupils is characterized by progredient dynamics, when from the beginning of the second until the fourth year of education the number of mistakes definitely increases, with a marked prevalence of motor mistakes. Studies testify that the nature of dyspraxia in children is connected with early organic lesion and lack of compensatory abilities of the central nervous system (CNS). Detailed analysis of the nature of mistakes shows that design and realization of the motor program of pupils suffers from ideomotor dyspraxia inherent to learners. Insufficiency of compensatory abilities is conditioned not only by the phenomena of early organic pathology, but also by sustained somatic weakness caused by chronic hypoxia, being the result of a chain of "hypoxias", when the first hypoxic damage of CNS in the perinatal period is followed by the secondary brain hypoxia caused by diseases of respiratory and nasal organs.

Keywords: junior schoolchildren, inadequate use of the phonemic principle of orthography, dysgraphia, progredient dysgraphia dynamics, the role of the somatic factor.

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The development of writing skills in children is a long and complex process. The process of mastering writing in the Russian language presents special demands to oral speech and skills of phonemic analysis. A typically developing child has relatively formed oral speech, pronounces and comprehends correctly the sounds of the native language, possesses knowledge of syllabic word structure, and can carry out conscientious

phonetical analysis and synthesis of simple words. He is capable of distinguishing similar images, location of pictures and letters, and can perform precise graphical actions when drawing separate lines and connecting them. A certain number of children who start learning writing are characterized by underdevelopment of these basic components of writing, which prevents them from successful learning at school. In many children it re-

sults in specific spelling errors which are called dysgraphic.

Dysgraphia may be defined as complex of symptoms which characterize the inability of children to master the phonemic principle of orthography in a proper way. Among all symptoms, the most significant of them are stable recurrent spelling mistakes of a special character which appear while performing written tasks of various kinds. Dysgraphic mistakes may be found in written works of the children who are considered to be ready for learning at the general education school.

Without logopedic treatment, early dysgraphia leads to various forms of poor progress at school the postponed result of which is manifested in disadaptation of the child in the education process. Although disadaptation has been a subject of research for a long period it has not been properly studied statistically; that is why many authors give different assessments of its prevalence (10-35%).

Use of specially designed programs for remedial purposes as a rule produces a positive effect, due to which a number of children overcome dysgraphia by the fourth grade. Such programs are based on the traditional for logopedics psycho-pedagogical approach worked out by R.E. Levina [7; 8; 9; 10]. This approach is aimed at remedial support for all speech underdevelopment indicators; and the main accent is laid on overcoming phonetic-phonemic inadequacy and non-formation of speech sound analysis and oral speech synthesis.

At the same time, observations

show that there is a special group of students who demonstrate aggravation of dysgraphia by the end of the primary school education which is manifested in the growing number of mistakes of various groups. In the first grade, these pupils more or less successfully master the initial skills of writing and reading and do not differ much from their peers. Beginning with grade 2, there appears a large number of dysgraphic mistakes in their written works; this number steadily grows which makes it possible to consider such dynamics of dysgraphia progredient.

The undertaken research is urgent due to the absence of systematic psycho-pedagogical observations of peculiarities of acquisition of the phonemic spelling skill and the reasons of progredient dysgraphia dynamics in such pupils.

The goal of the given research consists in an interdisciplinary analysis of the progredient dysgraphia dynamics in the process of a longitudinal observation (grades 1 – 4).

The scope of research includes the process of acquisition of the orthographic skills by junior secondary school pupils with dysgraphia.

The object of research is figuring out the reasons that lead to progredient dysgraphia.

The tasks of research alongside with analyzing dysgraphic spelling mistakes include the study of oral speech, intellect, cognitive functions, facts about development and learning and somatic state of the children.

Material and methods of research. We carried out a longitudinal

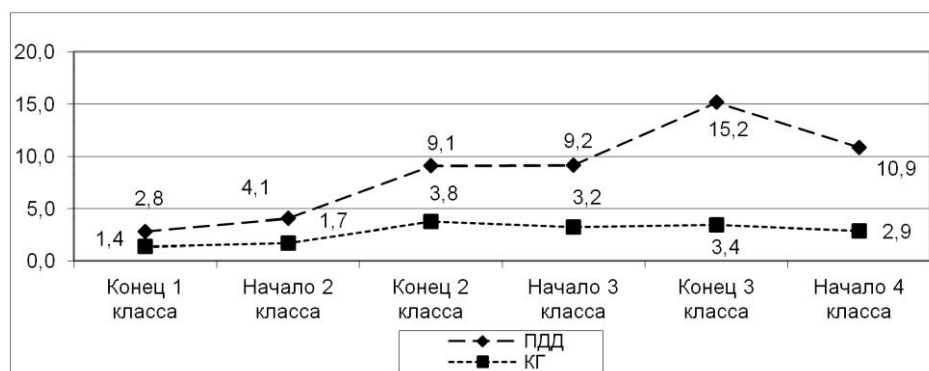
study of 206 pupils of grades 1-4 of a general education school. We allocated to the experimental group (EG) 19 pupils who had difficulties in mastering phonemic orthography in the form of dysgraphic mistakes the number or which grew by the fourth year of learning, and 54 pupils with no difficulties in mastering phonemic orthography over the same period were included in the control group (CG). Presence or absence of dysgraphia was established on the basis of analysis of pupil's written works with the help of a special standardized procedure [6].

For assessment of results of the longitudinal analysis of writing skills we used the prospective and retrospective methods of analysis, statistical nonparametric methods (the Mann-Whitney U test, the Wilcoxon signed-rank test), analysis of variance and methods of descriptive statistics.

In comparing two parameters, the difference of $p = 0.05$ is considered to be significant.

The pupils' oral speech was studied with the help of the method by T. A. Fotekova, T. V. Akhutina [15]. The data about the development and learning of the children were received through interviews, closed and open questionnaires of parents and teachers, medical histories and pedagogical documentation.

Results of research. The analysis of the number of mistakes in the process of acquisition of the phonemic spelling skill by the EG and CG pupils is represented in the form of the sum total of dysgraphic mistakes found in all written works of the children over the period of four years of learning (Fig. 1) which makes it possible to reveal the dysgraphia dynamics in these children.



End of Grade 1	Beginning of Grade 2	End of Grade 2	Beginning of Grade 3	End of Grade 3	Beginning of Grade 4
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ПДД – progredient dysgraphia dynamics

КГ – control group

Figure 1. Results of dynamics of acquisition of phonemic spelling skills by the pupils of experimental and control groups

Table 1

Results of comparative analysis of various kinds of dysgraphia mistakes made by EG and CG pupils at the time of beginning education (m)

Kinds of mistakes	EG	CG	(M/W)*
End of grade 1			
Mistakes of phonemic reception	0.53	0.23	P=0.071
Mistakes of speech sound analysis and synthesis	1.32	0.77	P=0.048
Motor mistakes	0.42	0.34	P=0.218
Visual-motor mistakes	0.53	0.13	P=0.160
Visual-spatial mistakes	0.05	0.06	P=0.818
End of grade 2			
Mistakes of phonemic reception	1.72	0.33	P<0.001
Mistakes of speech sound analysis and synthesis	2.44	1.24	P=0.069
Motor mistakes	3.28	1.37	P=0.002
Visual-motor mistakes	1.67	0.80	P=0.057
Visual-spatial mistakes	0.00	0.02	P=0.540
End of grade 3			
Mistakes of phonemic reception	2.84	0.51	P<0.001
Mistakes of speech sound analysis and synthesis	4.53	0.78	P<0.001
Motor mistakes	5.16	1.23	P<0.001
Visual-motor mistakes	2.53	0.81	P=0.002
Visual-spatial mistakes	0.16	0.02	P=0.149
End of grade 4			
Mistakes of phonemic reception	1.67	0.46	P=0.001
Mistakes of speech sound analysis and synthesis	3.20	0.67	P<0.001
Motor mistakes	4.73	1.08	P<0.001
Visual-motor mistakes	1.20	0.39	P=0.004
Visual-spatial mistakes	0.07	0.00	P=0.116

* (M/W) — significance of differences (the Mann – Whitney *U* test)

The data presented in Table 1 testify to the fact that both EG and CG children make the same kinds of dysgraphic mistakes. This fact proves that the process of acquisition of the given writing skill is in principal identical in all children. In the first grade, there is hardly any difference between the EG and CG children in the sum total of mistakes. Significant difference is observed between the children of these groups in only one kind of mistakes – in particular, in those of speech sound analysis and synthesis (1.32:0.77), demonstrating the inability of the children of the experimental group to determine the number and

order of sequence of letters in the process of writing. Irrespective of the significant difference in the number of mistakes their number is not sufficient enough to identify dysgraphia in the EG children as the number of mistakes in accordance with the standardized procedure of distinguishing dysgraphia should exceed three mistakes in a single written work but in our case their number totals to 1.32 in three written works. It may be possible that it is the presence of mistakes of speech sound analysis and synthesis that is the predictor of dysgraphia as they are observed during the whole period of primary education.

By the end of grade 2, we registered a significant increase in the number of the following mistakes in EG children compared with CG ones: motor mistakes ($p = 0.002$), when the children use a mistaken graphical sign for writing a letter; mistakes of phonemic perception ($p = 0.001$), which are connected with the difficulty of differentiating sounds similar in their acoustic-articulatory properties. It is also a period when the differences in the number of visual-motor mistakes become more evident and mark a new tendency ($p = 0.057$).

It is necessary to note that the increase of the number of dysgraphic mistakes in the experimental group by the end of learning in grade 2 coincides with the period of coming over to more complex learning material, i.e. with the beginning of the study of the morphological principle of orthography. We may argue that in the cases when phonemic spelling has not been properly developed yet the transition to acquisition of another orthographic

principle damages immature automatic skills which results in an increase of mistakes. The CG, on the contrary, demonstrates an insignificant decrease of the number of mistakes which indicates successful acquisition of the phonemic principle of orthography and absence of difficulties in the transition to the study of the morphological principle.

At the end of study in grade 3, we observed a significant increase in the number of motor, phonemic, visual-motor mistakes and mistakes of speech sound analysis and synthesis. Visual-spatial mistakes are again not numerous and don't differ in number in both groups. Motor mistakes evidently begin to dominate in EG children of grade 3 (5.16).

By grade 4 the total number of mistakes slightly decreases. But the differences between the EG and CG children still remain to be significant, especially in the number of motor mistakes. An analysis of all kinds of motor mistakes is given in Table 2.

Table 2

Indicators of the number of motor spelling mistakes in children with PDD (m)

Types of mistakes	Period of study						Total
	End of grade 1	Beginning of grade 2	End of grade 2	Beginning of grade 3	End of grade 3	Beginning of grade 4	
Kinesthetic start	0.16	0.21	0.61	0.89	2.11	2.07	6.05
Graphical search	0.00	0.00	0.00	0.00	0.00	0.07	0.07
Extra letter elements	0.16	0.79	1.72	1.47	1.63	1.40	7.17
Missing letter elements	0.05	0.00	0.56	0.47	0.89	0.80	2.78
Perseverance	0.05	0.00	0.39	0.37	0.53	0.40	1.74
Total	0.42	1.00	3.28	3.21	5.16	4.73	17.80

As seen from Table 2, the most widespread motor mistakes are represented by mistakes connected with writing extra letter elements (m =

7.17), mistakes of "kinesthetic start" (m = 6.05), and missing letter elements (2.78). Letter perseverence which is probably caused, according to neuro-

psychologists, by inertia of the motor program and the difficulty of turning over during writing (1.74), and graphical search of the image of the letter (0.07) take place much more seldom. Analyzing the dynamics of motor mistakes in grades 1-4 we observed the maximal increase of mistakes (16 times) connected with the missing letter element (irrespective of their insignificant number among motor mistakes). More often this mistake is reflected in the absence of the first element of the second letter in the letter clusters "mm", "kl", "nl", "um". The number of extra elements, for example, in the letters "k", "u" in grades 1-4 rises 13 times; the number of mistakes connected with incorrect realization of the graphical program leading to replacement of letters in writing, for example, "б — д", "n — m", "u — y", "m — л" increases 9 times.

The studied examples show that children with PDD in most cases demonstrate inadequate construction and realization of the motor program which indicates that they have dyspraxia (ideomotor dyspraxia according to Ch. N'okikt'en, 2004) [11].

Analysis of logopedic observation of oral speech of the EG children shows that a certain number of the first grade children of this category have pronunciation impairments. Only five children had no deviations in speech development on the date of observation. Ten children out of nineteen have lowered articulatory and mimic muscle tone, uneven tone of the tongue, inadequate velar mobility, and features of speech prosody disorders; one schoolchild has phonemic

underdevelopment and three pupils have impaired pronunciation. After the logopedic observation these pupils were enrolled in the logopedic center for remedial treatment. At preschool age all pupils of the experimental group had logopedic support and demonstrated phonetic-phonological speech disorders. The pupils of the control group displayed normal oral speech development in accordance with age indicators.

The results of observation of the intellectual aspect of the EG children (the method by Yu. I. Filimonenko, V. I. Timofeev, 1992 [13]) at initial stages of education show that the majority of the EG children have the general IQ value close to the lower norm border (IQ = 90—95). The structure of verbal and non-verbal intellect of pupils with PDD has peculiarities uncommon to the CG children. Low scores for the subtest "Knowledge" indicate low volume and level of acquisition of simple knowledge, limited cognitive interests and inadequate level of development of the basic intellectual functions.

Significantly lower results of non-verbal subtests "Constructing figures of cubes" ($p = 0.004$), "Encoding" ($p = 0.159$), "Labyrinths" ($p = 0.006$) suggest lower organization of perceptive, and visual and visual-spatial processes in particular, low speed of stimuli procession and, which is still more important, low capacities of children in the formation of visual associations necessary for timely acquisition of the visual-motor habit.

Statistic comparison of the EG

and CG children argues significant differences ($p < 0.01$, Kruskal — Wallis test) between the indicators of verbal and non-verbal intellect. The total indicator characterizing the non-verbal intellect in the group of pupils with PDD taking into account its structure shows that, as different from the norm, it is developed better than the verbal one.

More significant deviations from the control group can be seen in children with PDD while comparing the indicators combined into more general areas of cognitive functions: 1) verbal understanding of material (“General Knowledge”, “Finding Similarity”, “Remembering Figures”); 2) perceptive organization of material (“Encoding”, “Kohs Block Design Test”, “Sequencing Pictures”); 3) working memory (“Arithmetic”, “Repeating Figures”); 4) speed of procession of incoming information (“Constructing Figures”). It is known that working memory in particular influences successful acquisition of the native language, ability to learn academic subjects including spelling habits [3; 17].

In the result of comparison of summative indicators of experimental data about the state of cognitive functions of schoolchildren with PDD and the control group significant differences are found in the following lower value indicators: perceptive organization ($p = 0.045$), working memory ($p = 0.014$), and speed of procession of incoming information ($p = 0.01$). No differences were registered only between indicators characterizing verbal understanding of information ($p = 0.26$).

With lower indicators of working

memory development in this group accompanied by lower speed of information procession, the pupils of the experimental group cannot make the spelling habit automatic in compliance with the education program which is being constantly complicated.

Comparison of development of higher mental processes of schoolchildren with PDD and the control group on the basis of analysis of neuro-psychological observation results (T. V. Akhutina, 2008 [1]) shows that the EG children possess significant differences in the indicators of formation of the functions of programming, regulation and control ($p = 0.041$), and serial organization of movements ($p = 0.044$). We may assume that the above mentioned functions suggest their involvement in the emergence of progredient dysgraphia dynamics.

Reviews and questionnaires of teachers and analysis of pedagogical documentation show that the majority of schoolchildren with PDD often get “unsatisfactory” marks in Russian in the period starting at the end of grade 2. In comparison with other pupils, children of this group are slow in acquiring spelling habits, cannot complete written tasks quickly enough, especially when the quick tempo of performance is set by the teacher. Teachers pay attention to the slow “inclusion” of the children while completing various learning tasks, especially written ones. Performing written tasks is for a long time accompanied by numerous synkineses: sticking out the tongue, swaying on the chair in time with writing, making

legs or feet movements, etc., which stay even in grade 4. Arms and hands movements are constrained and clumsy; the children can hardly perform such actions as gluing, cutting out, sewing on; they reluctantly paint, draw, model, etc.

The process of mastering calligraphy habits is made difficult: the pupils hold the pen incorrectly; they cannot learn the trajectory of the letter curve design; they are slow in learning connected writing; all this results in poor handwriting. In written works, the children make many motor mistakes, cannot concentrate on learning, are often distracted and switch over to other kinds of written work. At physical training lessons, the children take a long time in learning to jump rope, climb wall-mounted ladder and ski. By the end of the lesson they show signs of fatigue and make more mistakes than at the beginning. The working capacity of children with PDD is always lower at the end of the week, quarter or school year. They are characterized by emotional disorders, tearfulness, irritability, and look languid and weak. School anxiety in some of them takes the form of refusal to go to school.

The results of reviews and questionnaires of the parents of schoolchildren with PDD reveal that in early childhood and at preschool age the children had nutrition problems, functional intestinal obstruction, and susceptibility to respiratory and bronchopulmonary diseases with recurrent nature and further chronification. Some children suffer from cardiovascular diseases.

All such babies demonstrate late independent sitting, non-active period of crawling and underdevelopment of independent walking. Children take a long time in developing complex motor actions: putting on clothes, tying shoelaces, buttoning and zipping, etc. They cannot learn to hold the pen or pencil correctly, drop objects and remain clumsy in their movements.

On entering school the parents observe high fatigability which begins progressing from the second year of study. While doing homework, schoolchildren often refuse to it, ask to put off written exercises for a later time and ask for breaks during doing them.

According to medical documentation all children have good hearing, intellect and eyesight. The materials reflecting the early period of development of schoolchildren with PDD contain data about prenatal, natal and postnatal periods of development and prematurity. Many mothers had psycho-somatic disorders during pregnancy which influenced fetal oxygen metabolism and led to hypoxia. Children, especially during the first months of life manifest motor anxiety and excessive muscle tone. Some children at this stage of development are under constant children neurological observation in connection with prenatal encephalopathy, minimal cerebral dysfunction and prematurity.

In the period of preschool childhood and later on, while learning at school, we registered chronic forms of ENT pathology: antritis, adenoiditis, and bronchopulmonary diseases which may cause secondary hypoxia.

During the first year of school

education children often suffer from somatic diseases of the respiratory system (whooping cough, bronchitis, tracheitis, pneumonia) and various kinds of children's infections (measles, rubella, chicken-pox, mumps, grippe, ARVI, and URI).

Discussion. Interdisciplinary analysis of the obtained results demonstrates a complex character of life activity disorders in children with progredient dysgraphia dynamics. Apart from specific motor features affecting the development of writing habits and non-specific motor functions indicating residual features of an early organic CNS lesion the EG pupils demonstrate somatic weakness which has a negative effect on the state of the child's organism as a whole.

In spite of regular logopedic work dysgraphic mistakes in the works of children with PDD are not overcome, and the number of mistakes keeps on growing which does not only prevent the development of the writing habits but also tells on the psychological and emotional state of the children and hinders their social development as they approach the age of adolescence.

Analysis of the character of spelling mistakes and of the state of general motor functions and oral speech impairments shows the presence of dyspraxia. The origin of dyspraxia is known to be connected with the early organic CNS lesion which is confirmed in our research by clinical observations.

Dyspraxia has a negative effect on performing smooth sequential, i.e.

serial movements taking place in time which are effected under inadequate control of the motor program or its inertia which results in mistakes in tracing similar letters. The works by Yu. I. Barashnev (2001), T. E. Ivanovskaya, L. V. Leonova (1989), A. B. Pal'chik (2002), A. B. Pal'chik & N. P. Shabalov (2000) show that organic CNS lesion may selectively influence the work of the CNS parts responsible for the processes of controlling movement design, including motor activity during writing [2, 5, 12, 13].

Progredient dysgraphia dynamics in the group under study is called forth both by brain dysfunctions and compensatory disabilities of the CNS. The state of the pupil's CNS defines the developmental peculiarities of the structure of intellectual and cognitive functions, whereas the general indicator of the children's IQ is close to the lower norm border.

We associate compensatory disabilities of the CNS of the children under observation not only with the phenomena of early organic pathology, but also with residual somatic weakness caused by chronic hypoxia which is the result of a "chain" of hypoxias when the first perinatal hypoxic lesion of the CNS is followed by secondary brain hypoxia.

Secondary hypoxia emerges on the background of brain tissue impairments caused by chronic disability of the cardiovascular and respiratory systems, various forms of ENT pathology, etc. In the long run, we can speak of progredient course of encephalopathy which is similar to the

description of investigation results by V. D. Emel'yanov (2010), V. M. Shaytor (2008), etc. [4; 16].

We believe that it is these phenomena that cause the progredient nature of dyspraxia and difficulties in the formation of writing habits. Unstable writing habits and introduction of more complex learning tasks and program requirements aggravate the problems of writing habits formation which need constant consolidation. Our longitudinal research shows that, as a result of the above mentioned problems, the traditional volume and character of logopedic assistance for junior school-children with PDD is not enough: they need complex support on the part of a whole number of specialists.

Logopedic support alongside with speech correction, development of speech sound and letter-sound analysis and synthesis should include longer and more detailed work for the formation of the motor writing habit beginning with movement design analysis and its serial organization till its complete automatization. Logopedic support should be provided all through the period of primary education be carried out in close cooperation with the teacher whose task will be granting pedagogical support for the pupils and creation of favorable conditions of learning at school based on careful relation to the nervous system and the pupil's organism as a whole. Alongside with the formation of oral speech, cognitive psychological functions and thinking carried out by neuropsychologists and psychologists such children need special measures aimed at health promotion,

i.e. constant observation by pediatrician, neurologist and other specialists. The child's parents should be also involved; they should be convinced of the necessity of consulting a doctor and closely following the prescribed treatment.

The obtained data open up new perspectives for working out special conditions, including individual ones, necessary for such pupils at the general education school.

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