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Method effectiveness of preschoolers' speech correction using adaptive physical education

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Abstract: Purpose: To reveal the reliability of the author's innovative method effectiveness of the 3-5 years old children speech correction with 3rd level of speech underdevelopment using adaptive physical education. 93 children of younger (3-4 years old) and middle (4-5 years old) preschool age with 3rd level of speech underdevelopment took part in the study. They were divided into two groups: experimental (48 children) and control (45 children). The formative pedagogical experiment was performed during 2022 - 2023. The research took place in specialized preschool education institutions, as well as kindergartens of the combined type in Odessa city, as well as in Dnipro city. In addition, the own experience of correctional work with such children in the Movement Rehabilitation Center (Odesa) was analyzed. According to the dynamics of general and manual praxis in the context of the 3-5 years old children speech correction with general speech underdevelopment using adaptive physical education, it can be stated that almost all indicators from the experimental groups had a statistically ($P<0.05$) confirmed results (improvement). Peers from control groups also had progress in indicators, but it was not statistically confirmed ($P>0.05$). The conducted formative pedagogical experiment made it possible to prove the innovative method effectiveness of younger and middle preschool age children speech correction with 3rd level of speech underdevelopment using adaptive physical education.

Keywords: *Adaptive physical education, Correction, Praxis, Preschoolers, Speech development.*

1. Introduction

Today's realities of life, unfortunately, lead to an increase of children with disorders of psychophysical development. This is facilitated by the prolonged epidemic of the COVID-19, which continues to affect the children's population of Ukraine, in particular, their central nervous system, brain formations, causing various deviations in the psychophysical development. The war in Ukraine increases the negative impact of stressogenic factors on children's psycho-speech development. This situation is aggravated by large-scale population migration to other, more peaceful and protected regions of Ukraine and European states. The forced change of life, the relocation of families to new regions, the change of the usual, comfortable society only adds the negative effects on children. All these troubles are especially felt by children of younger preschool age, whose mental sphere has not yet been fully formed and therefore remains very vulnerable.

Today, more than ever, innovative and effective methods of improving the psychophysical development of children have become relevant. Galushchenko [1], Korobko, Zhernovkova [2], Marchenko [3], Revutska [4] investigated the use of modern innovative pedagogical technologies, individual methodological approaches and special methods in corrective work with children. Danilyavichute et al [5] developed a strategy for organizing a humanistic educational environment for children with special educational needs. However, in these studies, we did not find a comprehensive

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approach to the development of the motor sphere (praxis) in the context of systematic improvement of the psycho-speech development of children with special educational needs.

Televna [6] devoted her research to the feasibility of using innovative health-preserving technologies in the work of a speech therapist. In our opinion, it expands the correction possibilities of the children's psycho-speech development and brings the mental sphere closer to the somatic sphere, forming a very powerful psychomotor direction in the corrective aspect. Chernichenko [7] and Yakovenko [8] analyzed the innovative activities of speech therapists in preschool educational institutions with inclusive education, as well as innovative technologies for improving the quality of speech therapy classes in modern conditions of general education. Konoplyasta and Sinytsia [9] studied the design of speech therapy support for young children with cerebral palsy. At the same time, in our opinion, the practical aspect was not sufficiently represented.

Pylyaeva [10] devoted her study to the problem of studying praxis and its deviations in special literature, and analyzed various approaches to its study. Ribtsun [11] also studied ways of implementing the logopsycho-synergistic approach in the formation of practical functions in children with stuttering. Moga also dealt with this problem: in particular, he studied the development of manual subject praxis in preschoolers with speech disorders based on the "Stupalki-LOGOS" technique. Yefimenko et al [12] worked in the same direction - they investigated the correction possibilities of wrist subject-practical activity using adaptive physical education and occupational therapy. They proposed the following classification of hand praxis: power, coordination and speed wrist functions. This approach significantly expands the understanding of the motor sphere possibilities in improving applied speech and practical functions of children. Sack, Dollagan, and Hoffman [13]investigated the contribution of early motor deficits in speech outcomes prediction of preschoolers with impaired speech development and found relevant correlations between the motor and speech spheres. Movement restrictions at an early age hurt the child's speech development. Gonzalez [14] reviewed the relationship between the state of general and fine motor development of children and their speech development. A close interaction between the above-mentioned types of praxis and the quality of children's speech was also observed here. The same Gonzalez et al [15] investigated the relationship between children's speech development and hand preference. In most cases, the priority is the right limb, while the left hemisphere of the brain is dominant. This tendency of the left hemisphere dominance remains relevant even if a child is lefthanded. But a group of children was identified, in which the right hemisphere was dominant. This suggests the flexibility, and plasticity of the construction of the brain's neural substrate and its significant adaptive capabilities. Nelson et al [16] studied the preferred hand trajectories of toddlers in the context of predicting 3-year speech performance. The following correlations were found: the more accurate and differentiated the typical trajectory of a child's hand (wrist, fingers) when drawing, the more prerequisites for the timely and high-quality development of the child's speech. Danilyavichute [17] considered the neurodynamic basis of modelling speech and fine motor skills in the context of the complex technology of providing care for children with cerebral palsy. We are impressed by the mentioned approach because children with cerebral palsy suffer from hand (wrist) motility. Also, we consider a comprehensive approach to solving the problems of children's speech development with special educational needs, in particular, a specialist in adaptive physical education and a speech therapist, a psychologist, to be promising. Yefimenko [18] in his program of horizontal plastic ballet for preschool children singled out a special direction called object plastic show, which is based on various object-manipulative actions during plastic movements of the whole body and limbs: grabbing small objects with a wrist, holding small objects in hands (hand), transferring small objects from hand to hand, scattering and collecting small objects, putting small objects together, rolling objects on the floor, throwing a ball, catching it, stringing objects on a rope or stick, rolling balls moving along the visual corridor, passing small objects from hand to hand, carrying small objects in the hands to a distance, stopping a rolling object with the hand, throwing a ball to a partner, manipulating cubes, tape, maces, rope, flags, with skittles, with plastic balls, with ropes of different lengths, balls of different types, etc. It is interesting that the given methodological approach harmoniously combines the

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elements of general praxis (basic movements), bimanual (wrist and finger praxis) (manipulation with objects), and oculomotor and visual-motor praxis. LeBarton et al [19] in their research proved that fine motor skills involve the stimulation of expressive speech of infants, brothers and sisters of children with autism, which emphasizes the relevance of the above methodical direction.

We consider the study of children's motor sphere with special educational needs on their psycho-speech development to be promising. Yefimenko [20] in his program for the physical development of early and preschool-age children "Fairy physical education" offers fundamentally different methodological approaches to improving the psychophysical development of the specified category of children. The author urges to follow the logic of nature in this sense, based on the phylogenetic principle of the animal world formation and human as a part of this world. The postulate formulated by him "ontogenesis repeats phylogenesis, and a reasonable system of physical education (development of praxis) should repeat the logic of ontogenesis" looks very attractive for its use in the correction of children's psycho-speech development with general speech underdevelopment. The author of the technology and the program recommends the following sequence of mastering the basic movements, which he calls the basic motor modes: lying down, crawling, sitting, standing, walking, climbing, running and jumping. His postulate that subject-manipulative activity does not make sense to be placed in a separate artificial subdivision of the program looks original. Praxis, in particular the interaction of hands with objects, should be implemented in each of the eight listed basic motor modes, starting from lying down and ending with jumping.

Altukhova [21] and her colleagues studied the peculiarities of the motor ability development of older preschoolers with general speech underdevelopment and showed the difference between the motor abilities of healthy peers. Pinchuk et al [22] developed a physical rehabilitation system for older preschool children with general speech underdevelopment, but it contributed to the correction of the preschoolers' motor sphere without its close connection with psycho-speech development. Demyanenko [23] is working in a similar direction, looking for appropriate ways of motor correction for children with speech disorders. Prytykovska [24] was engaged in research on movement coordination formation as a means of speech disorder correction of older preschool-age children. We consider this direction very important and promising in the context of Yefimenko's well-known postulate "coordination of all coordination". An attempt was made to trace the relationship of general motility (the child's main movements) with local coordination manifestations of the upper limbs and the articulatory apparatus. The positive effect of improving the general and local movements' coordination on the quality of children's speech was proven.

Kravchenko [25] dealt with the stuttering correction of early and middle school-age children using complex physical rehabilitation. We are impressed by the comprehensiveness-oriented approach, partially implemented by a colleague in her work. But at the same time, it should be understood that stuttering is a very specific speech pathology, which is significantly different from the pathogenesis of general speech underdevelopment. The stimulating potential of theatricalization, game and musical activities, as well as mobile games in improving children speech development, were investigated by Bilous [26], Konovalova [27], Bondarenko [28], and Gladchenko [29], but these researchers touch on relatively narrow directions of corrective pedagogy and do not reflect a comprehensive approach of the motor sphere possibilities in improving the psycho-speech development of children with special educational needs. We should especially note the developments of Yefimenko and Moga [30] regarding the "Stupalki-LOGOS" technique, developed for improving and correcting the motor-psycho-speech sphere of children with special educational needs. In the context of this article, we were primarily interested in the possibilities of the proposed method for improving the speech development of children with general speech underdevelopment.

Therefore, despite the above-mentioned literature, the issues of applying the possibilities of adaptive physical education to improve the speech development of 3-5 years old children with 3rd level of speech underdevelopment is not fully clarified. Such a situation determined the urgency of writing this article.

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The purpose of the study – is to prove the author's method effectiveness of the 3-5 years aged children's speech correction with 3rd level of speech underdevelopment using adaptive (in particular, general and manual praxis) physical education.

2. Material and Methods

2.1. Participants

93 children of younger (3-4 years) and middle (4-5 years) preschool age with 3rd level of speech underdevelopment took part in the study. They were divided into two groups: experimental groups (EG) (48 children) and control groups (CG) (45 children). Parents were previously given permission for their children to participate in a formative pedagogical experiment. The reduced number of preschoolers who participated in the experiment is a consequence of objective problems of our state: the continuation of the COVID-19 epidemic, the presence of hostilities, the unstable activity regime of preschool education institutions in various regions of Ukraine.

2.2. Procedure (Research Organization)

The study was conducted in the specialized preschool education institution #193 (Odesa City) for children with speech development disorders, as well as in the Movement Rehabilitation Center (MRC), located in Odesa City. Control groups of children were formed and observed at "Flowers of Life" and "Territory of Development" children development centres located in Dnipro city. They were engaged in traditional methods of correction of psycho-speech development.

For children from experimental groups, in addition to standard speech therapy methods, correction methods of adaptive physical education were additionally used. Special sets of exercises were used:

1. For general relaxation of the skeleton and individual areas of the muscle corset.
2. For correction of manual functions (wrist and finger praxis).
3. For global and local coordination of the trunk, limbs, musculoskeletal system.
4. To improve (correct) types of breathing.
5. Using the musical and rhythmic arsenal.
6. Voicing and speech accompaniment of movements.
7. With elements of the theatricalization of motor and speech therapy manifestations.
8. Specialized speech therapy correction.

In the experimental and control groups, the number of classes per week and their duration were the same. The majority of the formative experiment was implemented during the day in various forms of adaptive physical education for preschoolers: morning wake-up gymnastics, physical education classes, funny physical education games, horizontal plastic ballet, physical education corrective sketches, daytime wake-up gymnastics, and others.

The leading role in the formative pedagogical experiment was given to physical education instructors, who had consultations with the author of the methodology and experimental research. Preschool teachers were also involved in it, who were consulted by the physical education teacher regarding their education activity: morning gymnastics and the like.

During the formative pedagogical experiment, special attention was paid to the author's method "Stupalki-LOGOS" (Yefimenko and Moga). It was developed to stimulate general hand, wrist and finger praxis of children based on bimanual exercises. Paired hand exercisers are used mainly in the lying position, in the four-legged position and in sitting postures with support on the hands. With the help of these compact training complexes, it is possible to successfully develop strength, coordination and speed wrist functions, to implement complex manual praxis, which has a powerful effect on children's speech development.

Both before the formative experiment and after it, we investigated the state of children`s praxis, in particular, its changes. Thus, the following author's tests by M. M. Yefimenko were used as the basis for the study of general praxis: "Hoops", "Crane", "Well, turn around!", "On the path", "Rhythm walking",

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"Novice driver", "Blind walking", "Monkey and banana" [31]. We studied the most "socialized" basic movements: standing, walking and climbing.

2.3. Statistical Analysis

To analyze the results, standard methods of mathematical statistics were used (arithmetic mean value, root mean square deviation, coefficient of variation, reliability coefficient, discrepancies according to the Student's test (t), growth rate of indicators). The obtained data were analyzed using the capabilities of the Statistica computer program (version 10). Statistical analysis was performed by calculating percentages and P values. Results were calculated for variables and tabulated. The level of their significance was determined by the P value, where $P<0.05$ was considered statistically significant.

3. Results

With the help of the "Hoops" test, the qualitative and quantitative parameters of the child's sense of the own body were studied according to the following criteria: coordination of movements of the trunk and limbs, the fusion degree of movements, accuracy of movements, execution speed of a complete coordination action.

At the end of the formative pedagogical experiment, coordination movements were observed in 78.24% of cases (EG), and in 54.66% of cases (CG); fusion of movements was observed in 72.11% of cases (EG), and in 43.25% (CG); accuracy of movements when stringing hoops on a hook was observed in 66.39% of cases (EG), while children from CG had only 35.17% of cases; complete motor action (lift own body from the floor and hang five standard plastic gymnastic hoops on a hook at the top), children from EG did it on average 25.50% faster than children from CG ($P<0, 05$) Table 1.

Using the "Crane" test, the function of static balance was investigated (variant - with eyes closed). On average 72.34% of children from EG maintained stable balance at the level of age norms. In CG, 52.12% of peers demonstrated such stability. The difference in results is significant and was confirmed by statistical methods ($P<0.05$).

With the help of the test "Well, turn around!" the peculiarities of statodynamic equilibrium of children were clarified. 71.13% of children from EG performed a 360° rotation on a rotating disk quickly and efficiently. There were only 54.22% in the CG. A noticeable difference in the results was confirmed statistically ($P<0.05$).

Dynamic balance was studied using the "On the path" test (speed and quality walking on a straight rope 10 m long which lies on the floor). The analysis of the results proved that 69.54% of children from the experimental group performed this motor task quickly and efficiently (with a minimum number of errors – get off the rope). In CG, it was only in 49.88% of cases. The result difference was confirmed mathematically ($P<0.05$). As for the qualitative indicators of motor activity, children from the control group had 42.87% more manifestations of general dyspraxia, such as insufficient coordination of trunk and limb movements, imbalance when getting off the rope, violation of the rhythm and movement integrity.

The "Rhythm-walking" test was used to detect the degree of walking rhythmicity on the special simulator "Rytmohid". Preservation of a walking rhythmic pattern was observed in 72.10% of cases (EG) and in 52.97% of cases (CG) ($P<0.05$).

Peculiarities of mirror coordination were studied using the "Novice driver" test. During this test child looks in the mirror and moves backwards quickly (without looking back). The task is not to knock down 5 pins, which are located at the same distance from each other. On average, 56.35% of children from the experimental group completed this difficult task relatively quickly - the increase in their results was statistically significant ($P<0.05$). In the control group, the indicator was significantly lower - 37.05%, and the reliability of the increase in results was not recorded ($P>0.05$). As for the number of errors (knocked down or moved pins), children from EG made it 46.22% less than their peers from CG.

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Table 1.
The general praxis formation of 3-5 years aged children with the 3rd level of general speech underdevelopment during the formative pedagogical experiment (n=48).

#	Criterion name	Control group (The average indicator) 3–5 year		P t	Experimental group (The average indicator) 3–5 year		P t
		Before	After		Before	After	
1	General coordination of the trunk and limbs ("Hoops" test)	37.34%	43.25%	>0.05 1.845	38.02%	78.24 %	<0.05 2.048
2	Static balance ("Crane" test)	48.22%	52.12%	>0.05 1.886	48.97%	72.34 %	<0.05 2.041
3	Statodynamic balance ("Well. turn around!" test)	47.86%	54.22%	>0.05 1.892	47.10%	71.13 %	<0.05 2.038
4	Dynamic balance ("On the path" test)	45.50%	49.88%	>0.05 1.880	46.73%	69.54 %	<0.05 2.032
5	Rhythmicity of movements ("Rhythm walking" test)	46.24%	52.97%	>0.05 1.891	46.79%	72.10 %	<0.05 2.040
6	Mirror coordination ("Novice Driver" test)	33.64%	37.05%	>0.05 1.824	34.70%	56.35 %	<0.05 2.024
7	Tactile-kinesthetic sensations of the body ("Blind walking" test)	38.46%	45.66%	>0.05 1.853	39.78%	67.44 %	<0.05 2.027
8	Global coordination of the trunk and limbs ("Monkey and banana" test)	42.19%	50.25%	>0.05 1.882	43.66%	69.53 %	<0.05 2.031

The "Blind Walking" test made it possible to detect the state of the child's orientation in space without visual control. Children had to walk 4 meters in a straight line without visual control and also with prior vestibular stimulation in the form of rotations around the vertical axis. The obtained data revealed that children from EG performed this task 21.34% faster than their peers from CG ($P<0.05$). As for the quality of the test movement, here is the difference between the two groups: children from EG demonstrated a straight trajectory of movement in 67.44% of cases, while in CG this indicator was at the level of 45.66% ($P<0.05$). Among peers from the experimental group, the deviation number of the walking trajectory equal to or more than 1 m amounted to 17.68% of the total attempts number. In the control group, this indicator was equal to 32.03% ($P<0.05$). During testing, negative emotions (anxiety, uncertainty, fear) were observed in 10.25% of cases (EG). In CG, the number of such cases was significantly higher and reached 28.39% of the total number of attempts ($P<0.05$).

Onwards, the peculiarities of the general praxis in the way of complex coordination-wise basic movement as climbing were investigated. For this, the "Monkey and Banana" test was used: child has to climb to the top of a standard gymnastic ladder as quickly as possible and knock down a pin standing on the ladder with the elbow of the leading hand, then also quickly to get down. In order to successfully perform this test, it was necessary to realize the general coordination of the trunk and all limbs, rhythmicity of movements, eyesight and accuracy, and to do everything as quickly as possible. We consider this test informative regarding the study of general praxis and existing global dyspraxias. 69.53% of children (EG) completed this test quickly and efficiently - the positive dynamics of the results

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were statistically significant (P<0.05). In the CG, this indicator is equal to 50.25% and the increase in results was not mathematically confirmed (P>0.05). If we talk about the qualitative components of their movements, they were more purposeful, coordinated, integral, accurate and rhythmic Table 1. Thus, according to all criteria of general praxis, children from EG outrun their peers from the CG in quantitative and qualitative parameters. This confirms the effectiveness of the conducted formative pedagogical experiment and the author's method of using the possibilities of adaptive physical education in correcting the psycho-speech development of children with general speech underdevelopment.

Now let's consider the changes of manual praxis parameters in both groups. At the end of the pedagogical experiment, the finger praxis of poses according to the visual pattern in the experimental group improved from 3.62 to 4.52 conditional points, which corresponds to a positive dynamic of 24.86%, confirmed statistically (P<0.05). In the control group, progress was from 3.68 to 4.02 points (9.24%), but it was not statistically significant (P>0.05) Table 2.

Changes in *the finger praxis of poses according to the kinesthetic pattern* were also compared. According to the average of all test samples, children from EG significantly improved their results from 3.31 to 4.22 conditional points (positive dynamic of 27.92%), which was confirmed by the methods of mathematical statistics (P<0.05). In the control group, the progression of results was from 3.36 to 3.57 points (6.25%), but it was not confirmed mathematically (P>0.05).

Subjective wrist praxis was studied according to M. Yefimenko author's tests: "Pyramid", "Big buttons", "Sea pebbles", "Counting sticks", "Knots". Using the "Pyramid" test (quick stringing of four balls with a hole on the pyramid rod) the hand (finger) praxis of the leading hand was determined. At the end of the experiment, 60.28% of children from EG completed this task quickly (according to the age standards of healthy children) - the results increase was statistically proven (P<0.05). In CG, 47.14% of peers showed similarly high results (P>0.05) Table 2. At the same time, the qualitative indicators of the children from the experimental group at the end of the experiment also prevailed: they made significantly fewer mistakes when combining the balls and the rod, more rationally performed the grasping of the ball itself, made the movements of stringing easily and quickly.

The "Big buttons" test considers the bimanuality of the motor action: one hand has to hold the button, and the other hand direct the thread nose into the buttonhole. After the experiment, 57.22% of children from EG performed this task relatively quickly and almost without errors. The objectivity of positive changes was proven statistically (P<0.05). In the CG, the test results also progressed and reached the level of 44.82%, but were statistically unreliable (P>0.05). This was a logical result of the fact that children from CG significantly more often demonstrated uncertainty of movements, negative emotions (irritation, anger), mistakes of matching the thread nose with the buttonhole, irrational grasping of buttons with fingers, etc.

The tactile and kinesthetic sensitivity of the fingers was studied using the "Sea Pebbles" test. The child, with his eyes closed, was allowed to feel for 30 seconds a reference pebble, and then others were placed, including the reference one – he/she had to find it by feeling. The children from the experimental group had an advantage, 70.58% of cases were successful (the reference pebble was found) (P<0.05). In the control group, only 56.12% of cases were successful – while the progression was not statistically confirmed (P>0.05) Table 2.

The study of general hand praxis of the leading hand was carried out using the "Counting sticks" test - the child had to collect 20 standard counting sticks of the same colour, which were previously laid out by the teacher in the space of the gymnastic hoop, which was lying on the floor. Since the diameter of the hoop is approximately 50-55 cm, the amplitude of transferring the stick into a special box is quite large - therefore, almost the entire hand takes part in this movement: shoulder girdle, shoulder, forearm and wrist with fingers. Therefore, the test is dedicated to general manual praxis. The results revealed a noticeable difference: 73.28% of children from EG were able to collect counting sticks according to age norms - this progress was confirmed by mathematical statistics methods (P<0.05). In the CG, children demonstrated successful results in 52.44% of cases and this progress was not reliable (P>0.05). As for the qualitative parameters of movements, the children from the control group showed such typical

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symptoms of dyspraxia as a lack of purposefulness, uncertainty, mistakes of stick grasping, unnecessary additional movements while putting sticks into the box, etc.

Bimanual praxis was studied using the "Knots" test when the child had to quickly tie five tight knots on a 25 cm long string. In this test task, both hands participated, from their proximal parts to their distal parts - therefore, this test informs about the praxis possibilities of the upper extremities in general. In 70.65% of cases, children from the experimental group demonstrated fast and high-quality movements (P<0.05). In the control group, similar results were observed in 58.16% of cases and were not confirmed by the methods of mathematical statistics (P>0.05) Table 2. Thus, according to all manual praxis tests, children from the experimental group at the end of the pedagogical experiment had significantly better results than their peers from the control group, which further confirms the effectiveness of the proposed author's methodology.

Table 2.
The manual praxis formation of 3-5 years aged children with the 3rd level of general speech underdevelopment during the formative pedagogical experiment (n=48).

#	Criterion name	Control group (The average indicator) 3–5 year		P	Experimental group (The average indicator) 3–5 year		P
				t			t
		Before	After		Before	After	
1	Finger praxis poses according to the visual model	37.34%	43.25%	>0.05 1.845	38.02%	78.24%	<0.05 2.048
2	Finger praxis poses according to a kinesthetic model	48.22%	52.12%	>0.05 1.886	48.97%	72.34%	<0.05 2.041
3	Stringing balls on a rod ("Pyramid" test)	47.86%	54.22%	>0.05 1.892	47.10%	71.13%	<0.05 2.038
4	Stringing buttons on a string ("Big Buttons" test)	45.50%	49.88%	>0.05 1.880	46.73%	69.54%	<0.05 2.032
5	Tactile-kinesthetic sensitivity of the fingers ("Sea pebbles" test)	46.24%	52.97%	>0.05 1.891	46.79%	72.10%	<0.05 2.040
6	Collecting and assembling small objects ("Counting Sticks" test)	33.64%	37.05%	>0.05 1.824	34.70%	56.35%	<0.05 2.024
7	Tying knots on a cord ("Knots" test)	38.46%	45.66%	>0.05 1.853	39.78%	67.44%	<0.05 2.027

4. Discussion

The dynamics analysis of praxis capabilities, obtained during the formative experiment, already at the initial stage showed that with the help of the developed methodology, it was possible to significantly improve the children general praxis. This indicator occupies a fundamental place in the hierarchy of praxis types, which is why it can be considered as a root. When, with the help of the teacher, the child can improve both the quantitative and qualitative indicators of the main motor modes (basic movements), this should be considered as a successful preparatory stage of the entire hierarchy of praxis development, including speech praxis. In our opinion, the coordination system of all praxis types can be considered as a single integral mechanism, which has a common basis and which, according to M. O. Bernstein, in the process of the child's ontogenesis is improved by the supplementation of higher and

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more complex management levels. All of them create a single-level system of movement, both reflex and voluntary. Voluntary movements form the child's arsenal of praxis functions, which includes both articulatory movements and writing movements, which ensure oral and written speech in the process of their functioning.

In the context of the above, the positive results of the global coordination balance function on the spot ("Hoops" test), static ("Crane" test) and static-dynamic ("Well, turn around!" test) in the experimental group showed us a noticeable improvement of the first two levels of movements formation (levels A and B). They relate to the coordinates of the child's body, and his somatoagnosis in the static main motor mode of standing. The study of verbal training (children 4-9 years old) effect of visual attention styles Jurkat [32] and the developmental test of visual-motor integration Beery-Buktenica (Beery-VMI) Lim et al [33] should be considered interesting regarding hoops manipulation, but it touches the issues of our research obliquely.

The sufficient formation of these first levels allows the child in the process of his/her early ontogenesis gradually move to a higher level – level C, which corresponds to external space, i.e. different moves in the surrounding space. In our study, these were: walking on a straight rope 10 m long (test "On the path"), walking on the simulator "Rytmohid" (test "Rhythm walking"), mirror walking with your back to the front (test "Novice driver") and walking without visual control ("Blind Walking" test). The basis of these tests is the most convenient and widespread type of human movement - cyclic walking with the help of cross-lateral movements. The neural mechanisms of controlling such walking movements are old, and therefore the improvement of the dynamic balance results in combination with the general coordination of the trunk and limbs is perceived positively by us. Particularly important are the walking indicators results with mirror coordination (i.e. vice versa) and without visual control, which are based on the two previous levels of movement formation (levels A and B). The obtained data demonstrates a strong conditional chain of the first levels of movement formation (A–B–C), which reflect the improvement of the cerebral structure (from the internal space control to external space control). This positive impression from the conducted formative pedagogical experiment is strengthened by the results of high-speed climbing on a standard gymnastic ladder in combination with elements of manual subject-practical activity (knock down a pin from the top of the ladder with the elbow of the leading hand – "Monkey and Banana" test). In this case, we are talking about a more complex type of movement - climbing, which is performed vertically, against gravity.

The maximum result increase of the general coordination development in the static position ("Hoops" test) is 40%. This static level of general coordination should be considered basic for further practical superstructure of more subtle and complex motor actions of articulation and writing.

Analysis of manual praxis indicators also revealed interesting trends that confirmed our hypothetical expectations. The positive changes in the general praxis of the experimental groups affected more complex levels of praxis, in particular manual (bimanual and subject). At this level D of the movement construction, various manual manipulations with objects, and subject-practical actions begin to play a leading role. Studies of the obtained results of manual subject praxis only confirmed this. At the end of the formative pedagogical experiment, all indicators of manual subject praxis increased noticeably in parallel with positive changes in general praxis.

This was especially observed in subject manual praxis. First, we saw a noticeable progression in the activity of the leading limb of the child: in the Pyramid test, 60.28% of children from EG demonstrated results of successful manipulation with balls and a rod. A similar strong progress was made according to the results of the "Counting Sticks" test, according to which 73.28% of children from EG were at their best. This positive effect was strengthened by the results of the "Sea pebbles" test, which was used to examine the tactile-kinesthetic sensitivity of the leading hand fingers. In EG, 70.58% of children showed positive results. The tactile-kinesthetic sensitivity of the leading hand is the basis of the so-called micro-skill Twigger [34]. According to Twigger`s opinion, which he demonstrated in the example of drawing circles with a pen on paper, a successful result in this task can be achieved by using the following methodical techniques: hold the pen with your fingers higher (not near the tip); you need to draw a

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circle with your whole hand, not just your wrist; put your hand on the fist of the other hand and move both hands during the drawing (bimanuality of the general action); take the hand off the table and draw a circle with the entire upper limb, not just the wrist and hand. The researcher believes that the neurological reason for this phenomenon is that a much larger part of the brain will be stimulated in this way. Accordingly, such training will be absorbed more deeply and, in the long run, more effectively. In the context of this direction, Maldarelly et al [35] studied development of early handwriting, in particular, visual-motor control while copying a letter.

The bimanual coordination activity results were improved. In the "Big Buttons" and "Knots" tests, the results of successful actions at the end of the experiment were 57.22% and 70.65% for EG. It should be noted that an improvement of manual subject praxis of one hand may indicate a good morpho-functional state of the cerebral hemisphere opposite to the leading hand. We consider more significant the bimanual activity results, i.e. coordination activity of both hands, as they can testify to the effective neural relations of both large hemispheres of the brain. If we recall the three energy blocks of the brain according to O. Luria, then the successful bimanual activity of the child may indicate the effectiveness of the formation and functioning of the second functional brain block, which unites the neural formations of the occipital, parietal and temporal areas of the cortex. It can even be said that successful two-handed coordination activity is a kind of imprint of the successful activity of the corresponding brain formations.

McLeod et al [36] summarized the existing speech therapy practice regarding assessment, analysis, selection of goals, intervention and provision of services to children with speech sound disorders, but the problem of articulatory praxis was not considered by us in this article.

5. Conclusions

Summarizing the analysis of the obtained experimental results, we note that the formative pedagogical experiment conducted by us confirmed the reliability of author`s method effectiveness of the 3-5 old aged children speech correction with 3rd level of speech underdevelopment using adaptive physical education. In particular, this refers to a reliable improvement of general and manual praxis indicators in the specified category of children from the experimental groups ($P<0.05$), which should positively affect their further speech development. In control groups of children, improvement of general and manual practical functions was also observed, but it was not confirmed by mathematical methods ($P>0.05$).

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