

COGNITIVE DEVELOPMENT OF PRE-SCHOOL CHILDREN WITH LANGUAGE AND SPEECH DISORDERS



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Abstract

The modern educational situation in Russia shows that the number of children with developmental problems, including speech disorders in primary school is increasing. Therefore, primary education is beginning to focus on the problem of training and adaptation of the senior preschool children with speech disorders. The knowledge of cognitive development of preschool children with speech disorders will provide a theoretical basis for the creation of more effective corrective speech therapy programs taking into account the complex interactions of the higher mental functions of the child in the ontogeny which can contribute in overcoming the difficulties of preschool speech and the formation of a fully-fledged readiness for school. Language is an expression of human communication through which we can share ideas, information, emotions, and beliefs. Usually developing children learn the basics of language and speech in the toddler-preschool era. Language and speech skills serve a pivotal role in learning and social relationships. Delays in the early development of language and speech skills, which are prevalent in the population, may affect several fields of activity. The purpose of the study is to identify the characteristics of cognitive development of senior preschool children with phonetic-phonemic and general underdevelopment of speech. The factor analysis has shown that senior preschool children with speech disorders are characterized by cognitive development and intellectual readiness.

Keywords: Cognitive development, speech disorder, preschool children

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1. Introduction

Developing age-appropriate educational programs to support the intellectual development of children resulting from the reorganization of the preschool education system is fraught with problems. In order to solve these problems it is necessary to comprehend the intellectual development of senior preschool children by analyzing the principles of child psychology, as well as current local and international psychological research on the intellectual development of children.

The Soviet Union school of psychology was based on the same methodology, which was heavily influenced by the Bolshevik revolutions and Lenin's ideas:

1. Stages of cognitive development as a result of activity (Anan'ev, 2000; Leontyev, 1978; Elkonin, 1972; Vygotsky, 1978);
2. Law of "interiorization" and "zone of proximal development" (Vygotsky, 2000; Elkonin, 1972);
3. The variation of activities and learning strategies (Davydov, 1992; Galperin, 1978; Popov, 2002);
4. The role of individual differences in intellectual development and training activities (Averin, 2000; Ushakova, 2015).

Development can be described as a series of processes; of initiation and improvement of these internal means of activities, of overcoming internal obstacles at implementation of activities, expansion of the boundaries of actual and proximal development zones, assigning the ways of the joint activity by a child (interiorization), as a simultaneous movement in different directions, described by the multi-vector model of zone of proximal development, leading to an appearance of new vectors, to qualitative changes of the state of vectors and the interrelationships between them (Vygotsky, 2000).

Intellectual development was understood as a continuous dynamic process by most Soviet and post-Soviet authors. Different authors identified various aspects of intellectual development, indicated the quantity and quality of its structure, found features of mental activity (operations and mental actions), and different forms of thought (Galperin, 1978; Davydov, 1992; Volkov & Volkova, 1998; Zhukova, Mastiyukova, & Filicheva, 1998). The Russian psychologists are guided by the principles of the system and structural-genetic approaches to the study of children's intellectual development (Garber, 2013). They do not oppose education and intellectual development, general and special abilities, biological and social conditions of intellectual development (Kolomna & Panko, 1997).

Social interactions define the mechanism of distribution of functions on the one hand and the means or method of mastering those functions on the other hand (Vygotsky, 1987;

Vygotsky, 1988). Thus, for example, guided social interactions, which initially serve as instruments for social realization of the processes of cognition and communication later, begin to play the role of the cognitive function of self-regulation and mental representation of various kinds of information. These social interactions activate the yet to be developed cognitive functions, which allow the child to act on a higher cognitive level. The gap between that which a learner is able to do on his/her own (the actual level of development) and that which he/she is capable of doing with proper guidance is called “zone of proximal development”. Therewith, according to Vygotsky (Cole, 1996; Daniels, 2008; Daniels, 2010), learning is successful only when it goes ahead of development, when it awakens and brings to life those functions, which are in the process of maturing or are in the zone of proximal development. According to his views, this is the way by which education plays a crucial role in development.

Currently, it is revealed that children’s intellectual development depends on brain structures and specially organized challenging activities. Education is a leading factor in the intellectual development of children. There are also some basic directions in the study of children’s intellectual development in the Western psychological school. One direction is characterized by examining the child’s cognitive development as a result of the natural maturation of the nervous system and the whole organism (Martsinkovskaya, 2011). Other directions of research into children’s intellectual development process are related with the social environment (Hedegaard, 2012; Sannino, 2015).

There are two opposite tendencies in the scientific interpretation of concepts and structures of intelligence. The first comes from an understanding of intelligence as a single overall child-learning ability (Jensen, 1994); the second is based on an understanding of intelligence as a combination of many individual, relatively independent abilities (Guilford, 1982; Cattell, 1987).

Further development of ideas about the nature of intelligence in foreign psychology was associated with justification. On the one hand, intelligence is integral, on the other hand, it has a multiplicity of manifestations. Thus, Cattell (1987) identified two aspects of intellect: one was the peculiarities of the structure and functioning of the brain (the main function is fast and accurate processing of current information), the other was the influence of the environment (the main function is the accumulation and organization of knowledge and skills).

According to Piaget (1974), intelligence development occurs during the child practice with a variety of items. External material actions of the child are initially transferred into the internal plan through repetition in different situations, actions and schematized using symbolic tools (simulation, game, speech, and others). According to Wadsworth (1996) Piaget’s theory

determines the balance as a stable state of an open system. From the dynamic point of view, balance is characterized by the mechanism that provides the basic function of mental activity.

The process of development of the intellect consists of three large periods during which there is the emergence and formation of three major intellectual structures: sensor motor (system of reversible practical action), structures of specific operations (system operations performed in the mind, but with reliance on external visual data) and structures of formal operations (formal logic, hypothetical-deductive reasoning and inference). Syncretism is one of Piaget's (1974) basic concepts which is included in Child Psychology. He believed this phenomenon was one of the most characteristic features of the child's psyche, saying that until 7-8 years syncretism permeates their thought as purely verbal, and aimed at direct observation. Piaget also described the interrelated forms or manifestations of children's undifferentiated physical and mental judgments. He called one of these forms realism.

According to Vygotsky (1987) the cultural-historical theory of the specificity of a child's development relates to a social and historical basis. The main mechanism of a child's intellectual development is associated with the formation in their mind of verbal meanings (generalizations), the restructuring of which characterizes the direction of the growth of their intellectual capacities. The primary development process of a child's concepts development depends on changes in the generalization of the word. Vygotsky (1978) believed that intellectual development is characterized by the level of development of individual mental processes and also by cross-functional relationships and their changes. Each period of intellectual development is inherent in the structure of specific mental processes. According to Vygotsky (2000), higher mental functions such as perception and memory intensively develop during preschool age.

Language is an expression of human communication through which we can share ideas, information, emotions, and beliefs. Usually developing children learn the basics of language and speech in the toddler-preschool era. Language and speech skills serve a pivotal role in learning and forming social relationships. Delays in the early development of language and speech skills, which are prevalent in the population, may affect several fields of activity (Alexandrov, 2013; Butusova, 2012; Ushakova, 2015).

A speech disorder in children is characterised by difficulties in pronouncing certain sounds in words. This can make their speech difficult to understand. Children with a speech disorder may have language skills, which are otherwise good (Kozyreva, 2016). That is, they understand words and sentences well and can correctly formulate sentences (Konovalenko, 2012). Speech and language disorders in children include a variety of conditions that disrupt children's ability to communicate. Severe speech and language disorders are particularly

serious, preventing or impeding children's participation in family and community, school achievement, and eventual employment. Speech sound disorders is an umbrella term referring to any combination of difficulties with perception, motor production, and/or the phonological representation of speech sounds and speech segments (including phonotactic rules that which determine the form, structure and stress of syllable, as well as prosody) that affect the legibility of speech (Nishcheva, 2014).

Known causes of speech sound disorders include motor-based disorders (apraxia and dysarthria), structurally based disorders and conditions (e.g., cleft palate and other craniofacial anomalies), syndromes/condition related with a disorder (e.g., Down syndrome and metabolic conditions, such as galactosemia), and sensory-based conditions (e.g., hearing impairment).

Speech sound disorders can impact the form of speech sounds or the function of speech sounds within a language. Disorders that impact the form of speech sounds are traditionally referred to as articulation disorders and are associated with structural (e.g., cleft palate) and motor-based difficulties (e.g., apraxia). Speech sound disorders that impact the way speech sounds (phonemes) function within a language are traditionally referred to as phonological disorders; they result from impairments in the phonological representation of speech sounds and speech segments — the system that generates and uses phonemes and phoneme rules and patterns within the context of spoken language. The process of perceiving and manipulating speech sounds is essential for developing these phonological representations (Khanin, 2012).

Dysarthria is a speech sound disorder caused by medical conditions that impair the muscles or nerves that activate the oral mechanism (Caruso & Strand, 1999). Dysarthric speech may be difficult to understand as a result of speech movements that are weak, imprecise, or produced at abnormally slow or rapid rates (Morgan & Vogel, 2008). Neuromuscular conditions, including stroke, infections (e.g., polio, meningitis), cerebral palsy, and trauma, can cause dysarthria. Another rare speech sound disorder, childhood apraxia of speech, is caused by difficulty with planning and programming speech movements. Children with this disorder may be delayed in learning the speech sounds expected for their age, or they may be physically capable of producing speech sounds but fail to produce the same sounds correctly when attempting to use them in words, phrases, or sentences (Reutskaya, 2013).

Evidence suggests that speech sound disorders affect more boys than girls (Eadie et al., 2015), particularly in early life. In preschoolers, the ratio of affected boys to girls is 2 or 3:1, declining by age 6 to 1.2:1 (Pennington and Bishop, 2009). Although many children with speech sound disorders as preschoolers will progress into the normal range by the time of school entry, the close ties between spoken and written language have motivated many studies

of the extent to which speech sound disorders are associated with an increased risk of reading, writing, or spelling disorders.

According to the structural and integrative approach intellectual development indicator is the level of differentiation of cognitive structures as carriers of intelligence. Thus, the psychological and pedagogical sciences have decided to allocate one of the main conditions for speech and intellectual development training. Language and communicative competence provide critical tools for learning, engaging in social relationships, and behavior and emotion regulation from infancy onward. Communication and normal psychological development at a preschool age depends on toddlers' opportunity to speak and verbalize their thoughts.

2. Problem statement

The problem of this study relates to the training and adaptation of older preschool children with speech disorders to education in primary school. Without additional training for preschool children with speech disorders, they will not be able to comprehend the primary school curriculum. They will not be able to meet the requirements set by the school for the child, which can result in the education of the child being carried out in the school for children with special needs (understated educational standard), or cause a low learning motivation, low self-esteem of the child, leading to negative consequences in the child's emotional and personal development. Statistics show that the number of children with disabilities of speech development is increasing - the problem of adaptation and training of children with speech disorders to the school has not been solved yet, while insufficient empirical and theoretical material has been accumulated to solve this problem. The following questions remain open: timely assistance to such children, and methods of teaching these children. That is why, in preparation for school education, it is necessary to identify the specific features of the cognitive development of preschool children with speech disorders in order to develop a comprehensive school preparation program that will help them overcome their speech difficulties, based on the stored or age-appropriate cognitive functions.

3. Research Questions

The hypothesis of the study is that the cognitive development of preschool children with a variety of speech disorders is characterized by certain specific features in comparison with their peers with normal speech development.

4. Purpose of the Study

The purpose of this study is to investigate the cognitive development of preschool children with speech sound disorders.

5. Research methods

The research methods, which were used in our work, are shown in the Table 1.

5.1. Participants' characteristics

Children from a kindergarten in Samara, Russia (30 children in total) participated in the study. It was a typical kindergarten catering to two groups with a special program for children with speech disorders (i.e. more hours of speech development per week, less children in the group). 15 children with different speech and sound disorders were in the speech therapy groups. 8 children with phonetic-phonemic speech underdevelopment and 7 children with general speech underdevelopment were in the experimental group. 15 children of the non-specialized group without speech disorders were used as the control group. The selected kindergarten is located in the socially safe area of Samara; most of the parents of the children are gainfully employed, with an average income level. For the purpose of this study, the living conditions of children, the social status of parents, and the similarity in the overall living conditions of children were taken into account. The average age of participants was 6 years.

Table 1. Methods of research

General characteristics of methods	Structure of methods	Diagnosable indices
Method of rapid diagnosis of children's intellectual abilities aged 6-7 years		
This provides indicative information about the ability to learn in primary school and an individual structure of children's intelligence. It is an original design based on world-famous international intelligence tests.	I subtest	Total awareness, vocabulary
	II subtest	Understanding the qualitative and quantitative relationship
	III subtest	The level of logical thinking development
	IV subtest	Mathematical abilities
	an integral component of intellectual abilities	The overall level of intellectual abilities
Pictured Vocabulary Test		
The test is aimed at diagnosing the intellectual component of school maturity and to measure child verbal abilities. The test was adapted from the well-known famous American test "Phonic Key Card".		the level of higher mental functions development, including the orientation to outside world, awareness, vocabulary, visual perception, the dictionary resourcefulness

Screening test of school maturity		
The test is adapted from "Indicative test of school maturity" of Jirásek (Jirasek, 1978; Gutkina, 2000). It assesses the level of children's general mental development and their school maturity	Non-verbal subtest comprises three tasks: 1. Drawing a male figure on the proposal; 2. Imitation of a handwritten letter; 3. To copy a group of points.	Child's psychomotor development, development of motor skills and hand motor coordination. The ability to reproduce pre-schooler level of writing of letters and geometric shapes indicating the general level of child's intellectual development
	Verbal subtest contains twenty questions	The overall level of thinking, awareness about the world

5.2. Research Design

The purpose of the study was to compare the cognitive development of children of the same age with speech disorders and those without speech disorders and to disclose the resources of cognitive development of children with speech disorders or with deficiencies of speech development in comparison with children without speech disorders. Next, we compared the cognitive development of children with phonetic-phonemic speech underdevelopment and with general speech underdevelopment.

5.3. Data analysis

The results were processed using SPSS 21.0 in order to identify differences between experimental and control groups.

6. Findings and Discussion

Statistical analysis of the test of rapid diagnosis of children's intellectual abilities detected significant differences between the two groups using the U-Mann-Whitney criteria. All values of the Mann-Whitney test are shown in Tables 2 to 4. Firstly, one difference was revealed at the implementation of IV subtest, which aims to identify mathematical abilities. The average (by groups) score of those who performed this subtest showed that the control groups' score was almost three times higher than that of the experimental group (2.1 points and 0.73 points, respectively). Secondly, the general indicator of the value of intellectual abilities was different for both groups. The average value in the control group was more than 1.5 times higher than in the experimental group.

Table 2. Statistical analysis of children’s intellectual abilities between two groups

	Subtest 1 "General awareness, vocabulary"	Subtest 2 Understanding the qualitative and quantitative relationship	Subtest 3 The level of logical thinking development	Subtest 4 Mathematical abilities	The overall level of intellectual abilities
Method of rapid diagnosis of children’s intellectual abilities age of 6-7 years					
	70.500	71.700	74.000	31.000	39.000
Mann-Whitney-U	.059	.062	.065	.001**	.001**
	Not significant	Not significant	Not significant	p<0.001	p<0.001

The results show significant differences between the control and experimental groups in mathematical abilities and IQ level. The composition of the experimental group on the severity of speech disorders appeared heterogeneous: the group included children with phonetic and phonemic speech underdevelopment and the general underdevelopment of speech. In connection with this, an analysis of intra-performance subtests of rapid diagnosis of children’s intellectual abilities in the experimental group was carried out.

Table 3. Statistical analysis of children’s intellectual abilities between groups with two different speech disorders

	Subtest 1 "General awareness, vocabulary"	Subtest 2 Understanding the qualitative and quantitative relationship	Subtest 3 The level of logical thinking development	Subtest 4 Mathematical abilities	The overall level of intellectual abilities
Method of rapid diagnosis of children’s intellectual abilities age of 6-7 years					
	11.000	26.000	15.500	28.000	6.500
Mann-Whitney-U	.034	.782	.101	1.000	.009
	p<0.05	Not significant	Not significant	Not significant	p<0.01

Analysis of the data presented in Table 2 shows that there are several significant differences in subtests’ performance between the experimental group with the sound speech disorders and general underdevelopment of speech. The tests revealed significant differences in the performance of preschool children with speech sound disorders in first subtest ($p < 0.05$).

Children with speech sound disorders perform better with subtests of general awareness and vocabulary than children with general underdevelopment of speech.

Table 4. Statistical analysis of results of Pictured Vocabulary Test and Screening test of school maturity between experimental and control groups

	Pictured Vocabulary Test	Verbal subtest of Screening test of school maturity	Non-verbal subtest of Screening test of school maturity
	22.500	42.000	28.500
Mann-Whitney-U	.001**	.003**	.001**
	p<0.001	p<0.01	p<0.001

Analysis of Pictured Vocabulary Tests' and Screening tests' data revealed significant differences between experimental and control groups. The results of the preschool children with normal speech development (control group) was significantly higher ($p<0.001$) than the subjects of the experimental group (with speech disorders).

In addition, differences were detected between levels of performance of the different methods. A comparative analysis of the data presented in Table 5 shows the particular intellectual development of children with speech disorders. More than half of the preschool children with speech disorders (53%) revealed a low level of intellectual abilities (based on the total index Method of rapid diagnosis of children's intellectual abilities aged 6-7 years).

Table 5. Comparative analysis of groups' performance under the different methods

Levels	Low	Middle low	Middle	Above middle	High	Method
Experimental group	53%	47%	-	-	-	Method of rapid diagnosis of children's intellectual abilities age of 6-7 years
Control group	-	20%	67%	-	13%	
Experimental group	-	60%	40%	-	-	Pictured Vocabulary Test
Control group	-	13%	60%	20%	7%	
Experimental group	20%	53%	27%	-	-	Non-verbal subtest of Screening test of school maturity
Control group	-	40%	60%	-	-	
Experimental group	-	60%	40%	-	-	Verbal subtest of Screening test of school maturity
Control group	-	20%	53%	20%	7%	

The process of verbal designation as a transition from non-verbal to verbal content carried out among the majority of preschool children with speech disorders was below average. Backlog psychomotor (including hand-eye coordination) was detected in the majority of children with speech disorders (73%). Psychomotor development (including hand-eye coordination) is underdeveloped in the majority of children (73%) with speech disorders.

Overall, the number of preschool children with speech disorders was significantly lower than that of children with normal speech development (based on all the methods included in this study). There are differences in intellectual abilities in preschool children with various speech disorders. No significant differences were found between the experimental and control groups in terms of detection of logical thinking.

Table 6 shows the factor loadings matrix. After rotation two new factors were found. As shown in Table 6, these collectively explained 72.84% of the total variance, which is a good result.

Table 6. Results of Varimax rotation

Name of Test	Component 1	Component 2
Subtest 1 "General awareness, vocabulary"	-.025	.927
Subtest 2 Understanding the qualitative and quantitative relationship	.841	-.099
Subtest 3 The level of logical thinking development	.762	.078
Subtest 4 Mathematical abilities	.432	.586
Pictured Vocabulary Test	.874	.343
Non-verbal subtest of Screening test of school maturity	.726	.419
Verbal subtest of Screening test of school maturity	.799	.429

The first factor is the most informative (48.61%). It is associated primarily with the subtest measuring "Understanding of quantitative and qualitative relations" and indicator of Pictured Vocabulary Test. This indicates that one of the most important components of intellectual readiness for school of children with speech disorders is their understanding of the quantitative and qualitative relationships, which may compensate their speech development.

Thus, the first factor described as an intelligence component is school readiness. The second factor is the information content (24.23%) that is determined by the first subtest "Total awareness, vocabulary." It should be noted that this figure is almost not related to other indicators in the second factor. Perhaps this is due to the peculiarities of children's speech development when intellectual and verbal readiness for school disharmony suffers in development.

7. Conclusion and Implications

The following conclusions can be drawn from this research:

1. There are some differences in the intellectual abilities of preschool children with various speech disorders: general awareness and vocabulary are better formed in children with phonetic and phonemic speech underdevelopment.
2. The development of intellectual abilities of children with speech disorders is below the average level of their peers with normal speech.
3. The process of verbal designation as a transition from non-verbal to verbal content is lower in preschool children with speech disorders than in normally developing children.
4. The development of visual-motor coordination lags in children with speech disorders.
5. The factor analysis revealed that senior preschool children with speech disorders are characterized by cognitive development and intellectual readiness for school that consists of two factors: understanding of the quantitative and qualitative relationships as an essential component of intellectual readiness for school as well as general awareness and vocabulary.

Children with speech disorders also suffer from impaired cognitive development, which must be taken into account when developing comprehensive programs for preparing these children for school. It is not enough to develop the speech of children with the corresponding violations, it is necessary to pay attention to formation of cognitive functions, verbal designation of objects, visual-motor coordination of movements, and harmony in the development of cognitive functions, all of which would allow them to enjoy success in their studies in primary school. It is also necessary to differentiate the preparation of children with speech disorders for school. Namely, when working with children with general speech underdevelopment, special attention should be paid to the development of vocabulary and general awareness, while for children with phonetic-phonemic speech underdevelopment, attention should be paid to the harmony of the development of cognitive functions.

As mentioned earlier, language and speech skills serve a pivotal role in learning and social relationships. Delays in the early development of language and speech skills, which are prevalent in the Russian preschooler population may affect several fields of activity leading to the academic failure of the affected children which in turn would ruin these children's potential for future success. This study was undertaken as part of a concerted effort to redress the shortcomings in early detection and provision of remedial training for children with speech sound disorders.

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