Digitalization as a Tool for the Speech Development of Older Preschool Children with Autistic Disorders

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Abstract: - Autism is a neurological condition characterized by long-term and serious difficulties in communication and social interaction, so innovative methods are being sought worldwide to influence language development in such children. The study aims to study the influence of digitalization on the development of speech of senior preschool children with autistic disorders. Research methods: we examined 68 children of senior preschool age with autistic disorders (5 to 7 years old), of whom 38 were girls (55.9%) and 30 boys (44.1%). The child's speech development was carried out using specialized mobile software applications for 6 months for 1.5 hours a day. Results: the use of mobile software applications did not lead to the improvement of receptive speech in children with autistic disorders. In contrast, the percentage of children with expressive speech decreased: 19 (27.9%) vs 23 (33.8%), speech deficit - 28 (41.2%) vs. 35 (51.5%); the percentage of children with communicative speech increased - 39 (57.4%) vs. 30 (44.1%). Conclusions. It has been established that it is necessary to apply digitalization in speech development and to study its impact on senior preschool children with autistic disorders. Prospects for further research are to study the effectiveness of digitalization in senior preschool children depending on the level of the autism spectrum.

Key-Words: - children, preschool age, autistic disorders, digitalization, speech development, specialized mobile applications.

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1 Introduction

Autism is a pervasive, complex neurodevelopmental disorder that arises from genetic variations. Despite the rapidly increasing number of children with autism, there is no fundamental evidence on the etiology, risk factors, and progression of the disease, [1]. The early stages of these disorders are characterized by a social communication deficit and repetitive stereotypes of behavior, [2]. So, the early diagnostics of the two spheres of functioning and behavior is used in the diagnostics of autism. Regarding language development, 30% of children with autism do not acquire functional speech, [3], many children have language deficits even when spoken language is acquired.

Older preschool children with autism who have insufficiently developed language face problems throughout their lives. Language impairment is a common problem, therefore finding ways to develop language problems through digitization can benefit such children, [2].

Problems with pragmatics — understanding metaphors — are related to the state of language development in children with autism, such as vocabulary, and grammar, [4]. The analysis of modern scientific research confirms the fact that the difference between older preschool children with autism and speech disorders and healthy children of the same age with speech disorders is the degree of language deficit, not the degree of autism, [2].

An analysis of the world's scientific works in this field has shown insufficient literature on digitalization, specifically for older preschool children with autism. In contrast, several scientific works describe the results of using digital applications in children with autism at an early age quite exhaustively.

2 Literature Review

Autism is a neurodevelopmental disorder characterized by delays or differences in the development of social communication skills, as well as repetitions in behavior and problems with language development. Autism can be definitively diagnosed when the child is 3 years old; however, there are cases where the average age of this diagnosis will start from 4 years, [5].

Today, it has been proven that oral language is a multifaceted system that includes vocabulary (semantics), grammar (syntax and morphology), and discourse (pragmatics), which is processed in both expressive and receptive domains. Language's receptive and expressive domains go hand in hand during a child's development. At the same time, language comprehension develops somewhat earlier than expressive skills, [6]. Vocabulary development is the main component of language development. Therefore, indicators of expressive and receptive vocabulary and oral skills (morphology, word formation, syntax, narrative, and discourse development) are determined when diagnosing children with developmental disorders, [2].

According to [2] and [7], it is important to note that language trajectories for children with neurodevelopmental disorders are complex, and there is little or substantial variation in language acquisition both within and between diagnostic groups. Moreover, many studies show that these children may have deficits in various subcomponents of language, which requires assessment of subcomponents of oral language, [8].

Nowadays, researchers pay special attention to the development of new methods of restoring speech disorders in children with autistic disorders. One such method is Play and Language for Autistic Youngsters (PLAY), which is parent-mediated, developmental, and focused on social reciprocity. PLAY consultants conduct monthly 3-hour home visits; a 15-minute video of representative play interactions is recorded and analyzed, this analysis includes a written PLAY Plan that describes methods, techniques, and activities that promote the development of parents' interaction and play skills to promote the functional development of children with autistic disorders, [9], [10].

A randomized controlled study, [9], evaluated the PLAY program, a parent-mediated intervention model that uses a relationship-based approach, for young children aged 3 to 5 years with ASD. Treatment outcomes were demonstrated after 12 months of intervention: on the PLAY Mother/Father Behaviour Rating Scale, the parents significantly improved their ability to respond empathetically and effectively engage their child. On the PLAY Child Behaviour Rating Scale, children's interaction skills at home improved due to increased joint attention and initiative. Furthermore, PLAY children's social-emotional development improved significantly as measured by the Functional Emotional Rating Scale. Autism symptoms, as measured by the Autism Diagnostic Observation Schedule-Generic (ADOS-G), also significantly improved in PLAY children by more than twofold.

Most studies were conducted in children with language disorders and children with autism. The effectiveness of the application of digitization to oral language development in these children was similar, showing a moderate effect on alleviating language problems after testing. Some authors

indicate a positive and statistically significant effect after an average of 6 months of using tele- and video applications, [2].

Regarding moderator analyses, receptive vocabulary and omnibus receptive tests showed smaller effect sizes compared to expressive vocabulary, expressive language, and omnibus measures of expressiveness, in view of previous studies on these types of language interventions, [11]. As a rule, training has a greater effect on expressive measures than on receptive measures, [12], [13]. So, these kinds of interventions do not seem to be able to improve language construction itself, but only its aspects. However, this does not mean that improvement is priceless, expressive language is important, and improving it can have positive consequences, for example, in the classroom or in society. It also indicates that the improvement may reflect that children receiving teleintervention are becoming less cautious and shy and are better able to use their existing language in a social environment. Most children with autistic disorders need continuous and long-term support. Therefore, it should be noted that the long-lasting effects of teleinterventions, characteristic of most of these studies, are insufficient to solve the child's speech problems. Preschool communication therapy for autism is the only intervention in the field that has demonstrated sustained effects on autism symptoms. The therapy is based on theoretical studies of autistic development and aims to get parents to recognize their child's social communication differences and create an environment that gives the child space and time to communicate at their own pace. This intervention uses video feedback techniques to work with parents to improve their understanding and responsiveness to their autistic child's atypical communication, [14], [15].

The amount of time children spend in social interactions is positively related to their social communication and language development, [16], [17]. This is because children's capacity for social engagement facilitates their ability to associate behavior, experiences, or words with meaning and develop social interaction skills, [18], [19].

Children with autism often struggle with imaginative play, theory of mind, and acting out different scenarios in their minds, [20]. Researchers in [17], found that preschoolers with autism were more likely than their peers to spend more time looking at objects and less time engaging with partners in a game. Autistic children also tend to engage and initiate joint attention less often than their peers. Given the differences in social interaction patterns and the relationship between social activity and oral language development, research has found that preschool children with autism produce fewer verbal utterances than typically developing peers, [21]. As children's early speech is closely correlated with social well-being, it is necessary to apply all possible means of language development for autistic children.

Although impairments in aspects of communication are considered one of the main deficits of children with autistic disorders, this problem is actively studied, but there is still little literature on the structural aspects of language acquisition in such children, including lexicon/semantics, morphology, and syntax, [21]. There is considerable variation in language skills among children with autism, for example, some children with autistic disorders with Asperger's syndrome do not show any language delays, while about 25% of all children with only autistic disorders may never develop any functional language, [19].

The aim of the research is to study the influence of digitalization on the speech development of older preschool children with autistic disorders.

Research objectives:

- Identify the peculiarities of the level of ASD in older preschool children;
- Determine the deficit of language development in older preschool children;
- Measure the impact of digitization on the speech development of older preschool children with autistic disorders.

3 Materials and Methods

Autistic speech disorders in older preschool children were previously established by relevant specialists using the Checklist for Autism Spectrum Disorder (CASD), and Autism Diagnostic Interview-Revised (ADI-R).

According to the autistic spectrum, older preschool children correspond to the following levels:

- mild (n=38) — children who are characterized by non-standard and spontaneous behavior, shy, difficult to make contact, do not show initiative when communicating with other children, and have difficulties with a concentration of attention;
- moderate (n=24) — children with complex behavior, but show enthusiasm for the chosen subject, with the pronunciation of an encyclopedic vocabulary during conversation;

- severe (n=6) – children with strict restrictions in the behavior pattern, with periodic bouts of aggression and breakdowns, open enough, with simple speech, repeating the same or similar sound combinations regardless of language norms; can reproduce household skills.

Speech therapy diagnostics included research on the child's understanding of language, auditory attention, and phonemic perception, which determined the vocabulary volume, perception of the emotional meaning of the language, and readiness to develop the language system. The basic level of speech development in older preschool children with autistic disorders was determined according to the following indicators: intelligible and expressive speech, language deficit, sociability, small vocabulary, and difficulty in expressing words. A wide range of speech disorders was observed in older preschool children with autistic disorders: mutism manifested by refusal to speak when this function was possible; dysarthria — speech disorder; apraxia — inability to make general and/or speech movements.

Statistical analyses of the obtained data were carried out using Statistica 6.1 application software. Descriptive group differences between the baseline level and the level after the mobile software application were examined using χ^2 analysis for categorical variables.

The study involved 68 older preschool children with autistic disorders from 5 to 7 years of age: 38 girls (55.9%) and 30 boys (44.1%).

Inclusion criteria are children of older preschool age with autistic disorders and developmental language disorders. Exclusion criteria are children of younger, school, and older age with autistic disorders with developmental language disorders and children without autistic disorders with language development disorders.

After establishing the level of speech development in children, their parents were offered the use of specialized software mobile applications such as Quick Talk and DyvoGra for mobile phones and tablets for 6 months ≥100 min/day, after which the child was re-observed. Quick Talk promotes non-verbal communication of children with autistic disorders by touching buttons that turn words into speech. This application can be personalized with unique words, icons, and settings, as well as help with simple and complex choices, and yes/no questions. Options for pictures or words are included for different levels of literacy. The DyvoGra application is designed for speech development in older preschool children with autistic disorders and language, speech, and/or communication disorders.

The study was conducted in accordance with the Ethical Principles for Medical Scientific Research Involving Human Subjects, the Universal Declaration on Bioethics and Human Rights, and the principles of the Helsinki Declaration, and was approved by the local commission. All children's parents gave informed written consent.

The material was analyzed using descriptive statistics using the Statistica 6.1 application software.

4 Results

Based on the results of specialized psychological diagnostics of child development in 68 older preschool children involved in the study, the level of ASD was established in the form of mild — in 38 (55.9), moderate — in 24 (35.3), severe — 6 (8.8%) (Table 1). Table 1 presents the distribution of older preschool children with ASD by age and gender, as well as the percentage of the indicator of the relationship between parents and children.

Table 1. Features and Level of the ASD in Older Preschool Children and Parents' Status

Indicator	Q-ty, n (%)
ASD level	
Mild	38 (55.9)
Moderate	24 (35.3)
Severe	6 (8.8)
Child's age	
5 years	18 (26.5)
6 years	23 (33.8)
7 years	27 (39.7)
Sex	
Boys	30 (44.1)
Girls	38 (55.9)
Relations with a child	
Mother	60 (88.2)
Father	8 (11.8)
Parents' education	
Higher	21 (30.9)
Secondary	47 (69.1)

The following speech disorders were found in the examined children with autistic disorders (Figure 1).

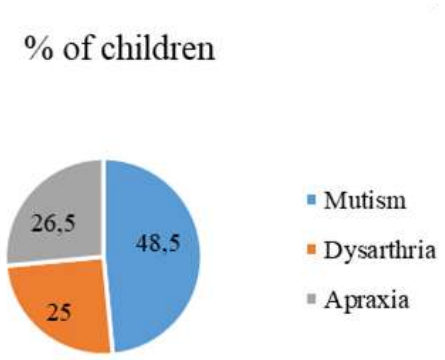

Fig. 1: Distribution of Speech Disorders in Older Preschool Children with ASD

When surveying parents (ADI-R questionnaire), specialists found that mothers (88.2%) pay more attention to coordinating and controlling the use of mobile applications by children (88.2%) than fathers (11.8%). Mothers were responsible for the recommendations of specialists and the provided programs for the correction of speech disorders in older preschool children with ASD. In the course of the work, the dependence between responsible/irresponsible control and the use of mobile applications by children on the education of both parents was not established, they were responsible for the recommendations of specialists.

According to the results of the study, there was no improvement in the receptive language indicator in those children who used specialized mobile applications for 6 months (Table 2). The percentage of children after using specialized mobile applications decreased: with expressive language 23 (33.8%) versus 19 (27.9%), language deficit — 35 (51.5%) versus 28 (41.2%). The percentage of children with communicative language increased — 30 (44.1%) versus 39 (57.4%), respectively.

Table 2. The Impact of Digital Technologies on Speech Development Indicators of Older Preschool Children with ASD

Indicators	Baseline level, n, (%)	After the use of specialized mobile applications n, (%)
Receptive language	10 (14.7)	10 (14.7)
Expressive language	23 (33.8)	19 (27.9)
Language deficit	35 (51.5)	28 (41.2)
Communicability	30 (44.1)	39 (57.4)
Small vocabulary	38 (55.9)	35 (51.5)
Difficulty with expressing words	33 (48.5)	33 (48.5)

The study confirmed the previously reported positive effects of video and television on expressive language but also revealed previously unspecified effects on some subjects in children with ASD. The relationship between receptive and expressive language suggests that passive digitization is not a consequence of socio-economic status. Spending a significant amount of time passively watching videos, children are deprived of the active mental stimulation that reading and recursive conversations with educators would provide, which are necessary for language development.

5 Discussion

It has been proven that the quality of life of children with autism is significantly lower than that of children without autism. Therefore, it is important to consider the factors that contribute to the difficulties these children have in communicating with others. Interventions for children with autism should focus on emotional regulation, sensory processing, and behavioral and social skills. In addition, it is necessary to help develop the basic processes that can facilitate their active participation in home life, friendships, education, and leisure, [22].

Early intensive interventions improve child development outcomes. The prognosis improves when children initially demonstrate functional play abilities, higher cognitive abilities, and less initial severity. Furthermore, with few exceptions, behavioral research on children with autism has largely focused on language and cognitive abilities as primary outcomes, [9], [23].

The impact of digitalization as a means of speech development in older preschool children with ASD is a matter of controversy. Some researchers support the benefits of mobile applications and television learning for autistic children, [24]. Others they emphasize that such digital applications may lead to the negative effects of screen exposure in children with neurological disorders, [25], [26]. It was shown that television and computer technologies are beneficial for children with autistic disorders due to increased vocabulary, but the impact of digitalization on the understanding of complex language, for example, still remains unclear.

Our research recorded no improvement in receptive language in older preschool children with ASD, which may be related to a small statistical sample and the period of use of mobile applications. However, we observed a positive trend regarding the following indicators: expressive language,

language deficit, and communicability, which is consistent with the results obtained by other researchers, [2], [27].

Helping autistic children involves interventions aimed at language skills development. They should use techniques ranging from explicit and structured activities (teaching vocabulary, story structure or grammar rules) to implicit and extensive activities (reading books together, general language stimulation), [2].

Social aspects, such as accessible materials and play environments, influence children's social interaction and language use, [28], [29]. This should be taken into account by professionals working with children with autism and language disorders. Assessing and supporting parental interaction with such children is of great importance. Adapting to the environment is a key strategy to support sociopragmatic development and naturalistic interventions aimed at behavioral development, [30].

6 Conclusions

The issue of improving speech development in older preschool children, especially with the use of mobile applications, is relevant because most children with ASD actively show interest in smart gadgets. One of the important factors to consider when providing support to preschool children with ASD is the play environment, particularly digital materials (mobile phones, tablets) that are available in the form of a game.

A significant correlation between receptive and expressive language was found, which indicates that passive digitalization is necessary to improve the indicators of speech disorders in children with autism.

After the use of specialized mobile applications Quick Talk and DyvoGra for mobile phones and tablets, positive dynamics were observed among such indicators of speech development as expressive speech, speech deficit, and communicability, indicating the continuation of studying their impact on indicators of speech development and their application. The positive impact of digitalization in the form of specialized mobile applications as a means of speech development in older preschool children with ASD is shown.

Research prospects may be a study of the effectiveness of digitalization in the form of specialized mobile applications, video, and television in older preschool children with ASD, depending on the level of the autistic spectrum.

6.1 Research Limitations

It was impossible to conduct these studies in a group of children who have the most profound and complex ASD. It is recommended to use digitalization in the form of mobile and tablet applications in the development of speech in older preschool children with ASD.

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