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Scientific and Theoretical Foundations of The Differential Approach to Enhancing Auditory and Speech Activity in Children with Cochlear Implants

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Abstract: This article analyzes the scientific and theoretical foundations of a differential approach aimed at enhancing auditory and speech activity in children with cochlear implants. Although the technology of cochlear implantation has been scientifically proven to positively influence the speech development of children with hearing impairments, the necessity for a special pedagogical approach that considers each child's individual characteristics remains a pressing issue. The study examines methodologies for increasing auditory and speech activity in children with cochlear implants based on the principles of differential approach. Additionally, the process of perception and the development of communicative skills in children with restored hearing is explored from the perspectives of psycholinguistics, defectology, and pedagogy. The research evaluates the effectiveness of special educational technologies and rehabilitation programs conducted on the basis of individualized programs and identifies factors contributing to increased outcomes. The article serves as a methodological guide for teachers, speech therapists, defectologists, and parents working with children with cochlear implants. Furthermore, the findings are expected to contribute to scientific research in the fields of surdopedagogy and special education.

Keywords: Cochlear implantation, auditory-speech activity, differential approach, special education,

rehabilitation, surdopedagogy, defectology, hearing function, speech development, pedagogical technologies, individual educational program, logopedics, compensatory mechanisms, sensory integration, communicative competence.

Introduction: One of the key areas of modern surdopedagogy is the development of innovative approaches aimed at ensuring the speech and communicative development of children with hearing impairments. The advancement of cochlear implantation technology has created new opportunities for children with hearing loss.

Scientific studies show that the effectiveness of auditory and verbal rehabilitation after cochlear implantation depends on the individual characteristics of the child and the pedagogical approach applied. A differentiated approach is of great importance when working with children who have cochlear implants, as each child's hearing ability, speech development, and psychological condition can vary greatly.

The theoretical foundations of a differentiated approach are based on the works of scholars such as Vygotsky, Luria, and Leontiev, who emphasized that a child's psychological development is shaped in accordance with their individual characteristics.

The aim of this study Is to explore the scientific foundations of a differentiated approach in enhancing the auditory-verbal activity of children with cochlear implants and to identify effective pedagogical methods. This issue remains relevant in the fields of defectology, surdopedagogy, and rehabilitation, with research results contributing to the improvement of special education practices.

Such an approach not only requires selecting educational methods tailored to the individual needs of the child but also relies on systematic monitoring of their auditory and speech development. Scientific sources emphasize that successful post-implant adaptation depends on the child's prior hearing experience, the intensity of initial rehabilitation sessions, and the level of familial and pedagogical support.

Looking back at the history of cochlear implantation, we find its roots in the distant past. In 1790, the renowned Italian physicist and physiologist Alessandro Volta discovered in one of his experiments that electrical stimulation of the auditory system could produce the sensation of hearing sound. This marked the first step in the direction of scientific research aimed at amplifying sound using electrical current.

In 1957, in France, André Djourno and Charles Eyriès invented a single-channel cochlear implant device. In 1961, in the United States, physician William House conducted experiments on implanting and stimulating single-channel electrodes on the auditory nerve. On December 16, 1977, at the otolaryngology clinic of the Vienna University of Technology, Kurt Burian performed the first surgical procedure to implant an eight-channel microelectronic cochlear implant.

That same year, Australian scientist Graeme Clark received a grant for research on "Developing Auditory Prostheses." In 1978, a successful surgical procedure to implant a cochlear device was carried out on a patient named Rod Saunders at the University of Melbourne.

Until 1984, the number of patients who had received cochlear implants did not exceed four hundred adult patients. Multi-channel implants began to be installed in patients. However, the technology was still not perfect. Surgical procedures were performed only on adults. By 1990, in the United States, surgical operations began to be conducted starting from the age of 2. Eight years later, it was allowed from 1.5 years, and another four years later, from the age of 1. In 1991, the first cochlear implant was registered in the Russian Federation. Since 2005, this technology has been successfully used at the Scientific and Clinical Center of Otorhinolaryngology, the St. Petersburg Research Institute of Ear, Throat, Nose and Speech, and the Russian Scientific and Practical Center for Audiology and Hearing Prosthetics.

By 2013, in Uzbekistan, surgical operations to install cochlear implant devices had been carried out for nearly 20 children with hearing impairments or deafness. In 2013, an international methodological seminar was organized in Uzbekistan on the topic "Psychological and pedagogical support for children with cochlear implants" by the Republican Specialized Pediatric Scientific and Practical Medical Center, Samarkand State Medical Institute, and the company "Medel" (Austria).

The aim of the seminar was to discuss the results achieved in recent years in the area of improving the effectiveness of rehabilitation for children with hearing impairments or deafness, to increase the efficiency of research work, to exchange experiences, and to establish cochlear implantation practices in or country.

Thus, since 2014, surgical operations for the free installation of cochlear implant devices for children with hearing impairments or deafness have begun in Uzbekistan.

In addition, the introduction of modern educational technologies plays an important role in this process. In particular, audiopedagogy and speech therapy sessions, multimodal teaching methods, and interactive methods adapted on the basis of information and communication technologies are seen as effective tools in developing

the speech competencies of children with cochlear implants. Therefore, this research is aimed at identifying the role and importance of a differentiated approach in the education and rehabilitation processes of children with cochlear implants, and its results will serve to develop scientific and methodological recommendations for use in special education institutions.

The l"sue of increasing auditory and speech activity in children with cochlear implants has been studied by many researchers, and various scientific theories and practical experiences exist in this area. In particular, the studies by McGinty and Kendall (2019) emphasize that the process of speech perception in children using cochlear implants differs from that of typically hearing children. The research results show that the processing of auditory signals requires prolonged adaptation and individualized educational approaches. Similarly, in the studies by Yoshinaga-Itano (2003), it is stated that children who undergo cochlear implantation at an early age achieve significant success in speech development, but this process requires continuous pedagogical and speech therapy support. It is noted that specially designed individual educational programs and additional sensory-motor exercises play a significant role.

In explaining the scientific basis of the differentiated approach, the theory of the "zone of proximal development" proposed by Vygotsky (1983) plays an important role. According to him, the difference between what a child can do independently and what they can accomplish with the help of a teacher or specialist determines their developmental potential. Therefore, when working with children with cochlear implants, it is necessary for educators to plan subsequent stages of development based on individual approaches and initial achievements (Vygotsky, 1983).

Additionally, the research conducted by Marschark and Spencer (2010) shows the effectiveness of multimodal teaching methods for cochlear implant users. In particular, lessons conducted with visual aids, sign language, and lip-reading can accelerate the processes of speech comprehension and production. These scientific sources confirm the necessity of individual and differentiated approaches in enhancing the auditory and speech activity of children with cochlear implants. Hence, this research is aimed at a deeper study of the scientific foundations of modern surdopedagogy and rehabilitation practices, and its results will serve to develop methodological recommendations for effective use in special education institutions.

Although the development of cochlear implantation technology has created broad opportunities for children with hearing impairments, implant installation alone is not enough to enhance their auditory and speech activity. Scientific studies show that post-implantation speech development outcomes depend on the child's age, the quality of the rehabilitation process, and the pedagogical approach. In particular, Moog and Geers, in their 2012 study, emphasized that when children who have undergone implantation receive intensive speech rehabilitation from an early age, their hearing and speech abilities can significantly improve.

Researchers Nevins and Chute (2016) studied the importance of interactive teaching methods in developing communicative competence in children with hearing impairments. According to them, multimodal educational approaches conducted by special education teachers and speech therapists—including sessions based on visual and tactile stimuli—produce effective results for cochlear implant users. Additionally, Mayer and Leigh (2018), in their research, found that the use of audiovisual methods in children using cochlear implants accelerates the processes of speech perception and production. Their studies indicate that using visual aids and verbal communication alongside auditory stimuli helps increase a child's vocabulary.

Furthermore, Shamma and colleagues (2020) explored the role of neuropsychological approaches in the development of hearing and speech, identifying cognitive and psycholinguistic changes in children with cochlear implants. Their findings show that artificial stimulation of hearing activates a reorganization process in the brain's auditory centers, which is one of the key factors in auditory-verbal development. At the same time, many studies have highlighted the significant role of social environment and family support in enhancing the speech activity of cochlear implant users. Specifically, Kirk and Hill (2015) found that the active involvement of parents and educators positively affects children's communicative development. Providing children with hearing and speech exercises at home and creating a constant communication environment is a vital part of the rehabilitation process.

Studies indicate that the use of cochlear implants is not limited to restoring hearing capabilities technologically—it also influences the restructuring of auditory centers in the brain. Over time, the artificial signals transmitted to the brain begin to approximate natural hearing processes, playing a crucial role in children's speech development. The importance of the communication environment and rehabilitation lies in the fact that family and social surroundings are among the decisive factors in strengthening a child's hearing and speech abilities. Children using cochlear implants learn to better perceive sounds through regular

communication and hearing exercises. Continuous support from parents and teachers has a positive impact on the correct formation of speech. It is recommended that children be actively engaged in communication at home and that special training sessions be conducted to develop listening skills, which are part of specialized educational programs for cochlear implant users.

The rehabilitation process for children with cochlear implants requires not only medical but also pedagogical approaches. In this regard, special education programs aim to:

- Conduct sessions based on specific methodologies for the development of hearing and speech.

- Provide speech therapy support for the use of cochlear implants.

- Increase children's confidence in communication and promote social integration.

Cochlear implants not only restore children's hearing ability but also have a significant impact on their cognitive, speech, and social development.** Research shows that after the implantation process, the brain's auditory centers adapt to the new conditions, leading to the development of sound perception, speech formation, and communication skills. However, this process is not only dependent on technological capabilities but is also closely linked to specialized education, rehabilitation, and family support.

While cochlear implants play a key role in the hearing and speech development of children, their effectiveness depends on the age at which the child receives the implant, the rehabilitation process, and the social environment. Children who receive the implant at an early age tend to acquire speech more quickly and can communicate effectively with their peers.

In contrast, children who undergo implantation at a later age may experience slower development of hearing and speech, and therefore require specialized pedagogical approaches and speech therapy sessions.

Restoring hearing ability also influences children's cognitive development. Children who receive implants improve their ability to concentrate, acquire information through hearing, and process it. In addition, their memory improves, and language acquisition accelerates. Studies show that children who use implants and engage in structured learning based on specialized methods can also achieve good results in academic fields.

From a social development perspective, cochlear implants enhance children's communication skills and support their integration into society. However, the role of parents, educators, and speech therapists is crucial in this process. The family environment directly influences the child's hearing and speech development. Regular engagement in hearing and speech activities, providing proper guidance, and involving the child in social interactions all contribute to their successful development.

CONCLUSION

The cochlear implant is an effective technology for restoring hearing ability, and it has a positive impact on children's speech and social development. However, its effectiveness is not limited to the implantation process alone; it also depends on rehabilitation, specialized pedagogical approaches, and social support. Early implantation accelerates the development of hearing and speech in children, giving them the opportunity to develop communication skills. Additionally, regular speech therapy sessions and the active involvement of parents and educators positively influence the child's academic and social adaptation.

Thus, the cochlear implant creates great opportunities for children with hearing impairments, but achieving effective outcomes requires a comprehensive approach and continuous support. Furthermore, cochlear implantation also affects the cognitive development of children. With restored hearing ability, they are able to perceive information more quickly, improve memory, and enhance their language-learning skills. Research shows that children using implants learn better through auditory input, which also improves their concentration and problem-solving abilities.

However, the success of the implantation process is directly related to how the child interacts with their environment. Without consistent pedagogical support and specialized rehabilitation training, achieving the desired outcomes from the implant may be difficult. Therefore, speech therapists, educators, and parents must work collaboratively and maintain continuous attention to the child's hearing and speech development.

In general, cochlear implant technology creates new opportunities for children, helping them become fully integrated members of society. Yet for this process to be successful, early diagnosis, rehabilitation, and an individualized approach are of critical importance. In the future, further advancement of this technology is expected to bring even greater improvements in children's development.

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