

Retraction

Retracted: Digital-Based Analysis of Speech Rehabilitation Data for Preschool-Age Exceptional Children

Journal of Sensors

Received 19 September 2023; Accepted 19 September 2023; Published 20 September 2023

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] Z. Fu, "Digital-Based Analysis of Speech Rehabilitation Data for Preschool-Age Exceptional Children," *Journal of Sensors*, vol. 2022, Article ID 2458947, 12 pages, 2022.

Research Article

Digital-Based Analysis of Speech Rehabilitation Data for Preschool-Age Exceptional Children

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Received 1 June 2022; Accepted 29 June 2022; Published 20 July 2022

Academic Editor: Yuan Li

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China has the largest number of hearing and speech disorders in the world. According to the second sample survey of the disabled conducted in 2006, there were 27.8 million disabled people in Hong Kong, about half of whom were disabled. The disabled account for 1.53%, and there are about 13,7000 hearing impaired children aged 0 to 6, an increase of about 2.3 million every year. About 2.3 million new babies are born each year. Research shows that more than 95% of exceptional children have been compensated for their residual hearing. How do 95% of hearing-loss children effectively use their remaining rumors? Technical assistance and scientific rehabilitation are effective tools to enable hearing impaired children to use their residual hearing. Therefore, this paper proposes a digital analysis method for speech rehabilitation data of preschool exceptional children to ensure that exceptional children can effectively obtain speech rehabilitation services and enhance their language ability.

1. Introduction

According to the results conducted in 2006, there are 27.8 million people with hearing and speech disabilities in China, of which about 137,000 are children with hearing disabilities aged 0-6 years and about 23,000 deaf children are born every year [1]. The majority of children with hearing disabilities have severe and profound hearing loss, and due to the severe hearing loss and the poor compensation effect of hearing aids, their speech ability is significantly lower than that of hearing children, resulting in their cognitive and communication abilities being lower than those of hearing children. This makes it difficult for them to acquire knowledge and brings them many difficulties in life, study and employment, which not only causes heavy burden to their families and society but also has a great impact on their life development [2].

For exceptional children who are poorly compensated with hearing aids, surgical implantation of a cochlear implant is now recognized worldwide as an effective way to improve their hearing. Cochlear implant technology began

in the 1950s, and after years of clinical application, it has now become the only effective treatment for patients with severe or profound hearing loss, with more than 50,000 deaf patients worldwide using cochlear implants. In China, cochlear implant surgery has been carried out since the mid-1990s, and since the official launch of the “China Disabled Persons’ Federation Cochlear Implant Rescue Rehabilitation Program for Poor Deaf Children” in July 2009, more and more exceptional children can enjoy national and provincial aid programs, receive free cochlear implant surgery and subsidized rehabilitation training fees, and enter professional institutions for rehabilitation [3]. The introduction of domestic cochlear implants has greatly reduced the cost of surgery, and more and more parents of exceptional children are aware of the importance of early rehabilitation and choose to pay for cochlear implants at their own expense, so that exceptional children can receive surgery earlier and enter institutions for rehabilitation.

Hearing impairment, also known as hearing loss, usually refers to a person’s difficulty in hearing the environment and speech sounds due to various reasons. The transmission of

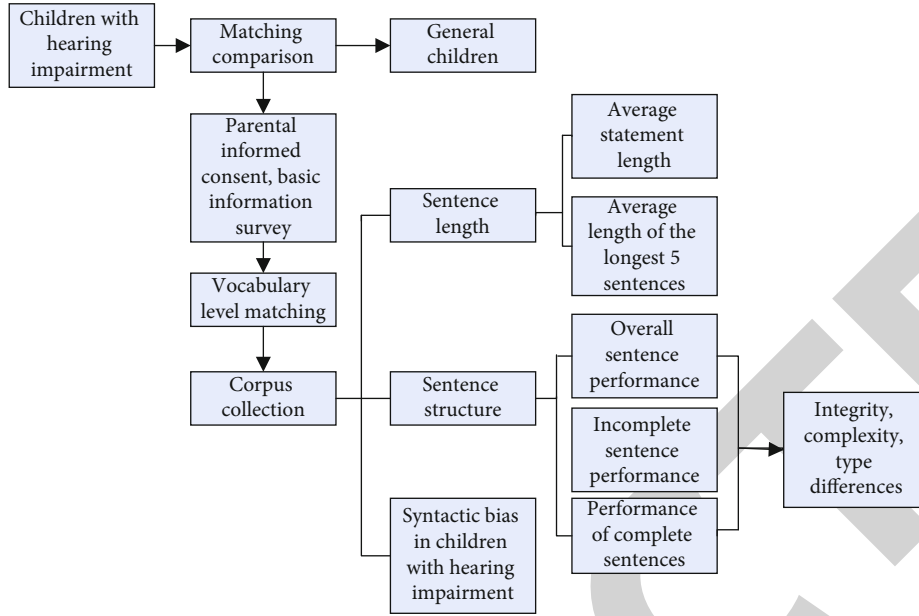


FIGURE 1: Analysis process.

TABLE 1: Distribution of the actual age of implantation within each group according to the age of the implantation group.

Implantation age grouping	Actual implantation age range	Actual implantation age mean value	N	Standard deviation
3-year-old group	30 months~41 months	3.1705	26	0.15605
4-year-old group	42 months~53 months	3.9474	32	0.24432
5-year-old group	54 months~65 months	4.9273	27	0.27895
6-year-old group	66 months~77 months	5.6592	13	0.15573
Total		4.2258	98	0.87525

sound from the outer ear to the brain to form the sense of hearing requires a series of complex transmission and processing processes, and any lesion or abnormality in the function of any tissue or organ associated with this process may cause hearing impairment. Hearing impaired children are referred to as exceptional children. Hearing impairment in children is divided into conductive hearing impairment and sensorineural hearing impairment. Generally, conductive deafness can be improved through surgery and other procedures, while neurological deafness does not usually recover after a long time and then after treatment [4]. For children with severe and profound hearing impairment, the most effective way to reconstruct hearing is through cochlear implantation.

Exceptional children have better hearing ability after hearing reconstruction with cochlear implants. However, hearing clearly to speaking clearly is not an overnight process and requires professional, systematic, and long-term language rehabilitation training after surgery. Language development is a dynamic process, and training programs should be adjusted at the appropriate time. Based on the evaluation results, we can adjust the teaching objectives, develop the rehabilitation plan for the next semester, and

conduct targeted individualized training to improve the rehabilitation effect. Exceptional children learn spoken language through hearing and need to rely on advanced hearing aid technology. The advent of the digital age has led to continuous updating of knowledge and advances in science and technology, and the main hearing aids that can help exceptional children compensate or reconstruct their hearing are electronic cochlear implants, digital hearing aids, and frequency transmission assistive devices [5, 6]. The auditory-oral-grammar rehabilitation model adapts to the developmental needs of the times and enables abilities through a series of proven rehabilitation methods and teaching techniques.

According to a survey, the annual birth rate of hearing-impaired children in China is about 1‰ to 3‰, and there are about 10,000 to 30,000 children [7]. Because of their young age and poor self-care ability, young exceptional children are not qualified to enter institutions. Therefore, domestic rehabilitation institutions provide rehabilitation services for young exceptional children through parent-child classes and an auditory-oral syntax rehabilitation model, which is based on the model of preschool education for ordinary children. Auditory-oral grammar advocates

TABLE 2: Means and standard deviations of the mean language age of exceptional children in different implantation age groups at different assessment points.

Group by implantation age	Mean language age before operation	First average language age	Second average language age	Third average language age	Fourth average language age	Fifth average language age	Sixth average language age	Seventh average language age	
3-year-old group	Average value	0.132	0.324	1.063	1.818	2.262	2.621	2.897	3.293
	<i>N</i>	26	26	26	26	26	26	26	26
	Standard deviation	0.4578	0.7465	0.8187	0.8759	0.9695	1.0533	0.9963	0.8736
4-year-old group	Average value	0.900	0.698	1.289	1.858	2.379	2.765	3.059	3.329
	<i>N</i>	32	32	32	32	32	32	32	32
	Standard deviation	1.2623	.9677	1.0987	1.0922	0.0168	1.1599	1.2226	1.2531
5-year-old group	Average value	1.647	1.399	2.152	2.536	3.092	3.405	3.475	3.778
	<i>N</i>	27	27	27	27	27	27	27	27
	Standard deviation	1.2203	1.0633	1.1208	0.8939	0.7744	1.0107	1.1138	1.0955
6-year-old group	Average value	2.092	1.583	2.829	3.119	3.529	3.765	3.967	4.146
	<i>N</i>	13	13	13	13	13	13	13	13
	Standard deviation	1.1141	1.1815	1.1818	1.1109	1.3306	1.3345	1.3276	1.4175
Total	Average value	1.053	0.903	1.657	2.188	2.687	3.028	3.245	3.544
	<i>N</i>	98	98	98	98	98	98	98	98
	Standard deviation	1.2596	1.0685	1.2034	1.0776	1.0764	1.1733	1.1859	1.1651

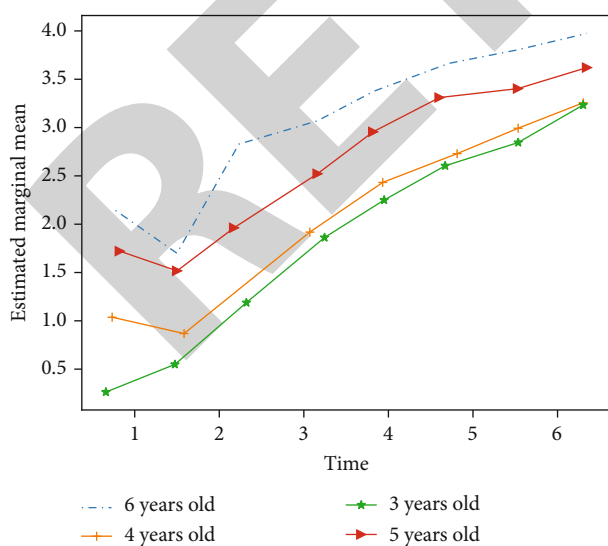


FIGURE 2: The mean language age of exceptional children in different implantation age groups at each assessment time point.

early diagnosis of hearing in newborns and infants and auditory oral grammar intervention for exceptional children. Research has shown that auditory-oral grammar follows the language development patterns of the average child, and because of their hearing deficits, exceptional children struggle more and learn language more slowly at the beginning.

Family rehabilitation education is a powerful supplement to institutional rehabilitation. The ability of family rehabilitation education, especially that of the primary guardian, plays a crucial role. The auditory-oral approach advocates that parents be guided and trained to be the primary facilitators of auditory and oral language development for their exceptional children through active and continuous participation in individualized auditory-oral therapy. The auditory-oral method emphasizes the role of parents, the practical recognition of the influence of parents' rehabilitation education ability on the rehabilitation, and the need to bring into play the educational potential of parents, who have acquired rehabilitation knowledge and skills, so that rehabilitation can be carried out anywhere and anytime for exceptional children, and the rehabilitation effect will certainly be substantially improved [8].

TABLE 3: One-way ANOVA results for mean language age at each assessment for different implantation age groups.

		Sum of squares	df	Mean square	F	Significance
Mean language age before operation	Intergroup	40.564	3	13.522	11.655	0.000
First average language age	Intergroup	19.927	3	6.645	7.032	0.000
Second average language age	Intergroup	33.188	3	11.063	10.006	0.000
Third average language age	Intergroup	18.833	3	6.278	6.415	0.001
Fourth average language age	Intergroup	19.692	3	6.231	6.372	0.001
Fifth average language age	Intergroup	15.129	3	5.041	4.050	0.011
Sixth average language age	Intergroup	10.939	3	3.648	2.753	0.049
Seventh average language age	Intergroup	8.168	3	2.724	2.077	0.107

TABLE 4: Means and standard deviations of speech intelligibility ratings at different assessment points for exceptional children in different implantation age groups.

Group by implantation age		Preoperative SIR	First SIR	Second SIR	Third SIR	Fourth SIR	Fifth SIR	Sixth SIR	Seventh SIR
3-year-old group	Average value	1.05	1.16	1.84	2.49	2.84	3.46	3.88	4.29
	<i>N</i>	26	26	26	26	26	26	26	26
	Standard deviation	0.208	0.835	0.985	1.081	1.194	1.081	1.141	0.863
4-year-old group	Average value	1.38	1.51	2.02	2.58	2.84	3.41	3.65	3.91
	<i>N</i>	32	32	32	32	32	32	32	32
	Standard deviation	0.808	1.008	1.288	1.277	1.369	1.223	1.243	1.187
5-year-old group	Average value	1.59	1.66	2.78	3.26	3.84	4.09	4.26	4.43
	<i>N</i>	27	27	27	27	27	27	27	27
	Standard deviation	0.882	1.048	1.352	0.988	0.867	0.775	0.674	0.587
6-year-old group	Average value	1.83	2.35	3.37	3.44	3.74	3.74	4.00	4.38
	<i>N</i>	13	13	13	13	13	13	13	13
	Standard deviation	1.169	1.361	1.287	0.821	1.008	0.906	0.892	0.921
Total	Average value	1.42	1.56	2.33	2.85	3.24	3.68	3.90	4.17
	<i>N</i>	98	98	98	98	98	98	98	98
	Standard deviation	0.711	1.071	1.328	1.155	1.238	1.01	1.058	0.948

The purpose of rehabilitation is to enable exceptional children to integrate into regular schools with their classes as soon as possible and to adapt to the learning and communication patterns of ordinary children. Experience shows that during the rehabilitation learning process, exceptional children are not able to communicate with others as flexibly and effectively as ordinary children because the channels of language acquisition are not smooth and learning is too rigid; many children will have the condition of parroting the language. The auditory oral grammar can effectively avoid the parroting situation in rehabilitation learning because it follows the law of children's language development, so that exceptional children can communicate more smoothly with ordinary children [9].

2. Related Work

Childhood is a critical period for language acquisition. Hearing children go through the word-sentence stage, the two-word stage, and the complete-sentence stage between the ages of 1 and 3 years, and by the age of about 4 years, they can master all the phonology, further increase their vocabulary, use more complex grammatical structures, and greatly enhance their pragmatic abilities. There are various views on how children learn and acquire language, and various theories have been developed; the most representative of which are acquired environment theory, innate determinism, innate and acquired interaction theory, and social interaction theory [10].

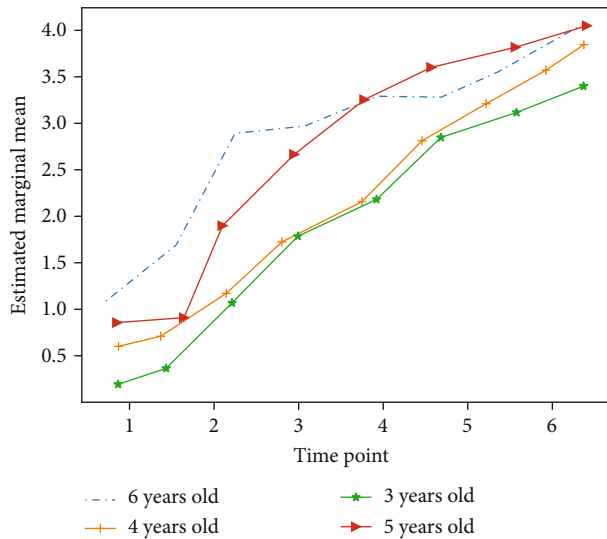


FIGURE 3: The speech intelligibility grading of exceptional children in different implantation age groups at each assessment time point.

The acquired environment theory denies or downplays the role of innate or genetic factors in children's language development, views language as a habit, and emphasizes the importance of learning, arguing that children form language habits and acquire language habits through a series of "stimulus response" learning in an acquired environment. Innate determinism emphasizes the decisive role of intrinsic genetic factors, i.e., a person's innate language ability. Over-emphasis on the importance of innate genetic factors and neglect or even denial of the influence of the acquired environment and education on the child. The innate and acquired interaction theory advocates that language development is accounted for in terms of the development of cognitive structures and that children's language develops as a result of the interaction of innate and acquired factors. The social interaction theory argues that children have their own purposes and intentions and are active language processors. The acquisition of language by children requires not only the possession of innate language skills but also a certain amount of physical maturation and cognitive development, as well as the need to use language in social interactions and to perform the communicative function of language.

Over the past few decades, as the interest in exceptional children has grown, more and more researchers have made their contribution in this field. The CDaCI, a group of six joint research centers, analyzes and compares differences in hearing, providing scientific evidence for decision-making in the intervention and rehabilitation process for deaf children. The CDaCI study established a baseline assessment system and a regular follow-up assessment system: a new standard and multidimensional baseline assessment system for comprehensive assessment studies including auditory, speech, language, cognitive, and social communication tests and a longitudinal follow-up assessment every six months using a comprehensive assessment framework similar to the standardized basic assessment system [11]. The possibility of developing hearing loss through cochlear implantation

in conjunction with oral communication rehabilitation and training has become a growing concern for audiologists and speech-language pathologists [4]. Common speech and language recognition are secondary to language development. All studies evaluating the effects of cochlear implants in children in the language acquisition age range must measure and assess their language skills [12]. Since the end of the last century, more studies have been conducted to measure the language abilities of exceptional children [13]. Earlier studies on factors influencing the assessment of language skills in exceptional children pointed more towards individual physiological factors and external environment, such as hearing status, history of deafness, family situation, and educational environment. [14] conducted a multicenter systematic study to explore different factors affecting the rehabilitation effects of cochlear implant interventions, which included educational environment, family, medical history, and intervention rehabilitation history. Indicators are used to assess intervention and rehabilitation outcomes, as well as verbal ability.

The CDaCI multidimensional baseline assessment system includes questionnaires for demographic information. They then conducted additional studies on factors affecting language development: early or late cochlear implantation, residual hearing before implantation time, parent-child interaction scores, and parental social experience status were all positively associated with the rate of language comprehension and expression development. In 2011, the team found that different factors had different effects on four aspects of language development: phonological, lexical, syntactic, and pragmatic. Since then, a growing number of centers and scholars have conducted in-depth research on the various factors that influence language development. The journal *Ear and Hearing* in 2003 discussed the outcomes of prelingually deaf children who received speech-language rehabilitation after the implant and used the cochlear implant for more than three years after the procedure [15]. In 2010 [16], a follow-up long-term outcome evaluation of children who participated in a study in 2003 showed that children in the early implantation group showed better language and reading skills comparable to those of school-age students by the time they reached secondary school. In 2013, [17] conducted a follow-up study of the language skills of children studied in the CDaCI (who were in elementary school at this time) and found that children with cochlear implants had higher standardized scores on standardized language tests for items such as lexical expression, syntactic expressive ability, and pragmatics. In a comparison of the overall accuracy of consonant articulation in children with different implantation ages, [18] concluded that children had a more rapid increase in early consonant accuracy and higher overall phonological accuracy than children with cochlear implants afterwards.

Large-scale outcome assessment studies have shown that even children with early cochlear implants typically lag behind their hearing peers in language ability, and that there is substantial individual variability. In recent years, it has been suggested that the process of language processing may involve a number of underlying attentional and

TABLE 5: Acceptance of learning ability and mental-behavioral developmental tests.

	Frequency	Percentage	Effective percentage	Cumulative percentage
Take Greiffels' mental development test	35	34.5	34.5	34.5
Effective Received the Greek-internal learning ability test	63	65.5	65.5	100.0
Total	98	100.0	100.0	

TABLE 6: Means and standard deviations of mean language ages of exceptional children with different preoperative Greiffels' intelligence levels at different assessment points.

Greiffels' intelligence level grading	Mean language age before operation	First average language age	Second average language age	Third average language age	Fourth average language age	Fifth average language age	Sixth average language age	Seventh average language age	
To be excellent	Average value	0.000	0.000	1.201	0.801	2.000	2.602	3.400	3.700
	N	1	1	1	1	1	1	1	1
	Standard deviation								
Excellent	Average value	0.0000	0.400	1.135	1.935	3.068	3.001	3.268	3.535
	N	4	4	4	4	4	4	4	4
	Standard deviation	0.000	0.2000	0.9453	0.9868	1.1017	0.8213	0.5036	0.4617
Moderately upper	Average value	0.000	0.000	0.268	1.168	1.401	2.069	2.136	2.664
	N	4	4	4	4	4	4	4	4
	Standard deviation	0.0000	0.0000	0.3056	1.2663	1.2489	1.5145	1.4469	1.8476
Moderate	Average value	0.000	0.219	1.083	1.907	2.554	2.642	2.978	3.243
	N	21	21	21	21	21	21	21	21
	Standard deviation	0.0000	0.4903	0.5658	0.9135	0.7893	1.1053	38629	0.7978
Moderately low	Average value	0.000	0.122	0.241	0.800	1.358	2.081	2.478	2.800
	N	5	5	5	5	5	5	5	5
	Standard deviation	0.000	0.1788	0.1639	0.8719	1.1263	0.9123	1.0259	0.6328
Marginal status	Average value	0.000	0.000	0.600	1.202	1.602	1.602	2.202	2.202
	N	1	1	1	1	1	1	1	1
	Standard deviation								
Total	Average value	0.000	0.184	0.855	1.624	2.128	2.493	2.828	3.124
	N	35	35	35	35	35	35	35	35
	Standard deviation	0.0000	0.3897	0.6278	0.9742	0.9987	1.0481	0.9198	0.8755

cognitive neural mechanisms that contribute to the wide variability in language developmental effects in deaf children [19]. In 2010, [20] studied exceptional children in 39 rehabilitation centers in the United States that emphasized oral

hearing and showed that children with cochlear implants were significantly more likely to achieve normal language development during kindergarten if they received surgery and early parent-child intervention before the age of one

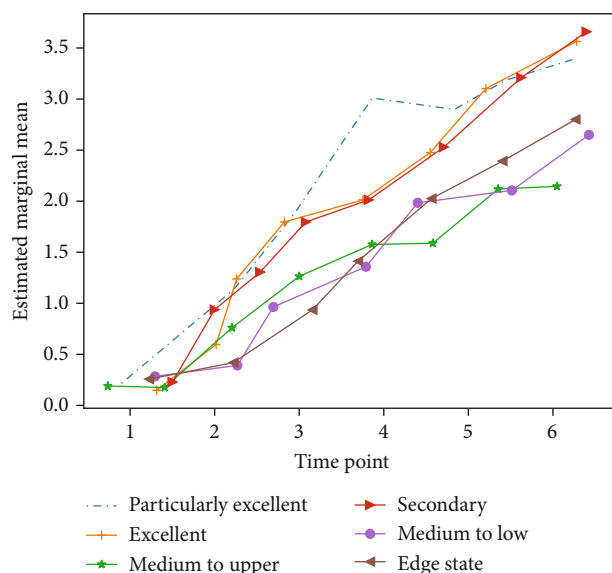


FIGURE 4: Mean language age of exceptional children with different levels of preoperative Greiffels' intelligence at each assessment time point.

and participated in an intensive early childhood program designed specifically to focus on oral language development at the age of two. [21] also investigated parent-child interactions in CDaCI and found that children's expressive language skills were closely related to the language skills used by parents and that children's language comprehension was predicted based on the total number of words used by parents. It is evident that a rich language environment and positive parent-child interaction can help improve the oral language skills of exceptional children [22–24].

3. Methods

This study investigated the syntactic characteristics of term-stage exceptional children based on data analysis, mainly in three aspects: utterance length, sentence structure, and syntactic bias. By comparing the consistency and difference of syntactic performance between term-stage hearing-impaired children and ordinary children, this paper summarized and discussed the syntactic performance of term-stage hearing-impaired children and finally obtained the syntactic characteristics of term-stage hearing-impaired children. Finally, this paper proposed relevant educational suggestions. The analysis flow of this study is shown in Figure 1.

The preoperative screening assessments were done in the assessment room of the Rehabilitation Guidance Center of the Disabled Persons' Federation, and the postoperative assessments were done in the designated rehabilitation institutions in the province, and the assessors were all professionally trained.

The preoperative evaluation included mental and intellectual assessment, average speech age, and SIR speech intelligibility rating, and the postoperative evaluation included average speech age and SIR speech intelligibility rating.

3.1. Preoperative Mental and Intellectual Assessment. In principle, exceptional children aged 0-3 years were assessed with Greiffels' intelligence test, and those aged 3 years or older were assessed with the Greek-internal learning ability, or if the Greek-internal learning ability assessment was not available at the age of 3 years or older, Greiffels' intelligence test could be administered. The results of the mental and intellectual assessments were reflected in the present study by Greiffels' intelligence level grading and the Greek-internal learning ability grading.

The total of the scores of the items passed in the subtest is the IQ of the child with hearing impairment (in months), and the IQ of the subtest is calculated by calculating the IQ (in months)/actual age (in months) * 100. The total IQ is the average of the three subtests. Exceptional children are graded according to their developmental quotients: <70 for low mental development, 70-79 for borderline, 80-89 for low intermediate, 90-109 for intermediate, 110-119 for upper intermediate, 120-129 for excellent, and >129 for exceptional. For test requirements, the primary test taker should strictly follow the guidelines, and parents are not allowed to prompt; the test is an assessment tool and cannot be used for teaching.

The Chinese deaf standing model revised version of the Greek-internal learning ability test is used for hearing impaired children aged 3 to 7 years to perform eight subtests: bead threading, color memorization, picture recognition, picture association, paper folding, short visual memory, log arrangement, and picture completion, and the raw scores of the 8-item test were recorded on a norm table on the back of the recording sheet, and the norm table converted each test score to mental age, which is the learning age of the child with hearing impairment. The average learning age was obtained by ranking the eight subtests from the highest to the lowest, and the middle quintile was the 4.5 quintile. The average learning age/actual age * 100 was calculated to obtain the ratio IQ (specifically, Learning Quotient (LQ)), and the exceptional children were graded according to their LQ: ≥ 149 was considered exceptional, 133-148 was considered excellent, 117-132 was considered moderately high, 84-116 was considered moderate, 68-83 was considered moderately low, 52-67 was considered mildly retarded, 36-51 was considered moderately retarded, and 36-51 was considered moderately retarded. The test was administered to subjects. For test requirements, subjects must strictly follow standardized procedures whether they use gestures or verbal instructions, and only the first two or three parts of each subtest need to be instructed, while the later parts of the test merely provide materials.

3.2. Mean Age of Speech. The assessment included five item subtests: speech intelligibility (articulation status), imitation sentence length (grammatical ability), listening and picture recognition (comprehension ability), picture reading and speaking (expressive language ability), and thematic conversation (language use and interaction ability). In the preoperative period, due to the low level of auditory and linguistic ability, only two subtests were administered, namely, listening to pictures and thematic conversations. Four testers (one

TABLE 7: One-way ANOVA of mean language age at each assessment point for exceptional children with different preoperative Greiffels' intelligence levels.

		Sum of squares	df	Mean square	<i>F</i>	Significance
Mean language age before operation	Intergroup	0.000	5	0.000		
First average language age	Intergroup	0.348	5	0.071	0.414	0.832
Second average language age	Intergroup	4.226	5	0.846	2.813	0.038
Third average language age	Intergroup	5.872	5	1.175	1.301	0.297
Fourth average language age	Intergroup	8.339	5	1.669	1.944	0.125
Fifth average language age	Intergroup	3.352	5	0.672	0.565	0.727
Sixth average language age	Intergroup	7.728	5	0.749	0.859	0.523
Seventh average language age	Intergroup	3.198	5	0.641	0.808	0.557

for level 1, one for level 2, and two for level 3) who met the requirements were asked to record the words they heard according to their pronunciation and to record the scores according to the standard answers, with 0.5 point for each correct word and 1 point for each correct word. The number of correct words recorded by the four testers was summed to obtain their speech intelligibility, and their speech age was recorded according to their speech intelligibility. The test consists of four levels: imitation sentence length, listening and picture recognition, picture talk, and theme conversation, all of which start from level 1. Imitation sentence length required the ability to repeat what was heard, listening and picture recognition required the ability to identify cards based on what was heard, and thematic conversation required the ability to answer questions related to the pictures. Exceptional children were considered to have completed the test (except for the speech intelligibility test) when they completed the imitation, identification, narration, and answering the corresponding questions as required.

The average language age of exceptional children after cochlear implantation is four years and older, and a language function assessment is performed to determine their language age. The language function assessment uses the language function assessment method for exceptional children to assess the expressive, instrumental, coordination, expressive, and recreational functions of exceptional children, with a score of 10 for each assessment. The expressive function was assessed using the storytelling method, the instrumental function was assessed using the "trained teacher and child with hearing loss" method of the behavioral assessment, the coordination function was assessed using the "assessor's involvement in the child's behavior" method of the behavioral assessment, and the expressive function was assessed using the "trained teacher and child with hearing loss" method of the behavioral assessment. The behavioral assessment used "the assessor as a bystander," and the recreational assessment used "the assessor is involved in the behavior of the child with hearing loss." Exceptional children were scored according to the elements, language forms, verbal behaviors, response behaviors, realization pathways, and behavioral performance that were present during each assessment. The combined scores of expressive function, instrumental function, coordination function, expressive function, and recreational function were calculated by

weighting 30%, 20%, 20%, 15%, and 15%, respectively, and the language age of the child with hearing impairment was obtained by checking the table according to the reference standard for assessment of language function of hearing children aged 4-6.

3.3. Speech Intelligibility Rating. Speech intelligibility rating (SIR) was used to assess the intelligibility of 88 exceptional children, and the preoperative and postoperative assessment criteria were the same. The SIR questionnaire was divided into 1-5 levels: level 1 is a level in which coherent speech (phrases or sentences) cannot be understood, words in the spoken language are not easily recognized, and gestures are the main means of daily communication; level 2 is a level in which coherent speech cannot be understood, but individual words in the speech can be gradually understood; level 3 is a level in which coherent speech can be understood when concentrated and combined with lip reading cues; level 4 is a level in which coherent speech can be understood when concentrated and combined with lip reading cues; and level 5 is a level in which coherent speech can be understood. Level 3 is when the child's speech is intelligible with concentration and lip reading cues. Level 4 is when the child's coherent speech is intelligible to unfamiliar people. Level 5 is when the child's coherent speech is intelligible to all people. For the test method, the test results were recorded by teachers trained in professional assessment techniques according to uniform standards (accurate and consistent understanding of key words) and by face-to-face interviews with close contacts of the child with hearing impairment, according to the stable level that the child with hearing impairment can achieve in life, and in between the two levels of ability, according to the lower level.

4. Case Study

We investigated the factors influencing speech rehabilitation in exceptional children through digital analysis, including two key factors: the influence of age at cochlear implantation and the influence of preoperative mental development and learning ability. Specifically, we selected the rehabilitation data of a total of 98 exceptional children in one region for analysis, and the results are shown below.

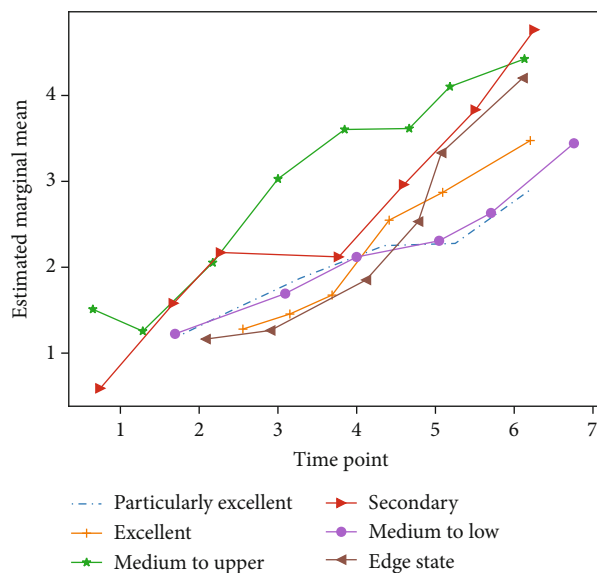


FIGURE 5: The change in speech intelligibility rating at each assessment time point for exceptional children with different preoperative Greiffels' intelligence levels.

4.1. Influence of Age of Cochlear Implantation

4.1.1. *Basic Information on the Age Grouping.* The actual age composition of each group of 98 exceptional children according to the age of implantation is presented in Table 1.

4.1.2. *Mean Language Age of Different Implantation Age Groups at Each Assessment Time Point.* From Table 2 and Figure 2, we can see that the mean language age of exceptional children in each implantation age group tended to increase from the second postoperative assessment, and the mean language age of exceptional children in each age group reached the level of nearly 3 years old or above at the seventh assessment, and the difference in the mean language age of exceptional children in different implantation age groups decreased compared with the preoperative level. Changes in mean language age were observed by assessment point. The 3-year-old group developed from 0.131 ± 0.4576 years preoperatively to 3.292 ± 0.8732 years at the seventh assessment. The 4-year-old group developed from 0.902 ± 1.2620 years preoperatively to 3.325 ± 1.2532 years at the seventh assessment, the 5-year-old group developed from 1.645 ± 1.2203 years preoperatively to 3.778 ± 1.0955 years at the seventh assessment, and the 6-year-old group developed from 2.092 ± 1.1141 years preoperatively to 4.144 ± 1.4175 years at the seventh assessment (since the first postoperative assessment was done within one month, when the hearing-impaired children had just reestablished their hearing and had not yet fully adapted, their language skills were generally lower at this time than before surgery).

4.1.3. *Differences in the Mean Language Age of Different Implantation Age Groups at Each Assessment Point.* A one-way ANOVA was performed on the mean language age of the different implantation age groups at each assessment

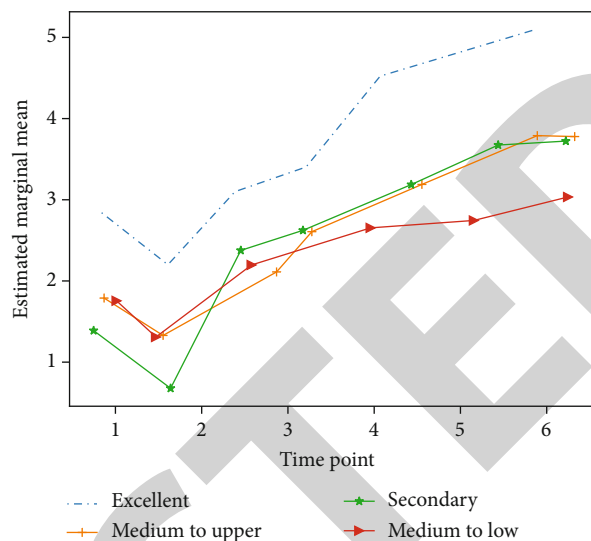


FIGURE 6: The mean language age of exceptional children with different preoperative Greek-internal learning ability ratings at each assessment point.

point. The P was less than 0.05 for the first, second, third, fourth, fifth, and sixth preoperative and postoperative assessments, and $P > 0.05$ for the seventh assessment, which means that the differences in the mean language ages of exceptional children in different implantation age groups were significant in the first six preoperative and postoperative assessments and not significant in the seventh postoperative assessment, as shown in Table 3. It can be seen that exceptional children in different implantation age groups had different mean language ages before surgery, but after systematic rehabilitation training, they could reach approximately the same mean language age about three years after surgery.

4.1.4. *The Effect of Different Age Groups of Implantation on the Speech Intelligibility Rating at Each Assessment Point.* As shown in Table 4 and Figure 3, the speech intelligibility ratings of exceptional children in each implantation age group showed an increasing trend from the first postoperative assessment to each assessment. At the seventh assessment, the speech intelligibility rating of all age groups was close to grade 4 or above, and the difference in speech intelligibility rating of exceptional children in different implantation age groups decreased compared with that before surgery. The change in speech intelligibility rating at each assessment point was as follows: the 3-year-old group developed from a preoperative grade of 1.04 ± 0.209 to a grade of 4.26 ± 0.864 at the seventh assessment; the 4-year-old group developed from a preoperative grade of 1.37 ± 0.809 to a grade of 3.90 ± 1.185 at the seventh assessment; the 5-year-old group developed from a preoperative grade of 1.58 ± 0.881 to a grade of 4.42 ± 0.584 at the seventh assessment; and the 6-year-old group developed from a preoperative grade of 1.82 ± 1.168 to a grade of 4.36 ± 0.924 at the seventh assessment.

TABLE 8: One-way ANOVA of mean language age at each assessment point for exceptional children with different preoperative Greek-internal learning ability ratings.

		Sum of squares	df	Mean square	F	Significance
Mean language age before operation	Intergroup	5.277	3	1.758	1.153	0.338
First average language age	Intergroup	3.931	3	1.132	1.051	0.379
Second average language age	Intergroup	4.252	3	1.418	0.945	0.427
Third average language age	Intergroup	2.907	3	0.968	0.934	0.432
Fourth average language age	Intergroup	8.862	3	2.954	3.264	0.029
Fifth average language age	Intergroup	9.246	3	3.083	2.542	0.067
Sixth average language age	Intergroup	12.454	3	4.152	2.897	0.044
Seventh average language age	Intergroup	9.058	3	3.018	2.066	0.116

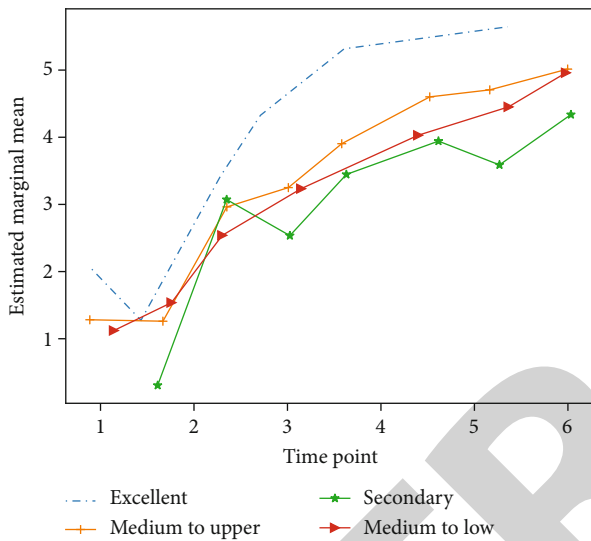


FIGURE 7: The change in speech intelligibility rating of exceptional children with different preoperative Greek-internal learning ability ratings at each assessment time point.

4.2. Effects of Preoperative Mental Development and Learning Ability

4.2.1. *Preoperative Greiffels' Mental Level and Greek-Internal Learning Ability Status.* Preoperative mental development and learning ability are shown in Table 5.

4.2.2. *Influence of Preoperative Greiffels' Intelligence Level Classification.* As can be seen in Table 6 and Figure 4, the mean language age of children with different preoperative Greiffels' levels of intelligence tended to increase from the first postoperative assessment, but the difference in mean language age between the groups increased from the preoperative level, as evidenced by the fact that children with exceptional and excellent levels of hearing impairment were significantly higher than children with intermediate and upper intermediate levels of hearing impairment, and children with borderline status were significantly lower than children with intermediate levels of hearing impairment. The children with marginal hearing loss were significantly lower than those with intermediate hearing loss.

4.2.3. *Differences in the Mean Language Age of Exceptional Children with Different Preoperative Greiffels' Intelligence Levels at Each Assessment Point.* A one-way ANOVA was performed on the mean language age of exceptional children with different preoperative Greiffels' intelligence levels at each assessment point, and only at the second assessment, $P < 0.05$, and at the rest of the preoperative and postoperative assessments, P was greater than 0.05; that is, the difference in mean language age between the groups of exceptional children with different preoperative Greiffels' intelligence levels at each preoperative and postoperative assessment was not significant, as shown in Table 7 and Figures 5 and 6.

From Figure 6, it can be seen that the mean language age of exceptional children with different preoperative Greek-internal learning ability ratings tended to increase from the second postoperative assessment, and exceptional children with excellent Greek-internal learning ability were significantly higher than children with other levels of hearing impairment, children with moderate to high and moderate hearing impairment were closer, and children with moderate to low hearing impairment had a slower development of mean language age from the fourth assessment significantly lower than children with excellent, upper intermediate, and intermediate levels of hearing impairment.

A one-way ANOVA was conducted to determine the mean language age of exceptional children with different preoperative Greek-negative learning ability ratings at each assessment point. Only at the second and sixth assessments, $P < 0.05$, and at the rest of the preoperative and postoperative assessments, P was greater than 0.05. In other words, the mean language age of exceptional children with different preoperative Greek-internal learning ability ratings did not differ significantly at the preoperative and postoperative assessments, as shown in Table 8.

4.2.4. *Speech Intelligibility of Exceptional Children with Different Preoperative Greek-Internal Learning Ability Ratings at Each Assessment Time Point.* As shown in Figure 7, the speech intelligibility ratings of exceptional children with preoperative Greek-internal learning ability ratings of excellent, moderate to high, and moderate all showed an increasing trend, especially during the first to fourth assessments. The speech intelligibility ratings of children with preoperative low to moderate Greek-internal

learning ability ratings were more average, with ups and downs at different assessment points, but also showed an overall increasing trend, and the speech intelligibility rating at the seventh assessment was higher than that at the preoperative one.

5. Conclusion

The widespread availability of newborn hearing screening, more comprehensive hearing assessment methods, and the use of cochlear implants have led to in-depth research into the effects of interventions and rehabilitation for hearing-impaired children. This paper analyzes the factors affecting the language rehabilitation of preschool disabled children and puts forward specific suggestions for rehabilitation work. We hope these suggestions can be helpful to improve the language rehabilitation ability of preschool disabled children. Through the analysis of rehabilitation data, it provides guidance for formulating rehabilitation methods and helping more children with disabilities.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

Acknowledgments

This work was supported by the general project in 2021 of the 14th Five Year Plan of Educational Science in Jiangxi Province (21YB278): Research on the current situation and countermeasures of educational rehabilitation of preschool special children—based on the investigation of special education schools in Jiangxi Province.

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