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# Application of RDLS scale to characterize oral language profiles in children using cochlear implant

## *Aplicação da Escala RDLS para caracterização do perfil da linguagem oral de crianças usuárias de implante coclear*

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**Keywords**

Hearing
Cochlear Implantation
Rehabilitation
Language
Deafness

## ABSTRACT

**Purpose:** Analyze and characterize the oral language of a group of children participating in an auditory rehabilitation program, with at least five years of dispositive use, based on skills of receptive and expressive language measured trough the verbal comprehension RDLS scale. **Methods:** Transversal and prospective study, evaluating 6 children with age between 8 and 11 years old, all with neurosensory bilateral severe deafness, average time of cochlear implant use of at least 5 years. The evaluation was performed using the RDLS scale, a Brazilian variant of the American scale known as Reynell Developmental Language Scales (RDLS). It consists of the comprehension scale, expression scale, in addition to sub-scales: structure, vocabulary and content. **Results:** The naming skills were significantly better when compared to abilities involving pragmatic language functions, demonstrated by the sub-scales of content and structure, like the description of a figure and construction of longer sentences or syntactic organization compared to objects, words and figures identification. **Conclusion:** There were no significant differences between the Comprehension and Expression scales; however, we noted that the performances in more complex structures, like sentences recognition, were inferior to their word recognition performances. These results imply possible implementation of educational and rehabilitation programs for children using cochlear implant.

**Descritores**

Audição
Implante Coclear
Reabilitação
Linguagem
Surdez

## RESUMO

**Objetivo:** Analisar e caracterizar a linguagem oral de um grupo de crianças, participantes de um programa de reabilitação auditiva, usuárias de implante coclear (IC) há, no mínimo, cinco anos, com base nas habilidades de linguagem receptiva e expressiva, mensuradas por meio da Escala de Compreensão Verbal da RDLS. **Método:** Estudo prospectivo transversal, no qual foram avaliadas seis crianças, com idade entre 8 e 11 anos, surdez profunda sensorioneural bilateral, cuja média de tempo de uso de IC foi de, no mínimo, cinco anos. Utilizou-se como instrumento a Escala RDLS, uma versão brasileira da escala americana conhecida como Reynell Developmental Language Scales (RDLS). É composto das Escalas de Compreensão e de Expressão, além das Subescalas Estrutura, Vocabulário e Conteúdo. **Resultados:** As habilidades de nomeação apresentaram-se evidentemente melhores em comparação às habilidades que envolveram funções pragmáticas de linguagem, demonstradas nas Subescalas de Conteúdo e Estrutura, como a descrição de uma figura com elaboração de sentenças mais longas ou a organização sintática comparada à identificação de objetos, palavras e figuras. **Conclusão:** Não houve discrepâncias significativas entre a Escala de Compreensão em relação à Escala de Expressão Verbal, no entanto nota-se que, em estruturas mais complexas, como reconhecimento de frases, os desempenhos foram mais baixos do que no reconhecimento de palavras. Tais resultados implicam possíveis implementações de programas educacionais e de reabilitação para crianças com IC.

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## INTRODUCTION

In Brazil, the number of deaf children who have undergone cochlear implant surgery (CI) is increasing in order to acquire hearing close to normal thresholds and thus develop oral language[1-3]. This requires hearing habilitation and rehabilitation through rehabilitators to help these children and their families through the language acquisition stages[4-6]. This surgery has recently been performed in Manaus by private initiative; however, most children from the region are referred to other implant centers in Brazil for care in the Unified Health System (SUS), most commonly to the Southeast, through out-of-home treatment (OHT). They then must return to their hometown for hearing stimulation and language skills, a fact that favors the study, since certain aspects of the subject have not been depleted[7].

The children using CI since then are being included in mainstream schools and no longer in special education schools, making the development of these skills a necessity.

Deaf children are known to show significant difficulty in all aspects of oral communication, such as delays in vocabulary acquisition, compression and verbal expression, grammar, pragmatics, etc. The literature reports that these children have difficulties in structuring sentences, generally using more nouns and articles than indefinite verb forms and pronouns[6,8,9]. Considering these specificities, we can assure that technological resources such as CI have contributed to enable hearing within or closer to normal hearing thresholds, thus facilitating the development of oral language.

The interest in conducting this study arose after the implementation of a pilot program for the rehabilitation of this public. The objective is to provide hearing habilitation and rehabilitation to deaf children who use the CI and study in the regular municipal school system. This program is composed by a team of two speech-language pathologists, a psychologist and a Portuguese-language teacher who specializes in deafness and seeks to meet the criteria for speech and language stimulation through the aurioral approach, as well as to encourage participation of the family in this process.

It is important to report that children who require the use of LIBRAS (Brazilian Sign Language) are referred for educational support when needed. In addition, it has been reported that after a period of care, longer periods of device use by older children (above 4 years of use) are scarce.

Numerous discussions about language acquisition have been held by the most varied sciences and researchers on the subject, and the number of studies that have sought to verify the linguistic performance of these children after the placement of the hearing device is increasing[2,5,6,8,10]. As mentioned earlier, some of these studies[2,11,12] indicate a lack of studies reporting results after long periods of use of the device, and consider that CI has effectively contributed to the development of functional communicative skills in adolescents who grew up using the electronic device. They report that some syntactic communication patterns can only be measured after some time of implant use, which justifies our research during the minimum period of use of five years. They confirm the need for further assessment of the course of language skills development.

Among the studies on the quality of language comprehension conducted in Brazil, with emphasis on language rehabilitation, we highlight those using the RDLS Scale as an instrument[13,14]. These studies propose the use of this scale, which objective of evaluation is to characterize language to direct the clinical and educational intervention of children with any language alteration, and may also be used to investigate the language of hearing impaired children.

Given the above, this study aims to analyze and characterize the oral language of a group of children, participants of a hearing rehabilitation program, and users of CI for at least five years, based on receptive language skills and measured by the RDLS Verbal Comprehension Scale.

## METHODS

The research was approved by the Research Ethics Committee of the Amazonas State University (UEA), under protocol number 215.008. Regarding ethical care, it is noteworthy that all parents or legal guardians of the participating children consented to this research and the dissemination of their results. All signed the informed consent form about the research objectives, highlighting its voluntary nature. The study was characterized as prospective and cross-sectional.

### Description of participants

The study included six children diagnosed with profound sensorineural deafness, users of CI, who were assisted in a hearing rehabilitation program, aged from 8 to 11 years, at the time of the research. All were included in regular municipal classrooms and were being accompanied by the program's educational advisory team. Inclusion criteria were: diagnosis of bilateral deep deafness; use of the CI device for at least five years; continually verify, through reports sent by the centers where they performed the implant, new map adjustments, as well as the use of oral language as a means of communication. Participate in auditory rehabilitation therapy in the program with essentially aurioral approach and present receptive and motivated family in the rehabilitation process. Children who did not meet these criteria, those with post-lingual hearing impairment and those with any impairments to global development or those with deafness were excluded.

Of the six participants evaluated, five used the Cochlear Corporation Nucleus 5 CP810 speech processor and one, the Freedom device of the same brand. At fairly regular intervals, at the centers where they underwent surgery, they performed mappings and adjustments of the CI speech processor that guided the therapy. Importantly, all electrodes were inserted at the time they received the CI, according to information from medical records.

The children were evaluated in the therapeutic attendances context performed in the program. Table 1 shows the characterization of the study participants regarding gender and etiology; age at the time of evaluation and the time of implant use; age at the time of electrode activation and at the same time, sensory deprivation; the model of the device in use at the time of scale application and the speech detection threshold.

**Table 1.** Characterization of study participants

| Participant | Sex | Etiology | Current age (year/month) Time of assessment | CI use time | Activation Age | Time of hearing deprivation | Device model | Speech Detection Threshold |
|---|---|---|---|---|---|---|---|---|
| P1 | F | Cytomegalovirus | 9:2 | 6:11 | 2:2 | 2:2 | Nucleus 5/ Cochlear | 25 |
| P2 | F | Prematurity Ototoxicity | 9:6 | 7:0 | 2:0 | 2:0 | Nucleus 5/ Cochlear | 25 |
| P3 | M | Prematurity Ototoxicity | 8:1 | 5:4 | 2:9 | 2:9 | Nucleus 5/ Cochlear | 30 |
| P4 | F | Congenital | 11:2 | 7:5 | 3:9 | 3:9 | Nucleus 5/ Cochlear | 35 |
| P5 | M | Idiopathic | 10:0 | 5:3 | 4:9 | 4:9 | Nucleus Freedom/ Cochlear | 40 |
| P6 | M | Idiopathic | 8:10 | 5:1 | 3:9 | 3:9 | Nucleus 5/ Cochlear | 35 |

**Caption:** F = Female; M = Male; CI = Cochlear Implant

It is noteworthy that at the time of the surgery, participants had characteristics that met the implant indication criteria, such as pre-lingual deafness, hearing thresholds above 90 dBHL at frequencies of 500, 1,000, 2,000 and 4,000 Hz and initial age of 2 years up to 4 years and 11 months, maximum. Photographic records and video recording were performed during the exam application.

## Instrument

We used the instrument proposed and adapted by Fortunato-Queiroz[14], known as RDLS, a Brazilian version of the American scale known as Reynell Developmental Language Scales (RDLS). This instrument is composed of two scales for oral language assessment: The Verbal Comprehension Scale and the Expression Scale.

The Verbal Comprehension Scale works by means of a few verbal commands, which must be given one at a time, clearly and easily. If the child responds inappropriately, the result will be considered negative, according to the researchers. The command may only be repeated once if the child requests or does not respond. This scale consists of 67 items divided into ten sections that evolve in complexity and, during collection, the sections were grouped according to material indications. Thus, we have: pre-verbal behaviors (section 1); recognition and relationship between lexical words (nouns), with nouns directly linked to context: objects considered familiar (sections 2 and 3); objects representing people and animals (section 4 - Figure 1); two objects that have obvious relationship to each other (section 5); lexical word recognition (nouns and verbs): verbs linked directly to the objective (section 6); verbs not directly related to nouns (section 7); comprehension of nouns, verbs and closed-class words (adverbs, pronouns and adjectives) in the same sentence (sections 8 and 9 - Figure 2); comprehension of nouns, verbs and closed-class words forming content sentences that go beyond hard evidence (section 10). Each item in each section corresponds to a verbal command directed at the child.


**Figure 1.** Aplication of verbal comprehension scale section 4 – objects that represent people and animals


**Figure 2.** Section 9. Application of verbal comprehension scale. Comprehension of nouns, verbs and closed class words (adverbs, pronouns and adjectives) in the same sentence

The Expression Scale is composed of 67 items grouped into three sections: structure, vocabulary and content. The structure was assessed through spontaneous conversation and behavioral observation, in which each item corresponds to one point, totaling 21 points. As for vocabulary, the children named specific items, computing 22 points. Regarding the content, they were called to talk about specific figures, totaling 24 points. At the time of data collection, the evaluator was positioned next to the child, allowing orofacial reading. Each child was evaluated separately, with a maximum duration of 60 minutes, only once, which was carried out. The materials used during the research investigation, suggested by RDLS, were: toys, objects, miniatures and figures, selected according to the application and purpose of each section. During the test application, the answers collected were annotated in the registration form proposed by the instrument.

Data were transcribed for analysis and findings compared to other studies described in the specialized literature. The total score of the RDLS computes 134 points, adding the 67 points of the comprehension scale to the 67 of the expression scale. The analysis of these data followed the criteria proposed by the instrument, which were analyzed and related using the software SPSS (program for statistical measurement, through descriptive analysis), version 22.0, in Portuguese for Windows, as well as some data organized in the Excel. Thus, the receptive and expressive evaluation and characterization of the oral language of the program participants were performed descriptively based on the scale scores, considering the most relevant findings.

## RESULTS

The study compared the relationship between oral comprehension performance and oral expression performance of a group of children using CI for at least five years. However, we must emphasize the limitations of our study, in which it was not possible to generalize the results to consider a small sample with many variables. Total mean scores were calculated in the Children's Comprehension and Expression Scale (Table 2).

The correlation between these two scales (Figure 3) suggests that words with lexical meaning were easier, with the Comprehension Scale showing better results, despite minimal variation, compared to the Oral Expression Scale.

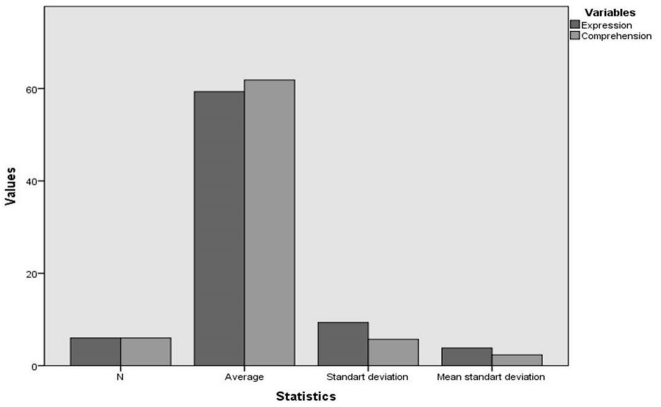
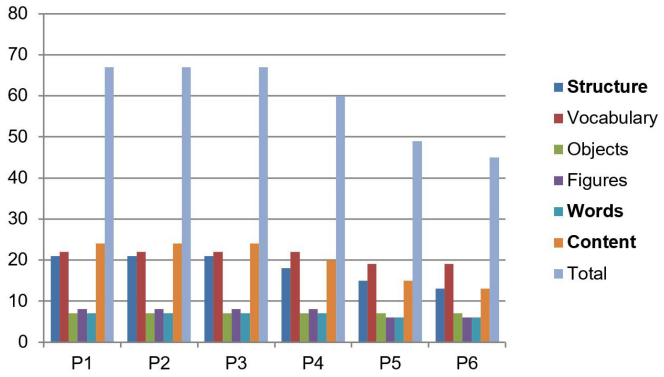



**Figure 3.** Comparison between the Comprehension Scale versus Expression Scale. Standard deviation




**Caption:** P1 = Participant 1; P2 = Participant 2; P3 = Participant 3; P4 = Participant 4; P5 = Participant 5; P6 = Participant 6

**Figure 4.** Acquisition of the language evaluated with the RDLS Scale - Expressive Language/Expression Scale. Maximum score of the test: Expression scale: 67 points; Structure: 21 points; Vocabulary: 22 points; Content: 24 points

**Table 2.** RDLS Verbal Expression and Comprehension Scale Average

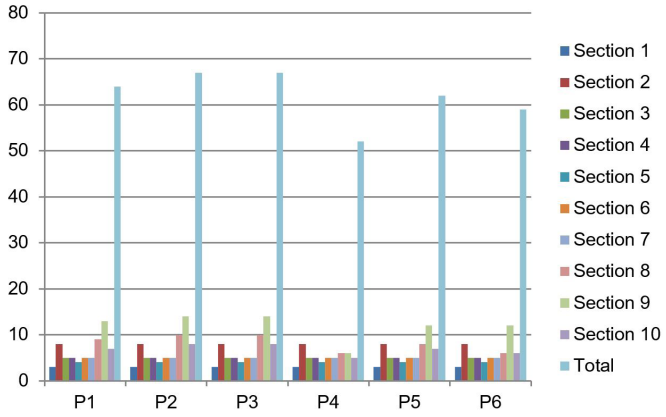
| Scales | N | Average | Standard deviation | Mean standard error |
|---|---|---|---|---|
| Comprehension Scale | 6 | 61.8333 | 5.70672 | 2.32976 |
| Expression Scale | 6 | 59.3333 | 9.35236 | 3.81809 |

**Caption:** N = number of participants who took the test

**Table 3.** Statistical analysis of expressive skills

| Statistics - Structure, Vocabulary and Content | | | | |
|---|---|---|---|---|
| | N | Average | Standard deviation | Mean standard error |
| Structure | 6 | 18.0000 | 3.34664 | 1.36626 |
| Vocabulary | 6 | 21.3333 | 1.21106 | 0.49441 |
| Content | 6 | 20.0000 | 4.93964 | 2.01660 |

**Caption:** N = number of participants who took the test




**Caption:** Maximum comprehension scale score: 67 points; Section 1 = 3 points; Section 2= 8 points; Section 3 = 5 points; Section 4 = 5 points; Section 5 = 4 points; Section 6 = 5 points; Section 7 = 5 points; Section 8 = 10 points; Section 9 = 14 points; Section 10 = 8 points. Data for correlation with the findings. P1 = Participant 1; P2 = Participant 2; P3 = Participant 3; P4 = Participant 4; P5 = Participant 5; P6 = Participant 6

**Figure 5.** Receptive language evaluated with RDLS Scale - Verbal Comprehension Scale

Figure 4 presents the overall result of expressive language measured with the RDLS Scale, with attention to the Structure, Vocabulary, and Content sessions.

Table 3 shows the results of the partial scores averages of the participating children referring to the Expression Scale Subscales.

Figure 5 shows the Verbal Comprehension Scale score results.

## DISCUSSION

The children participating in this research were between 8 and 11 years old. They had used CI for at least five years and had scores of receptive and expressive oral language skills similar to the results found in the Fortunato-Queiroz[14] 14 survey of 4-year-old hearing children, who scored from 51 to 61. The mean score found in this group of implanted children, as shown in Table 2, was 61.83 on the Verbal Comprehension Scale, which was lower than expected for CI use time and chronological age. The mean value for the Expression Scale was 59.33, compared by the same author to the results found in hearing children of 5 years of age, who had a variable score between 55 and 61[14]. It is important to mention that another research aimed at profiling the oral language of children with at least five years of CI use showed similar results to those found[11].

When analyzing the results of the Expression Scale, we noted that the lowest score found in our study was related to the Structure Subscale, whose section evaluates the language structure from the first vocalizations to the appropriate use of the syntactic structure and verb tenses, as guided by this instrument. This finding explains the difficulties also found in the Content section (Table 3), in which it is possible to perceive more difficulty in the child's ability to use language creatively, such as describing a figure with elaboration of longer sentences, than in identifying objects, words and pictures. All participants presented clear verbal recognition responses with word emission, making naming easier.

However, regarding the Expression Scale Content Subscale, it is more difficult to assign meaning to the word, since the purpose of this section was to evaluate the pragmatic use of language. These findings were also reported in a research that referred that the children surveyed had great difficulty in describing the meaning of a word, corroborating our data[11].

The results, shown in Figure 5 regarding the Comprehension Scale score, showed that the children did not present difficulties regarding the recognition or the relationship between lexical words, present in sections 2 to 5 of the Verbal Comprehension Scale. These data agree with a study in which seven participants were evaluated for the receptive/comprehensive vocabulary repertoire through the Peabody Picture Vocabulary Test, an instrument that allows assessing the level of receptive language development for both preschoolers, children and adults. In the phrase recognition test, participants' performances were lower than in word recognition[15].

When comparing these results, another study evaluated the language of seven children using CI for five years, using standardized scales[16]. Their results indicated variability in performance among the individuals surveyed, as found in this research, however, as significant point in the findings, the authors pointed out evidently better semantic skills compared to syntactic and morphological skills.

This study concluded that all patients demonstrated impaired skills in relation to their hearing pairs. According to the authors, the findings have implications for the implementation of optimal rehabilitation and education programs for children with CI. It is important to mention that several studies indicate that this variability in participants' performance in relation to the rate of evolution of pre-linguistic skills is influenced by numerous variables, such as time of auditory sensory deprivation, age of CI surgery and time of use of CI[5,8,11,16-20].

Regarding the precocity of the CI, a research carried out in Coimbra had as an instrument the Language Assessment Test in children to verify the development of oral language, and the main objective of this study was to investigate the evolution of the performance of children using the device within over time and the influence of age on this evolution. The group of children with the best final results and the evolutionary curve closest to the existing normative data was the one with the earliest implantation[21]. Participants in this study received the implant at a minimum age of 2 years and later, which is considered late for the language acquisition process. In our survey, we can see the difference in age of device implantation regarding age.

Another retrospective longitudinal study used the the RDLS Scale to analyze the expressive language of 288 children aged 8 years, users of CI, with one, two and three years of use of the device. It showed that children implanted before 2 years of

age presented significantly better performance in the test than those implanted later. The research emphasized that contralateral stimulation and family participation in the therapeutic process were reported as variables that influenced the language development of the researched population. Understanding these variables will allow parents and professionals to create better circumstances for the acquisition of the language of implanted children[19].

Thus, it is possible to enumerate many variabilities in the results of these studies. However, although they point to lower linguistic and educational development than their hearing pairs, they may, over time, give better results[21].

We reiterate that there are few cases in this study, a fact that does not allow us generalizations, especially when talking about deafness. However, considering the specificities of the North region, where the number of implanted children is still quite small compared to other regions of the country, we understand that it is still essential to monitor the development of hearing and language skills.

Thus, the results presented in this research deserve careful interpretation, considering the small number of participating children, according to the established inclusion criteria, a fact that should not be a discouraging factor to measure the answers, understanding the need for replication of this study with a larger sample of participants.

## CONCLUSION

The participants in this study did not show significant discrepancies between the Comprehension Scale and the Verbal Expression Scale. However, correlating the two scales facilitates the lexical and semantic levels, without difficulties in recognizing these words.

In more complex structures such as phrase recognition, performances were lower than in word recognition. Such results imply possible implementation of educational and rehabilitation programs for children with CI. We emphasize that among the evaluated skills, naming skills were evidently better compared to those involving pragmatic language functions after five years of effective use of the implant.

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## Author contributions

*MSP data conception, design and interpretation; data collection in the application of the scale, analysis of medical records, discussion of the findings in the literature, writing of the manuscript and revision; MBPC data design and interpretation, elaboration of tables and graphs, data collection, discussion of the findings in the literature, writing of the manuscript and its revision.*