Journal of Social Sciences and Humanities,
Vol:16, N°:01, 2026, P:318-344
https://journals.univ-msila.dz/index.php/JOSSH
ISSN Online: 2602-6961
ISSNPrint: 2253-010X

The orthographic mistakes for non-hearing children with cochlear implants-Case study-

الأخطاء الاملائية لدى الأطفال الصم الحاملين للزرع القوقعي -دراسة حالة-

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How to Cite
Bagaa, H. The orthographic mistakes for non-hearing children with cochlear implants-Case study- . Journal of Social Sciences and Humanities , 16(01). Retrieved from https://journals.univ-msila.dz/index.php/JOSSH/article/view/10165

Received: 26-07-2025
Accepted: 28-04-2026
Published: 10-06-2026

Abstract

This study aims at finding out the orthographic mistakes made by children with cochlear implants through an analysis of their writings, and at diagnosing the difficulties they face when transforming the spoken into written. The study was conducted on 03 primary education learners with cochlear implants aged between 10 and 11, who were chosen at random. In addition, the study uses the analytical descriptive method, the case study, and the scale designed by Hachani Souad (2016) to measure the orthographic mistakes and classify them into lexical and phonological. Findings show that children with cochlear implants suffer clear difficulties in orthography, mainly substitution and distortion of consonants, reflecting troubles in representing the phonological structure of words and matching sounds with letters. Besides, children with cochlear implants suffer difficulties in the auditory (phonological) recognition and a lexical poverty. These two dimensions are integral and directly affect the quality of writing. Therefore, the study recommends adopting an early comprehensive educational approach that targets the linguistic and auditory skills, and fostering the individual interventions according to the specificity of each child to achieve linguistic

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efficiency after cochlear implant. These results do not only help diagnose the deficits; rather, they shed light on the urgent need to develop specialized and adapted teaching programs based on an exact understanding of these children, which include therapeutical and preventive educational activities that strengthen the vocal representations and distinction between consonants and vowels, and train children on identifying the points of articulations inside each word (start, middle, end), with focus on the recurrent orthographic patterns that cause common mistakes.

Keywords

orthography; orthographic mistakes; hearing impairment; cochlear implant.

الملخص

تهدف هذه الدراسة إلى الكشف عن طبيعة الأخطاء الإملائية لدى الأطفال الحاملين للزرع القوقعي، من خلال تحليل كتاباتهم وتشخيص أنماط الصعوبات التي يواجهونها في تحويل المنطوق إلى مكتوب. وقد أجُريت الدراسة على عينة قصدية مكوّنة من ثلاث حالات لأطفال حاملين للزرع القوقعي تتراوح أعمارهم بين **10** و **11** سنة، يتابعون تمدرسهم في المرحلة الابتدائية.

واعتمدنا في هذه الدراسة على المنهج الوصفي التحليلي، باستخدام أداة لقياس الأخطاء الإملائية، تم تصميمها من طرف الباحثة حشاني سعاد (**2016**) قصد تصنيف الأخطاء وفق أبعادها المعجمية والفونولوجية.

وقد أظهرت نتائج الدراسة أن الأطفال الحاملين للزرع القوقعي يعانون من صعوبات بارزة في الأداء الإملائي، تتجلى أساسًا في كثرة الأخطاء من نوع التعويض والتشويه، خصوصًا على مستوى الصوامت، داخل كل من البُعد المعجمي والفونولوجي، مما يعكس اضطرابًا في تمثيل البنية الصوتية للكلمات وفي عمليات الربط بين الصوت والحرف، أي انهم يعانون من صعوبات تشمل ضعف التمييز السمعي (الفونولوجي والفقر المعجمي) وهما بعدان متداخلان يؤثران بشكل مباشر في جودة الكتابة. كما تؤكد هذه النتائج على ضرورة تبني مقاربات تعليمية متكاملة ترتكز على تنمية المهارات السمعية واللغوية في وقت مبكر، مع تعزيز التدخلات الفردية المصممة حسب خصوصية كل طفل، حتى تتحقق الفعالية اللغوية المرجوة بعد زراعة القوقعة.

وتكمن أهمية هذه النتائج لا فقط في تشخيص جوانب القصور، بل في تسليط الضوء على الحاجة الملحة إلى تطوير برامج تعليمية متخصصة ومكيفة تستند إلى فهم دقيق

لخصوصيات هذه الفئة من المتعلمين إن هذه البرامج ينبغي أن تتضمن أنشطة تعليمية علاجية ووقائية في آن واحد، تعنى بتقوية التمثيلات الصوتية والتمييز بين الصوامت والصوائت، وتدريب الطفل على مواقع الحروف داخل الكلمة (بداية، وسط، نهاية)، مع التركيز على الأنماط الإملائية المتكررة التي تسبب أخطاء شائعة.

الكلمات المفتاحية

الإملاء، الأخطاء الإملائية، الإعاقة السمعية، الزرع القوقعي.

1. Introduction

Orthography is an important language aspect with a high status for its importance in correct writing, mainly in the early learning phases. In this regard, orthography skills help transform the spoken into written based on some rules. Besides, it is such an important linguistic measure that a child with linguistic wealth and no orthographic skills cannot produce meaningful passages. In this regard, the orthographic difficulties lead to mistakes that change meaning and create opacity. Therefore, listening to the content and articulation points is vital. Besides, correct writing is important, and orthography has a big effect on the school life because of its relation with all the school subjects and works. Studies showed that children with orthographic skills perform well in schools because the orthographic mistakes distort writing and comprehension.

Listening is the nexus between the human and his external world. A hearing impairment raises difficulties in response and verbal interactions, hinders the child growth, and needs solutions. Fortunately, scientists introduced the cochlear implant to help children with hearing impairments hear voices and speech, communicate with others, and overcome isolation. Usually, children with hearing impairments face difficulties in acquiring reading and writing and commit orthographic mistakes. However, children with cochlear implants can hear voices and understand the relation between sounds and letters.

Orthography is one of language aspects that transform the spoken into written based on rules. Correct writing reflects the orthographic skills and helps develop the artistic, cultural, and scientific skills. Orthography is vital for written expression and is the tool identified by humans to translate ideas and communicate. In addition to grammar, orthography is an exact measure to judge children learning achievements (Samak, 1979, p.521). In this regard, the orthographic difficulties require the collaboration of many education scholars and practitioners, mainly the teachers who must teach children correct spelling and writing to communicate correctly. Experts attribute such difficulties to the specificity of language, exceptions, orthography rules, similar words, silent letters, different writings of one letter, dots, lack of motivation, and inappropriate teaching methods.

Writing is the 03rd form of the linguistic system that is based on the complementarity of oral language, reading, and written language, which is a highly complicated communication tool. The written language is an important tool to express the self, preserve history and civilization, and learn and teach. (Messad, 2012, p.111). On the other hand, speech is the best tool to express feelings and ideas and acquire knowledge. Besides, the spoken statements can better express the inside more than the written (Mahmoud, 1981, p. 01). However, writing is still necessary, as it allows children to write what they see and what is dictated. It is achieved after learning letters, sounds, and their rules. In this regard, children with hearing impairments face difficulties in writing, as Fabrito Voltaro Bontikorfer (1998) states that children with hearing impairments face difficulties in applying language rules, and that the orthographic skills are an important process that requires more efforts than copying writing. And the brain learns naturally through this effort, giving the learner the opportunity to achieve a better education and opening the door to better possibilities beyond the confines of the classroom. (Sari Alali 2025, p. 526).

Undoubtedly, language is the growth aspect that is most affected by hearing impairments, as the inability to produce sounds, hear the others' speech, or know their reactions to the sounds made by people with hearing impairments limits their language balance and creates difficulties in its use. Thus, people with hearing impairments should get programs to learn efficient communication with their surroundings and acquire knowledge and skills that suit their ages and peers. In this regard, the private schools and centers provide interventions to teach these children and prepare them for life and participation in building their societies, as societies need everybody (Ghanim, 2016, p. 66).

Cochlear implant is a modern medical tool that aims at improving hearing for people with impairments. It transforms sounds into electrical signs sent to the auditory nerve, and helps the users develop the ability to hear and speak. Usually, children with hearing impairments face difficulties in reading and writing acquisition, and commit orthographic mistakes. In this regard, they do not naturally understand sounds and face difficulties in matching them with the letters. Besides, children with cochlear implants may acquire language late, what affects their orthographic skills. Based on what was said, we shall investigate the orthographic mistakes for children with cochlear implants and focus on the orthographic difficulties faced in distinguishing the similar sounds that cause omission, addition, or substitution.

Despite the importance of this topic, studies did not focus on it, as most of them discussed the linguistic auditory development without focus on the orthographic performance. Therefore, we decided to tackle these difficulties to better understand them and pave the way for future studies to foster the support provided to such children.

Literature review, the study of Yamina Attal (2014): It focused on the brain hemispheres, the degree of hearing impairment, and the writing skills (written expression, handwriting, and dictation). It compared normal children to children with hearing

impairments to know the effect of cerebral hemispheric dominance and hearing impairments on handwriting, dictation, and written expression. The study used the descriptive method and relied on comparisons. The sample included normal and non-hearing children. The author used writing skills tests designed for 04th and 05th grade learners and a cerebral hemispheric dominance questionnaire, and found out insignificant differences between the two groups, and no differences between children with moderate hearing impairments and those with a deep one regarding writing and cerebral hemispheric dominance.

The study of Safih Lamia & Souli Wassila (2019): It focused on the effect of school integration on the development of written language through dictation for children with cochlear implants included in public schools. The authors used the case study and dictation scale, and focused on 04 children. After examining the psychometric properties of the tool and answering the study questions, the study found out that inclusion has a positive effect on the development of written language of children with cochlear implants who are included in public schools. Besides, there were statistically significant differences in writing development according to the years of inclusion. Thus, the study recommended including children with cochlear implants in public schools, training the teachers, and adjusting the school curricula to suit their skills.

The study of Hachani Souad & Salima Latoui (2022): It analyzed the orthographic difficulties for some 04th grade learners suffering phonological writing difficulties, and used the clinical method and case studies. Besides, the authors used Wechsler test and an orthographic scale. After examining the psychometric properties of the tool, it was applied on 04 cases; 02 males and 02 females. Findings showed that addition was the most common phonological mistake in consonants while omission was the most common phonological mistake in vowels. As for substitution, the learners substituted a consonant with another one that has a different point of articulation but the same phonological nature. Besides, most of the phonological mistakes happened in the end of the word. Moreover, these difficulties may affect writing and dictation and lead to orthographic mistakes.

Based on the literature review, we shall focus on children with cochlear implants and raise the following problematic, "Do children with cochlear implants show orthographic mistakes?". From this question, sub-questions arise as follows:

- Do children with cochlear implants show phonological mistakes?
- Do children with cochlear implants show lexical mistakes?
- What are the common consonant substitutions made by children with cochlear implants?

General hypothesis:

- Children with cochlear implants show orthographic mistakes.

Sub-hypotheses:

- Children with cochlear implants show phonological mistakes.
- Children with cochlear implants show lexical mistakes.

- Consonant substitution with another consonant that has the same phonological properties but different articulation point is the most common substitution made by children with cochlear implants.

Aims of the study:

- Revealing the orthographic mistakes caused by the writing effect for children with cochlear implants.
- Identifying the orthographic mistakes for children with cochlear implants.
- Widening the scope of studies that focus on the orthographic mistakes for children with cochlear implants.

Importance of the study:

- Studying writing skills, mainly orthography, for children with hearing impairments included in public schools.
- Shedding light on the status-quo of children with hearing impairments by including them in the academic field.
- Studying the development of written language, mainly orthography, for included children during the inclusion years.

2- The study concepts:

2.1 Orthography:

It is the science that focuses on rules that help avoid addition or omission. Besides, it focuses on the added and omitted letters, the syllables, and any point that targets linguistic correctness and avoids spelling mistakes that affect writing (Saad Dine, 1932, p. 14). Procedurally speaking, it is the ability of children to write words and sentences respecting language rules. We shall measure it using the scale of Hachani for the orthographic mistakes, which reveals the nature of mistakes, such as substitution, omission, addition, and distortion, with focus on the phonological and lexical mistakes in consonants.

2.2- The orthographic mistake:

It is the mistake made during writing, such as miswriting letters or disordering them, what changes the word and deviates from the language rules (Al Adawi, 2017). Procedurally speaking, it is any wrong spelling of words and any deviation from writing rules. It is detected in children with cochlear implants after applying Hachani test. It primarily covers the phonological and lexical substitution and distortion of consonants.

2.3- The orthographic mistake at the phonological level:

It is that mistake made due to the difficulty of distinguishing similar letters in spoken language. In his "language science and lexicography", Ahmed Omar Mokhtar defines it as the mistake due to confusion of sounds and similar or convergent pronunciation (Mokhtar, 2008, p. 75). Procedurally speaking, it is the mistake during dictation due to issues in representation and distinction of consonants. It appears in Hachani test and covers substitution and distortion and reflects difficulty in matching the sound and the written letter.

2.4- The orthographic mistake at the developmental phonological level:

It is a trouble in writing due to difficulty in matching the sounds and the written words, as the child faces difficulty in transforming the sound into correct symbols. This trouble appears in the phase of language development for children suffering difficulties in spelling words, despite their ability to pronounce them correctly. This difficulty is believed to be the outcome of weakness in the phonological processes that include sounds distinction and representation (Abderrahman, 2017). Procedurally speaking, it is the mistake due to difficulty in phonological development. It manifests in sound substitution or distortion during dictation. For children with cochlear implants, it can be detected using Hachani test. It reflects delay in acquiring the phonological system of language.

2.5- Child with cochlear implant:

He is the child suffering such a deep or acute hearing impairment that he needs cochlear implant, which transforms the voice signals into electrical signs that stimulate the auditory nerve. This helps improve the auditory abilities and develop oral language, mainly if accompanied by pronunciation training (Fani, 2014; Chikh Touhami & Yaalawi, 2016). Procedurally speaking, he is the child with mild hearing impairment who has a cochlear implant to make up for the hearing problems through an electrical stimulation of the auditory nerve. His educational level is measured based on his response to the vocal stimuli after implant, and on his ability to acquire spoken language and communicative and writing skills. Such children are a specific case in writing and reading learning, as their interaction with the sounds, their vocal and writing representation difficulties, and their phonological delay or difference are studied.

3- Methodology of the study:

3.1- Method:

This study aims at studying the orthographic mistakes for children with cochlear implant using the descriptive analytical method and the case study because they are the most suitable. The descriptive analytical method relies on describing the phenomenon or problem, collecting and interpreting data, and making conclusions that help deeply understand the phenomenon (Abidat, 2007). Besdies, the case study aims at identifying a given situation in detail. It is used with the cases that we cannot understand or judge because of their unique conditions. Thus, we collect and analyze the data and information to know more about the case and make conclusions (Bouhouch, 1985, pp. 30-31).

3.2- The study sample:

The sample includes 03 ten to eleven years old children from the 2nd grade at a private primary school, with cochlear implant. They were chosen for having cochlear implants, being in convergent grades, and having +90 IQ to ensure homogeneity and suitable conditions to exactly and objectively study the orthographic mistakes.

Table N°1. The study informants

Cases	Gender	Age	Date of cochlear implant	Cause of hearing impairment	Grade	IQ
Case 01	Male	10 years	2021	Disease (Meningitis)	02	93
Case 02	Male	11 years	2021	Disease (Rubella)	02	92
Case 03	Male	11 years	2021	Hereditary	02	90

3.3- The study limitations:

The study was conducted in the school of "Small deaf and non-verbal people" in Rouiba from February 2025 to April 2025.

3.4- The study tools:

3.4.1- The observation:

We used the direct and indirect observations to collect exact and objective data on the study cases. We attended classes to directly monitor the children's linguistic behaviors and interactions and identify the difficulties they face in real life educational contexts. Besides, we accessed their medical and pedagogical files, including the medical diagnoses and educational reports, to build up a comprehensive image on their linguistic and cognitive states.

3.4.2- The interview:

We interviewed the experts who manage special classes for children with cochlear implant to collect deep information. Besides, we got to know the children and collected information on their health and educational history to choose the most suitable cases. In addition, we interviewed the class teacher to have a quality assessment of the cases' levels, mainly the linguistic efficiency and the verbal development, and to build up a database that helps direct our analysis more objectively and exactly.

3.4.3- Orthography scale:

It is a written linguistic scale applied individually or collectively, which was designed by Souad Hachani to evaluate the orthographic abilities of children between 08 and 09 years; i.e., those in 03rd and 04th grades. Based on the orthographic mistakes, we conclude the existence or absence of developmental writing difficulties and their types (phonological, lexical, or mixed).

3.4.3.1-The dimensions of the orthography scale:

It has three dimensions, namely:

- The phonological memory;
- The phonological channel;
- The lexical channel.

3.4.3.2-Instructions:

The examiner says: "I will dictate a word on you, listen well and write it"

3.4.3.3-The scale application:

The test was applied individually in a calm place to avoid any dischannelion. It takes 20 to 25 minutes. It requires reading the words to the informant in one batch, without any spelling, for 03 times to help him make sure of the words.

3.4.3.4-Tools:

The test needs a paper, a blue pen, and no rubber.

In this study, we relied on two items, namely:

3.4.3.5-The phonological channel: It tests the child ability to write regular words, which are words written as they are pronounced and pronounced as they are written. They are pseudo unfamiliar words that neither have meaning nor belong to the linguistic system. They are used because they are unfamiliar and not used in reading and writing. This dimension includes 20 words.

3.4.3.6-The lexical channel: It tests the irregular familiar words, which are neither written as they pronounced nor pronounced as they are written. They are more frequent in reading and writing. This dimension has 20 words.

4. Presentation and Analysis of Results:

4.1 Presentation of Case 01 (M.S)

4.1 Presentation of the Results of the Clinical Interview and of the Observation:

M.S is a 10 years old boy at the 02nd grade of primary education with good cultural, economic, and social conditions. The boy suffers no health, mental, or psychological issues and has good relations with his family, colleagues, teacher, and external world. He did not face any shocks in early childhood and suffers no mental delay. For the linguistic development, a speech therapist provided early care. M.S. is very polite, has fairly good academic results, but is chaotic, as noticed from his copybook. Besides, he is hasty and impetuous in answers, and is always blamed by his teacher for his bad handwriting and orthographic mistakes despite the absence of any problems in visual-motor harmony, muscular command, and pen grab. Moreover, he is very slow at writing, faces difficulty in copying long sentences, feels tired very fast, and suffers problems in attention, retention, planning, problem-solving, and math.

4.1.6.1 Presentation and Analysis of the Results of the Phonological and Lexical Channels for Case 01 Regarding Constants and Vowels:

Table N°2. The percentages of phonological orthographic and lexical orthographic mistakes for case 01 regarding consonants and vowels

Phonological channel		
Consonants and vowels	Consonants: degree (percent-ages)	Vowels: degree (percentages)
Substitution	6 (%30)	(0%) 0
Omission	1(%5)	15(%75)
Addition	1 (5%)	(0%) 0
Transposition	(0%) 0	(0%) 0
Distortion	5 (%25)	(0%) 0
Lexical channel		
Consonants and vowels	Consonants: degree (per-centages)	Vowels: degree (percentages)
Substitution	2 (%10)	(0%) 0
Omission	3 (%15)	20 (100%)
Addition	(0%) 0	2 (10%)
Transposition	(0%) 0	(0%) 0
Distortion	1 (%5)	(0%) 0

Quantitative Analysis:

a. The Phonological Channel:

The main vocal mistake is deletion, as the case deleted 15 sounds with a rate of 75%, indicating clear trouble in sound production that shows deficit in controlling vocal channels points of articulation or sounds order when uttering. Then, submission ranks second with a rate of 30%, as he substituted 06 sounds, confirming some phonological awareness despite the difficulty of accurate application. Moreover, we find other types of mistakes, such as addition and vocal transposition; with a rate of 5% for each (they are not very high or impacting on the case). Finally, distortion had a rate of 25%, without a clear number of distorted sounds, showing some changes in sound features, such as mumbling, without full change.

b. The Lexical Channel:

The main issue is deletion, as we noticed 20 cases of deletion out of 20 sounds (100%), showing high inability to retrieve or use words; this limits the efficiency of the linguistic message. In addition, we reported other, even little occurring, mistakes, such as substitution (10%), addition (10%), and distortion (05%), while transposition was not reported. This confirms that the case has major issues with lack or full

deletion of sounds, not with their substitution.

Qualitative Analysis:

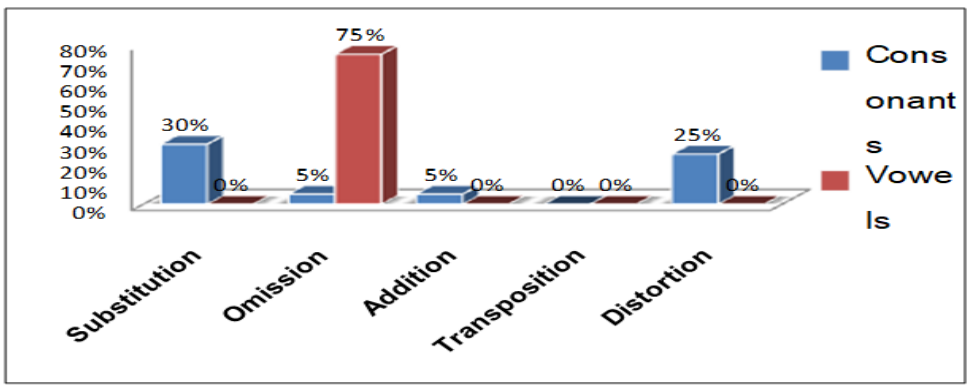
a. The Phonological Channel:

The orthographic mistakes of the case show a recurrent pattern in the phonological and lexical levels, namely vowels' deletion that distorts the word structure and meaning. Besides, we noticed consonants' substitution, such as substituting /b/ with /p/ due to the similar vocal tracts. Besides, he added some consonants in some words, what complicated the mistakes.

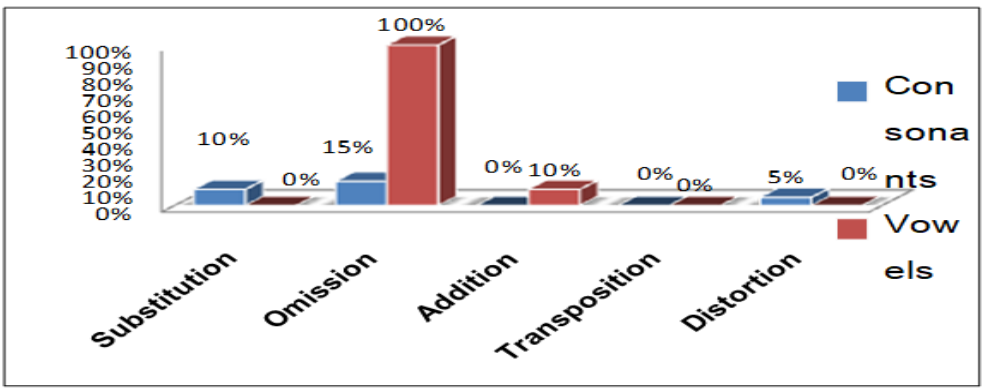
b. The Phonological Channel:

Regarding the unfamiliar words, the case faced more difficulty and made composed mistakes of substitution and distortion, showing weak lexical representation and distinction between familiar and unfamiliar words. Therefore, it is necessary to initiate a pedagogic intervention focusing on vocal awareness, audiovisual distinction, and directed orthographic drills on unfamiliar words and similar consonants.

Graph N° 1. The percentages of the phonological orthographic mistakes in consonants and vowels for case 01



Graph N° 2. The percentages of the lexical orthographic mistakes in consonants and vowels for case 01



3.1.2- Presentation and analysis of the results of the phonological and lexical channels for case 01 regarding the location of the mistake

Table N°3. The percentages of phonological orthographic and lexical orthographic mistakes regarding the location of the mistake for case 02

Quantitative Analysis:

The Phonological Channel:

The vocal mistakes are made in the beginning of words, as we recorded 03 mistakes (50%), showing that the word start is very sensitive regarding the phonological difficulties. Besides, we reported 01 mistake (16.66%) in the middle of the word, and 02 (33.33%) in the end, with no lexical mistakes. Thus, we can say that the difficulties for case 01 appear most in the word start, reflecting weakness in the primary vocal preparation or in the retrieval of phonological representation in the start of pronunciation.

b. The Lexical Channel:

We reported diverse mistakes, mainly in the middle of the word (05 phonological mistakes and 05 semantic mistakes with a rate of 55.55% for phonology and 11.11% for semantics). This shows that the middle of the word raises challenges when retrieving or composing words internally. As for the end, the case made one mistake (22.22%) and no phonological mistakes. Concerning the beginning, we found one semantic mistake and one phonological mistake, with a rate of 11.11% for each. This distribution shows that the lexical mistakes are most common in the middle of the word, indicating trouble in the internal structure of the word or deficit in accessing the full lexical shape, mainly in word production.

The Qualitative Analysis:

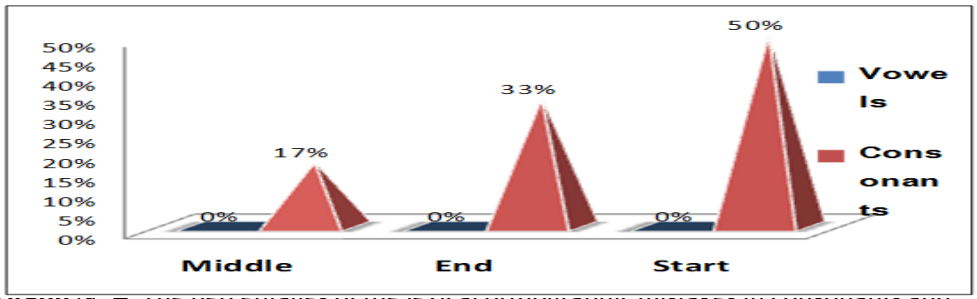
a. The Phonological Channel:

Results show the importance of phonological treatment for the orthographic mistakes, as the vocal processes affect the cognition of vowels and consonants, raising the need for educational strategies that focus on the retrieval of final letters and reduction of phonological mistakes.

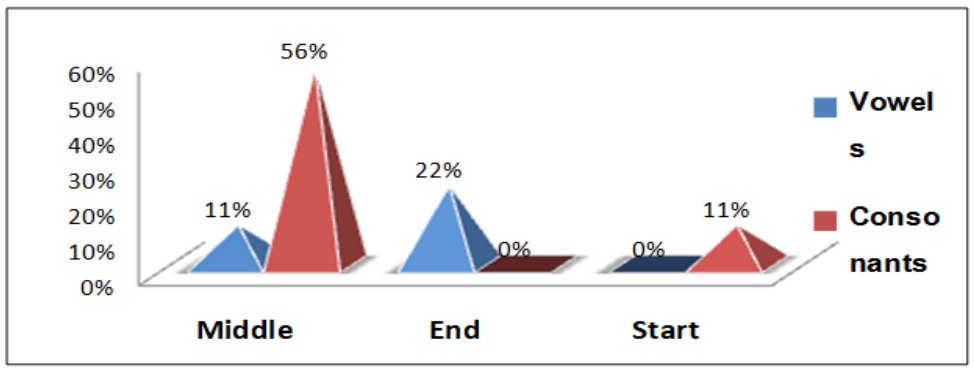
b. The Lexical Channel:

Results show the importance of the lexical treatment for the orthographic mistakes, as the size of the lexical balance and the number of vocabularies in the memory affect the child ability to retrieve and write words correctly. In this regard, the relevant mistakes reflect weakness in identifying the orthographic shape of familiar words, confirming the need for educational approaches that foster the linguistic balance and the visual recognition of familiar words to reduce the mistakes resulting from the low lexical treatment.

Graph N° 3. The percentages of the phonological orthographic mistakes in consonants and vowels regarding the location of the mistake for case 01



Graph N° 4. The percentages of the lexical orthographic mistakes in consonants and vowels regarding the location of the mistake for case 01



external world, and is loved by people. Moreover, he shows ordinary motor-sensor development and improving linguistic development thanks to the ongoing early speech therapy. B.A. is an obedient boy with strong attachment to his mother and elder sister. He has good academic results, loves drawing and handcrafts, but finds difficulties in handwriting. He grabs the pen correctly and suffers no troubles in motor-visual adjustment. Finally, he finds difficulty in copying long texts and suffers deficits in attention, memory, and math.

4.2.1.1- Presentation and analysis of the results of the phonological and lexical channels for case 02 regarding consonants and vowels:

Table N°4. The percentages of phonological orthographic and lexical orthographic mistakes regarding consonants and vowels for case 02

Phonological channel				
	Vowels		Consonants	
Location of the mistake	Degrees	Percentages	Degrees	Percentages
Middle	0	0%	1	16.66%
End	0	0%	2	33.33%
Start	0	0%	3	50%
Lexical channel				
	Vowels		Consonants	
Location of the mistake	Degrees	Percentages	Degrees	Percentages
Middle	5	11.11%	5	55.55%
End	0	22.22%	0	0%
Start	1	0%	1	11.11%

The Quantitative Analysis:

a. The Phonological Channel:

Deletion is the dominant phonological mistake, with 17 mistakes and a rate of 85%, while the semantic mistakes are 02 with a rate of 10%. Besides, substitution was dominant in semantics with 08 degrees and a rate of 40% in sounds, showing that the case substitutes words due to issues in semantics not in the vocal channel. In addition, we reported 01 addition of sounds (05%) and no transposition, and 02 distortion mistakes in semantics and 00 in phonology.

b. The Lexical Channel:

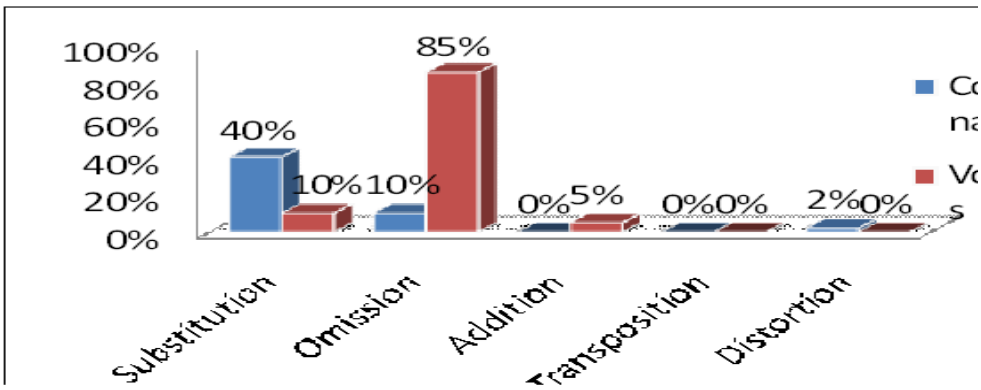
The table shows that deletion is the most common phonological mistake, as we reported 20 mistakes (100%), reflecting the continuity of deletion at the lexical level and a low storage or retrieval of words. Regarding semantics, we reported 04 mistakes (20%), indicating that the lexical treatment is not as difficult as that of the vocal. For substitution, we recorded 06 semantic degrees (30%) and 04 phonological ones (20%), showing intersection between phonological and semantic problems. Moreover, we reported one deletion of sounds (05%) and no transposition. Finally, we reported 08 mistakes (45%) in semantics, without effect on sounds, reflecting deficit in morphology or syntax.

Qualitative Analysis:

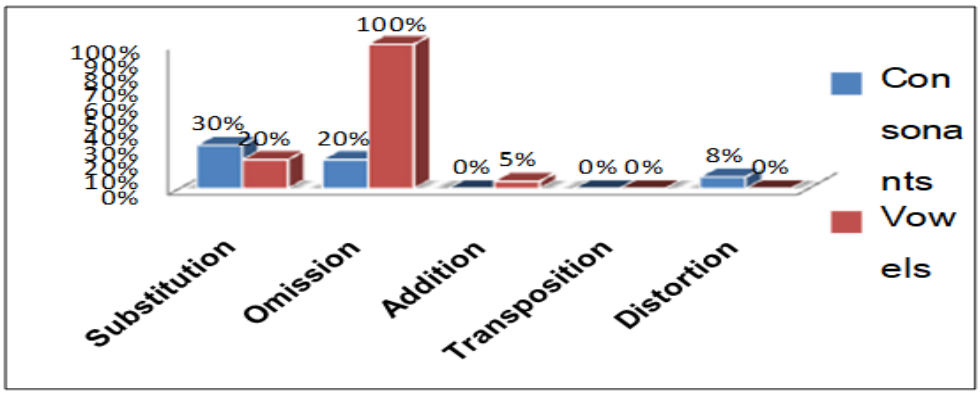
Deletion dominates the phonological aspect while substitution dominates semantics, indicating deficit in the phonological system that causes deletion and a

trouble in the semantic system that leads to using inaccurate alternatives and variance in the ability to produce sounds and reach meaning. In addition, deletion is the most common in the two dimensions, showing severe deficits in the phonological formation of words. Besides, substitution and distortion are more common in semantics, showing issues in the semantic treatment and the inaccurate substitution of words. Finally, we reported no transposition and found out that addition is marginal.

Graph N° 5. The percentages of the phonological orthographic mistakes in consonants and vowels for case 02



Graph N° 6. The percentages of the lexical orthographic mistakes in consonants and vowels for case 02



mistakes regarding the location of the mistake for case 02

Phonological channel				
	Vowels		Consonants	
Location of the mistake	Degrees	Percentages	Degrees	Percentages
Middle	1	8.33%	4	33.33%
End	1	8.33%	3	25%
Start	0	0%	3	25%
Lexical channel				
	Vowels		Consonants	
Location of the mistake	Degrees	Percentages	Degrees	Percentages
Middle	0	0%	1	12.5%
End	5	62.5%	0	0%
Start	0	0%	2	25%

Quantitative Analysis:

a. The Phonological Channel: We found the most phonological mistakes (04 mistakes with a rate of 33.33%) in the middle of the words , 03 mistakes (25%) in the end, and 03 (25%) in the start. As for the semantic aspect, the mistakes happen in the middle and the end of the word, with one degree for each (8.33%). Moreover, no semantic mistakes were reported in the beginning.

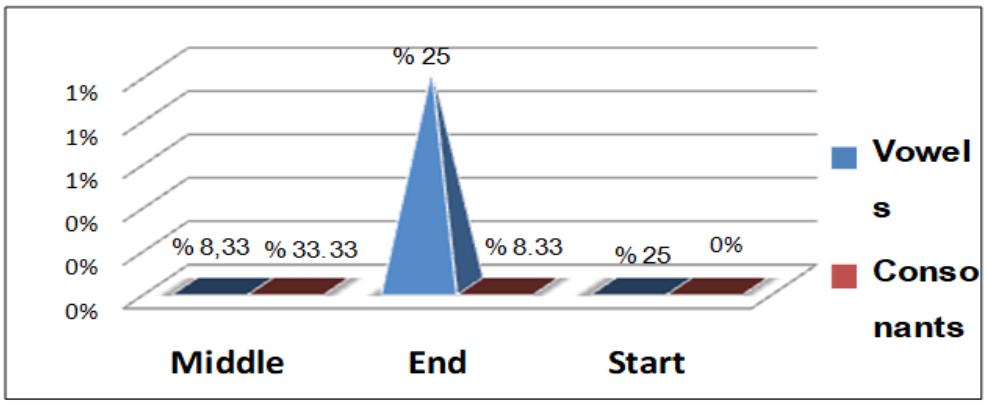
b. The Lexical Channel: For phonological mistakes, we reported 02 degrees (25%) in the beginning, one degree (12.5%) in the middle of the word, and no mistake in the end. Regarding semantics, we reported most mistakes in the end of the word (05 degrees with a rate of 62.%) and no mistakes in the middle or start.

Qualitative Analysis:

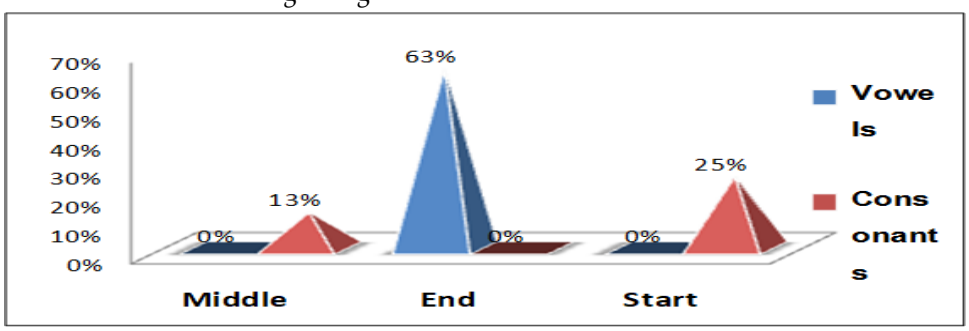
a. The Phonological Channel: We reported recurrent mistakes of deleting vowels, what distorts the structure of the word. For example, all vowels in the words "Qumua and Teel" were deleted, causing unclear or distorted words. Besides, some consonants were substituted, like /b/ sound, marking difficulties in the auditory recognition of similar sounds. Together, these mistakes show weakness in the phonological awareness and the ability to recognize sounds and their positions inside the word. These results agree with those that confirm that the difficulties in the auditory recognition affect children orthography.

b. The Lexical Channel: We reported difficulties in dealing with the unfamiliar words, as the case distorted words by deleting consonants and vowels and substituting some consonants, causing strange words, such as turning "Nami" into "Tamma" and "Aadadan into Aadad", marking difficulties in retrieving the correct shape of the word from the lexical memory and in the lexical representation of words. These results are in line with the studies that tell that the difficulties in the lexical representation affect children orthography. In addition, the child suffers difficulties in the phonological and lexical treatment and issues in the phonological awareness and the lexical representation of words, which affect his orthography skills. Therefore, it is necessary to start a pedagogical intervention.

Graph N° 7. The percentages of the phonological orthographic mistakes in consonants and vowels regarding the location of the mistake for case 02



vowels regarding the location of the mistake for case 02



3.3 Presentation of Case 03 (B. K)

3.3.1 Presentation of the Results of the Clinical Interview and the Observation:

B.K. is 11 years old boy at the 02nd grade of primary school with good cultural, social, and economic conditions. He suffers no health problems, except that he had undergone a surgery on the left foot when he was 05 after a car accident. He suffers no brain or psychological problems and has good relations with family, colleagues, teacher, and external world. He received an early speech therapy and shows acceptable academic results. He suffers no issues in the motor-visual coordination and correctly grabs the pen. He suffers some issues in writing, attention, memory, and math, and is slow in copying long sentences.

3.3.2.1- Presentation and analysis of the results of the phonological and lexical channels regarding consonants and vowels for case 03:

Table N°6. The percentages of phonological orthographic and lexical orthographic mistakes regarding the location of the mistake for case 03

Phonological channel		
Consonants and vowels	Consonants: degree (percentages)	Vowels: degree (percentages)
Substitution	9 (45%)	(50%) 10
Omission	6 (10%)	0 (0%)
Addition	0 (0%)	1 (%5)
Transposition	0 (0%)	0 (0%)
Distortion	8 (25%)	0 (0%)
Lexical channel		
Consonants and vowels	Consonants: degree (percentages)	Vowels: degree (percentages)
Substitution	2 (10%)	(35%) 7
Omission	6 (30%)	(35%) 7
Addition	4 (20%)	1 (%5)
Transposition	0 (0%)	0 (0%)
Distortion	8 (40%)	(0%) 0

4.3.3 The Quantitative Analysis:

a. The Phonological Channel:

We reported 30 mistakes in total; 19 in consonants and 11 in vowels. For consonants, 09 mistakes (45%) were in substitution, 8 (25%) were in distortion, and 2 (10%) in deletion. Regarding vowels, 10 mistakes (50%) were in substitution, and 01 (05%) was in addition, with no cases of deletion, distortion, or transposition. These results confirm the domination of substitution with complete absence of transposition, showing trouble in the accurate phonological awareness and auditory distinction, mainly in sounds inside words. This is directly linked to the nature of the auditory treatment of children with cochlear implants.

b. The lexical Channel:

We reported 35 mistakes in total; 20 in consonants and 15 in vowels. For consonants, we recorded 8 (40%) distortion mistakes, 06 (30%) deletion mistakes, 4 (20%) addition mistakes, and 2 (10%) substitution mistakes, with no transposition. Regarding vowels, we reported 07 deletion and 07 substitution mistakes, 01 mistake of addition, and no distortion or transposition. This confirms that the child shows

weakness in retrieving words correctly from the lexical memory and tries to makes guesses that result in distortion or deletion, mainly in consonants. This reflects the limited lexical balance and weak acquisition of mental images of words.

Qualitative Analysis:

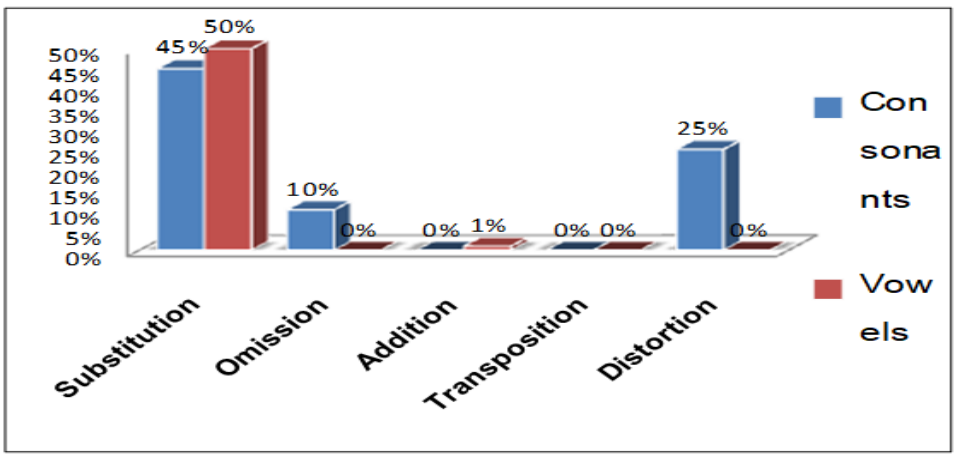
a. The Phonological Channel:

The phonological mistakes show that the child highly relies on the vocal representation of the word when writing it. However, this representation is not accurate and causes many mistakes of substitution, mainly in consonants and vowels. These mistakes reflect issues in the auditory distinction, mainly the phonologically similar sounds. This is normal for children with cochlear implants because such distinction requires long time and continuous auditory training. Moreover, the distortion of consonants, without mistakes of addition or transposition, reflects partial or incomplete vocal representations in the child's auditory memory, causing sounds similar to the original. Finally, the absence of addition or transposition indicates structural control of sounds order inside the word despite trouble in its accuracy.

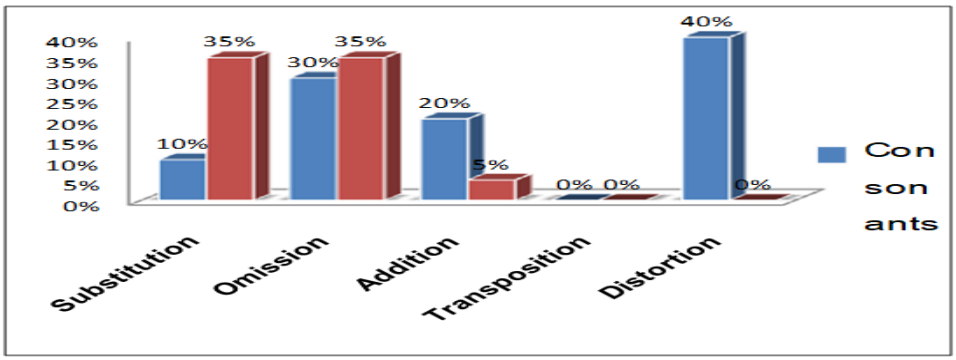
b. The Lexical Channel:

The mistakes are diverse and show deficits in retrieving the word as a full image from the lexical memory. Therefore, the child recurrently deleted consonants and distorted words, confirming that he does not rely on the word as a stored cognitive unit as is the case in the neurotypical children; rather, he tries to build it vocally without considering the context, leading to morphological distortions. In addition, the high rate of distortion in consonants reflects an inaccurate mental image of the word, low linguistic exposure, or insufficient word development.

Graph N° 9. The percentages of the phonological orthographic mistakes in consonants and vowels for case 03



Graph N° 10. The percentages of the lexical orthographic mistakes in consonants and vowels for case 03



4.3.3.1- Presentation and analysis of the results of the phonological and lexical channels regarding the location of the mistake for case 03:

Table N°7. The percentages of the phonological orthographic and lexical orthographic mistakes regarding the location of the mistake for case 03

Phonological channel				
	Vowels		Consonants	
Location of the mistake	Degrees	Percentages	Degrees	Percentages
Middle	4	20%	5	25%
End	7	35%	2	10%
Start	2	10 %	4	20%
Lexical channel				
	Vowels		Consonants	
Location of the mistake	Degrees	Percentages	Degrees	Percentages
Middle	2	10%	3	15%
End	6	30%	0	0%
Start	0	0%	2	10%

The Quantitative Analysis:

a. The Phonological Channel:

We reported 07 mistakes (35%) in the end of the word, 04 mistakes (20%) in the middle of the word, and 02 mistakes (10%) in the start. As for sounds, 05 mistakes (25%) were in the middle of the word, 04 mistakes (20%) in the start of the word, and 02 mistakes (10%) in the end of the word. This shows that the phonological challenges increase in specific parts, mainly in the end regarding meaning and in the middle regarding sound, reflecting difficulty in treating sound series or sequences.

b. The Lexical Channel:

We reported 06 mistakes (30%) in the end of the word, 02 (10%) in the middle, and no mistakes in the start. As for sounds, we recorded 03 mistakes (15%) in the middle of the word, 02 (10%) in the start, and no mistakes in the end. This indicates that the lexical difficulties happen in the end of the word regarding meaning and in the middle regarding the lexical sounds, reflecting deficits in retrieving or choosing the suitable words when reaching the ends of the lexical units or when producing sounds in the middle.

The Qualitative Analysis:

a. The Phonological Channel:

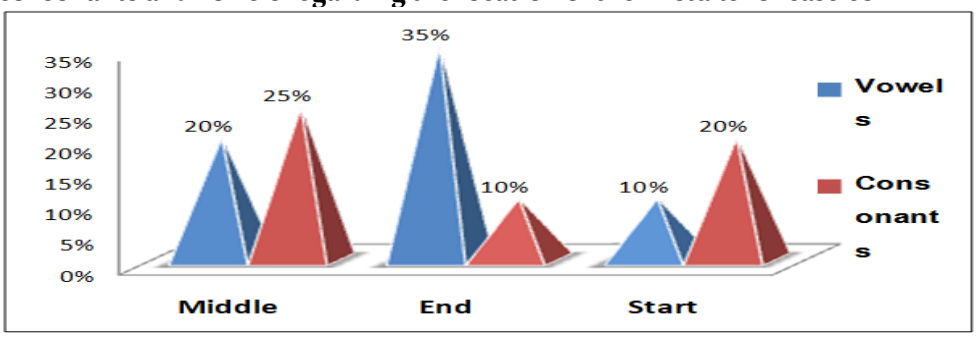
We recorded issues in transforming sounds into written symbols, with a high number of mistakes. In addition, we noticed 03 main phenomena at the phonological channel, namely:

- Addition, as the child added sounds that do not exist in the original word (he added "A " to Naza to be Nazaa),
- Substitution, as he substituted /b/ with /z/ in (Shorba- Shorza).
- Distortion, as the shape of the word changed completely, making it unclear and far from the original, such as turning Niqma into Nebba after substituting /k/ with /b/ and changing vowels.

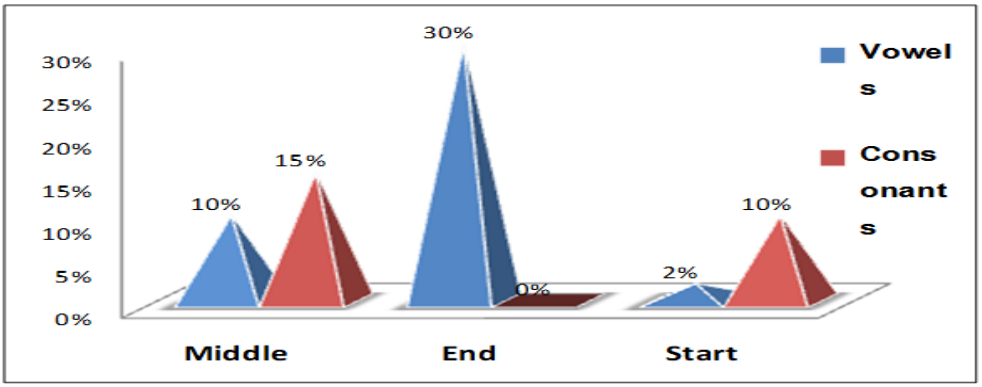
b. The Lexical Channel:

We found the same mistakes with different rates. In this regard, he committed distortion and changed the word, such as Lamma that turned into Tamussu because of substituting /l/ with /t/ and changing the vowel /a/ in the end. Besides, we found addition of unoriginal syllables or letters, such as Tashdu that turned into Tumashidun. In addition, we noticed substitution of consonants and vowels, such as Kassara that turned into Kasha after substituting the last consonant and adding /a/ vowel. These mistakes come from a morpho-phonological issue that causes the inability to distinguish similar sounds inside the word, and from a lexico-semantic problem that leads to difficulty in finding the suitable word and its meaning.

Graph N° 11. The percentages of the phonological orthographic mistakes in consonants and vowels regarding the location of the mistake for case 03



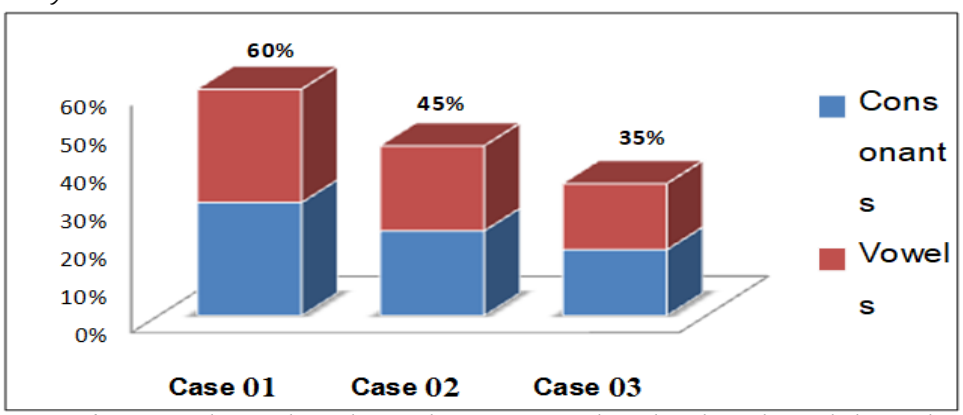
Graph N° 12. The percentages of the lexical orthographic mistakes in consonants and vowels regarding the location of the mistake for case 03



5. Results discussion:

5.1- Discussion of sub-hypothesis 01:

It states that children with cochlear implants show phonological mistakes and supposes that the auditory perception for children with cochlear implant is not mature and exact. Therefore, it affects the phonological representation of the word and causes writing mistakes due to the inability to distinguish or recognize sounds correctly.



Graph N° 13. The total results for the cases regarding the phonological channel

Based on the percentages of the 03 cases, we find out that case 01 shows a rate of 60% of mistakes that reflects the repetition of the same type of mistakes, mainly regarding the consonants (such as deletion or substitution) and vowels (forgetfulness and misplacement). As for case 02, the mistakes percentage is 45%, indicating a partial improvement thanks to an auditory training or to repetition. For case 03, the percentage clearly decreased to less than 35%, showing a gradual development in vocal recognition. This gradation confirms that reliance on the phonological channel alone is not enough to achieve exact results, mainly in the first phases of learning, as the difficulties clearly appear in voice recognition and understanding. Thus, we can confirm hypothesis one, as the mistakes' percentage was high in some cases, reflecting the weak vocal representation of words due to deficits in the auditory perception and inability to distinguish sounds.

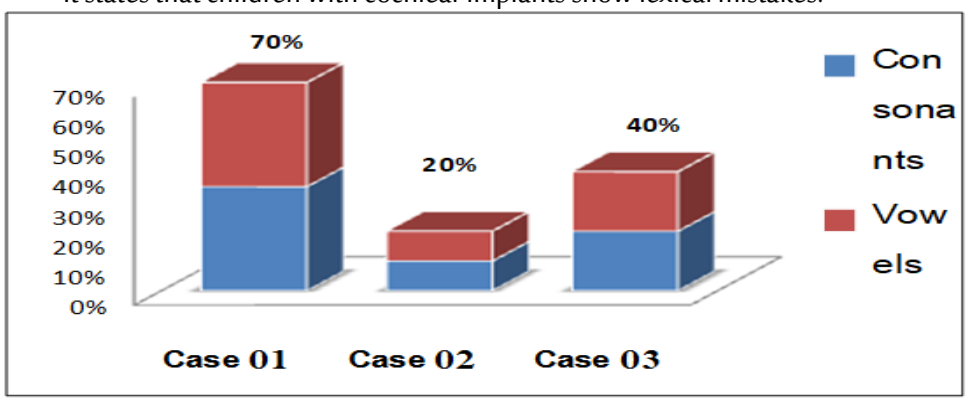
Compared to the study of Hachani Souad & Salima Latoui (2022), we find out

that children with cochlear implants suffer a delay in phonological development compared to normal children, mainly in the vocal representations that affect writing. Besides, the lack of exact distinction between sounds leads to recurrent mistakes in consonants, mainly those with similar points of articulation. In addition, children with cochlear implant need much time to build up the relation between the sound and the letter; this goes with the results that showed increase in the rate of vocal mistakes when relying only on the phonological channel. Based on what was said, both studies confirm that the phonological representation for children with cochlear implants is weak and directly affects orthography.

On the other hand, compared to the study of Safih Lamia & Souli Salima (2019) "the effect of weak hearing on the linguistic development of children, mainly the phonological, and on reading and writing", we find out that children with cochlear implants face clear difficulties in perception, mainly in the long and complex words. Our results are completely in line with the results of other studies, confirming the validity of sub-hypothesis 01 and proving that the vocal difficulties for children with cochlear implants is scientifically proven and requires a special educational intervention.

5.2- Discussion of sub-hypothesis 02:

It states that children with cochlear implants show lexical mistakes.



Graph N° 14. The total results for the cases regarding the phonological channel

The percentages from the figure show that children with cochlear implants face considerable difficulties in the lexical channel. In this regard, the lexical mistakes in case 01 reached 70%, reflecting deficits in recalling the suitable words. As for case 02, the percentage is 20%, showing a slight improvement thanks to direction and context. Concerning case 03, the percentage is 40%, indicating troubles in the mental lexicon. These percentages show that children suffer problems in the lexical storage and recalling the words exactly, may be due to the limited or late auditory experience. In comparison with the study of Yamina Attal (2019), we find out that the study focused on the relation between hearing impairment and cerebral hemispheric dominance on one hand, and writing skills from another. Besides, it showed that children with hearing impairments show clear weakness in the lexical skills, as they have few vocabularies, use inexact and general words, and face difficulty in making linguistically

correct sentences due to the late auditory acquisition, the difference in the cerebral hemispheric dominance, and its effect on language procession.

Both studies confirm that children with hearing impairments, either with cochlear implant or no, suffer clear weakness in the lexical channel, what negatively affects their ability to produce written language, choose words, and build up sentences. Our study focused on the linguistic analysis in the phonological and lexical channels while that of Attal (2019) added the hemispheric dominance. Our findings agree with those of Attal (2019), which showed that the lexical weakness for children with cochlear implant is tightly related to limited hearing and brain neurological factors, and negatively affects writing skills and vocabulary choice.

5.3- Discussion of sub-hypothesis 03:

It states that consonant substitution with another consonant that has the same phonological properties but different articulation point is the most common for children with cochlear implants. In comparison to the study of Hachani Souad & Salima Latoui (2022), we find out that our study highly confirms the sub-hypothesis, as the analysis of the orthographic mistakes made by children with cochlear implant shows that the phonological substitution ranks at the top, as we witnessed recurrent substitution of consonants with other consonants that have different points of articulation but similar phonological traits. This reflects the difficulty of exact auditory distinction for children with cochlear implants. For instance, the sound /b/ (Voiced, bilabial, and plosive) is substituted with /m/ (Voiced, bilabial, and nasal). This shows the partial similarity in the vocal traits despite the different points of articulation. In comparison with the findings of Hachani & Latoui (2022), we find convergent results, as it confirmed that substitution is one of the most common mistakes in writings of children with hearing impairment, and that it is generally about consonants that have different points of articulation but same phonological traits; this reflects deficits in the exact auditory distinction of sounds. Besides, the study shows that such mistakes are related to the difficulty of the phonological procession that affects writing and orthography. Thus, the sub-hypothesis is confirmed and shows that the substitution of consonants due to partial similarity in traits is a common orthographic characteristic for children with cochlear implant. Therefore, the exact phonological auditory training is very important for their educational and linguistic development.

5.4- The general hypothesis

It states that children with cochlear implants show orthographic mistakes. We examined it by analyzing the informants' results in dictation, mainly at the phonological and lexical levels. Findings show that children with cochlear implants really suffer considerable orthographic difficulties, ranging from mistake in recalling the right words (lexical dimension) to misplacement in the right context (phonological dimension), with some differences according to the age and auditory training. Besides, the lexical mistakes showed high rates of disability to recall the terms, substitution with inexact terms, or leaving spaces when writing due to the early auditory deprivation

that affects the lexical balance of children despite the cochlear implant. At the phonological level, we notice the inappropriate employment of words; this weakens the written message. The phonological mistakes are less than the lexical and have less effect.

These findings are in line with those of Attal (2019), which proved the lexical poverty and difficulties in writing for children with hearing impairments, mainly regarding the mutual effect between the cerebral hemispheric dominance and the degree of impairment. In this regard, Attal (2019) confirmed that children with hearing impairments face high challenges in writing; this supports our hypothesis. The orthographic mistakes show recurrent types of mistakes, such as the omission, substitution, and repetition, which generally result from the inexact auditory distinction, and mistakes in the contextual structure that reflect weakness in the semantic dimension. These mistakes show that children with cochlear implants need an early methodological linguistic support because the auditory training alone does not ensure good linguistic skills.

Based on what was said, we can confirm the general hypothesis, as children with cochlear implants really suffer orthographic difficulties, ranging between the semantic and lexical aspects. Nevertheless, these difficulties can be alleviated if we use early linguistic programs designed to develop writing and expression skills for these children. Children with cochlear implants really suffer orthographic mistakes resulting from weak phonological auditory distinction and lexical poverty, which directly affect writing. These results show the need to adopt educational approaches that focus on developing the linguistic and auditory skills at an early age, and foster the individual interventions designed based on the specificity of each case to ensure linguistic efficiency after cochlear implant.

6. CONCLUSION:

The orthographic mistakes raise complicated educational and linguistic challenges for children with cochlear implants, which require multilateral responses and efforts from the family that represents the first linguistic environment, the teacher who develops the academic level, and the speech therapist who builds and fosters the linguistic and vocal awareness. Our study showed diverse orthographic difficulties resulting from a deficit in the auditory distinction and inability to shape an exact mental image of sounds. This negatively influences the child's ability to match sounds with letters and apply the orthographic rules appropriately. These results show the deficits and shed light on the urgent need to develop adapted and specialized educational programs based on the specificities of these children, and to promote preventive and therapeutic activities to foster the vocal representations, help distinguish consonants from vowels, train children on the letters positions inside the word (start, middle, and end), and focus on the recurrent orthographic patterns that cause common mistakes.

These activities should be conducted within an interactive educational environment that relies on stimulating audiovisual tools and encourages the active practice and repetition to help children digest the information and improve writing. In addition, it is necessary to adopt the continuous assessment and the constructive feedback to monitor the development of orthographic skills and correct the educational path. Thus, remedying the orthographic mistakes for children with cochlear implant is not limited to the educational context; rather, it requires multilateral work to foster their self-trust, facilitate communication with their environment, and integrate them in the social and educational systems. Upon our study, we recommend:

- The Ministry of Education should review the programs used with children with hearing impairments to suit their needs and abilities.
- It is necessary to make therapeutical training programs to remedy the difficulties of distinguishing the letters audiovisually.
- It is necessary to provide educational programs that develop writing in the two or three first years of education.
- Children should be trained on good writing that combines quality and speed.
- Educational models that combine the linguistic, vocal, and psychological aspects should be introduced to teach orthography according to the specificities of children with cochlear implant.
- Teachers should use audiovisual tools in class to foster the ability to match letters with sounds, spell, and write.
- It is necessary to prepare special programs that consider the linguistic and cognitive specificities of children with cochlear implant and develop the orthographic and phonological awareness.
- Gradual orthographic activities must be integrated within the school curricula, starting with activities that focus on basic skills, such as sound distinction, consonants and vowels recognition, and complex orthographic rules application.

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