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Graphic Skills of Deaf Children with Cochlear Implants: A Study of Drawing Development

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Abstract:

This study aims to identify the graphic skills of deaf children with cochlear implants in comparison to those of hearing children by analyzing their drawings. The sample includes 30 Algerian children, aged 6 - 10 years, comprising 15 hearing children and 15 deaf children with cochlear implants, all enrolled in regular schools. Two tests were employed to assess graphic skills: the Draw-a-Person test and simple Rey Complex Figure test.
The results demonstrate that the drawings of cochlear-implanted children are generally more detailed than those of hearing children. These observations were statistically confirmed using the Mann-Whitney test. For the Draw-a-Person test, the Mann-Whitney value obtained was 64, with a statistical significance of 0.044, indicating a significant difference at the $p<0.05$ level. Similarly, for the Rey-Osterrieth figure, the Mann-Whitney value was 55, with a significance of 0.017, again confirming a significant difference at the same level of significance.
These findings suggest that cochlear-implanted deaf children develop particular graphic skills due to their unique sensory and cognitive experiences, which influence the quality and detail of their drawings.

Keywords: Deafness, Cochlear implant, Graphics, Graphic skills, drawing.

Introduction

The development of graphic skills in children is a complex process that begins in early childhood with primitive scribbles. These initial attempts, typically emerging between one and two years of age, are driven by the pleasure of exploring various movements and leaving a mark on paper (Bernson, 1957). This process is deeply intertwined in the child's overall development, including motor, emotional, and cognitive aspects. Key factors influencing this development include the perceptual system, fine and gross motor skills, and social and emotional factors that interact with graphic progress (Cohn, 2012). Ajuriaguerra et al. (1989), Lurçat (1979), and Wallon (1982) also highlight the significance of motor maturation, body schema, spatiotemporal structuring, and hand-eye coordination.
Graphic development in children follows two main trajectories: drawing and writing. While writing requires formal learning, drawing is a spontaneous activity, often regarded as an innate form of expression in young children (Prudhommeau, 1948). Baldy (2016) draws an analogy between drawing and a "graphic alphabet," where various graphic elements such as circles, lines, and squares are combined to represent objects, characters, or scenes.
Graphic activities are not merely a form of play or creativity; they also reflect children's cognitive and language skills. Drawing enables the expression of concepts and ideas, thereby fostering the ability to organize and structure thought—a key skill for writing. Zerbato-Poudou (2002) highlights that, like any academic activity, graphic expression contributes to the development of essential cognitive functions for learning, including analysis, comparison, sequencing, classification, memorization, and voluntary attention.
While many studies have focused on graphic development in general, few have discussed this area in deaf children, and even fewer in those with cochlear implants. Existing research, such as the study by Silvestre and Cambra (2009), which analyzes the relationship between drawing and oral language in deaf children aged three to five years, or the study by Davis and Hoopes (1979), which compares drawings of houses, trees, and people between deaf and hearing schoolchildren, have offered interesting insights but focus on specific aspects without addressing the comparison of graphic quality in drawings.

Our study aims to address this gap by comparing the graphic skills in the drawings of cochlear-implanted deaf children with those of hearing children. By examining drawings as cognitive products, as well as expressions of perceptual and motor abilities, we hope to offer a new perspective on the effect of deafness and cochlear implants on graphic development.
The main question of this research is a follows: Is there a significant difference in the graphic skills displayed in the drawings of cochlear-implanted children compared to hearing children?

Hypothesis
Children with cochlear implants reveal superior graphic skills in their drawings compared to hearing children.

2Study Importance

- Drawing can be regarded as a predictor of the appearance of learning difficulties, as supported by various authors who emphasize the relationship between children's graphic abilities and symptoms of learning disorders or difficulties.
- Highlighting the development of skills for mastering and applying a comprehensive graphic program in schools can promote the academic integration of cochlear-implanted deaf children.
- Contributing to the existing literature by offering new perspectives on sensorimotor integration in cochlear-implanted deaf children.

3-Study Objectives

- we hope to enhance the understanding of graphic development in children with hearing impairments and inform educational and therapeutic practices.
- A comparative study of the graphic activity of hearing children and cochlear-implanted deaf children is essential to identify the specific effects of deafness and cochlear implantation on graphic development.
- Evaluating differences in graphic quality: Analyze whether cochlear-implanted deaf children exhibit particular features in their drawings compared to hearing children, in terms of precision, detail, and graphic coherence.
- Understanding the influence of hearing on graphic development: Exploring how access to hearing, whether normal or via a cochlear implant, impacts the development of graphic skills in children.
- Examining the interaction between language and graphic development: Study how language skills, influenced by hearing, are reflected in children's ability to visually represent their ideas through drawing.
- Identifying specific needs for educational and therapeutic support: Determining whether cochlear-implanted deaf children require specific interventions to enhance their graphic development, and how these interventions should differ from those designed for hearing children.

4-Study Terminology

4-1-Deafness
Deafness is a pathological condition characterized by a partial or total loss of hearing. In medical terminology, deafness is synonymous with hypoacusis (HAS, 2007). According to the OMS (n.d.), a person is considered to have hearing impairment if they cannot hear as well as someone with normal hearing, specifically sound levels of 20 dB or higher in both ears. The hearing loss can be mild, moderate, moderately severe, severe, or profound and can impact one or both ears. The primary causes of hearing loss include congenital or early childhood hearing loss, chronic middle ear infections, noise-induced hearing loss, age-related hearing loss, and ototoxic medications that damage the inner ear. The effect of hearing loss is broad and can be profound, especially resulting in difficulties in communication with others or delays in language development in children, which can lead to social isolation, loneliness, and frustration.

4-2-Cochlear Implant
A cochlear implant (CI) is an implanted hearing prosthesis that electrically stimulates the auditory nerve endings by bypassing the sensory organ of Corti. Theoretically, the CI is intended for nearly all cases of bilateral profound deafness (often called total deafness), regardless of the cause, with a few exceptions. Today, it is also demonstrated for severe bilateral hearing losses that make hearing aids ineffective—these are devices that only amplify sound provided to the labyrinthine fluids through air or bone conduction. This is because nearly all cases of total deafness are due not to complete destruction of the auditory nerve but primarily to damage to the organ of Corti (Chouard et al., 1979).

4-3-Graphics
According to Lurçat (2011), graphic activity refers to all activities that involve creating lines, encompassing drawing and writing. She suggests that the purpose of graphic activity is the creation of lines, which can be studied on three levels: focusing on the movement, the form, or the content. Movement can be examined by analyzing the transposition

of gestures into lines, focusing on the motor aspect, which is crucial to studies on graphic motor skills. Form can be studied by exploring how the line translates into shape, highlighting the perceptual aspect. The intersection of motor skills and perception is the focus of studies on form.

4-4-Drawing

The verb "to draw" comes from the Latin word "designare," which means to designate or mark with a sign, thereby leaving a trace that, with the child's development, will have some meaning. Drawing is a complex act that requires the involvement, integrity, and perfect coordination of biological, cerebral, sensory, and motor mechanisms. Therefore, the ability to draw follows and accompanies the child's psychomotor development (Valleteau de Moulliac, 2022). Drawing is also a learned language, based on polysemic graphic signifiers and organized according to conventional graphic codes specific to the child's cultural background (Baldy, 2011; Cohn, 2012).

5-Study Methodological Procedures

5-1-Study Methodology

This study used a descriptive comparative method, which is suitable for research aimed at describing and comparing drawing line skills among deaf children with cochlear implants and their hearing peers.

5-2-Study Sample:

The study sample consists of 30 children enrolled in regular primary schools, aged between 6 and 10 years, divided into two groups: 15 deaf children with cochlear implants and 15 hearing children. The selection was purposive, ensuring that various criteria were met, including the absence of any accompanying disorders such as visual, motor, or cognitive impairments that could affect performance on the tests. The following table outlines the features of the sample:

Table 1 indicates the features of the sample of deaf children with cochlear implants

Case	Name	Age	Gender	Transplant date	Equipment type	Institution
1	A	10 years	Female	2018	Cochlear implant	Mekacher primary School, Tizi Ouzou province
2	C	10 years	Female	2019		Mekacher primary School, Tizi Ouzou province
3	D	7 years	Male	2021		Balwa Hospital, Tizi Ouzou province
4	F	10 years	Female	2018		Mimoun primary School, Tizi Ouzou province
5	I	8 years	Female	2021		Mekacher primary School, Tizi Ouzou province
6	K	6 years	Male	2022		Balwa Hospital, Tizi Ouzou province
7	Kh	8 years	Female	2021		Mimoun primary School, Tizi Ouzou Province
8	L	10 years	Male	2019		Mekacher School, Tizi Ouzou province
9	M	10 years	Male	2018		Mekacher School, Tizi Ouzou province
10	O	8 years	Male	2021		Balwa Hospital, Tizi Ouzou province
11	R	6 years	Female	2022		Mustapha Pasha Hospital, Algiers province
12	S	8 years	Male	2021		Mimoun primary School, Tizi Ouzou province
13	T	8 years	Male	2022		Mekacher primary School, Tizi Ouzou province
14	W	6 years	Male	2022		Mekacher primary School, Tizi Ouzou province
15	Z	6 years	Female	2022		Mekacher primary School, Tizi Ouzou province

Table 2 represents the characteristics of the hearing children sample

Case	Name	Age	Gender	Institution
1	A	7 years	Male	The Seven Destitute Primary School in Zekri, Tizi Ouzou Province
2	A	6 years	Female	
3	A	6 years	Female	
4	L	8 years	Male	
5	L	10 years	Male	
6	L	10 years	Female	
7	M	8 years	Female	
8	O	6 years	Female	
9	O	10 years	Male	
10	R	8 years	Male	
11	R	10 years	Male	
12	S	6 years	Female	
13	T	7 years	Male	
14	T	6 years	Female	
15	Z	10 years	Male	

5-3-Study Tools
This study employed two tests: the Draw-a-Man Test and the Rey Figure Test (form B).

5-3-1-Draw-a-Man-Test
This test was introduced in 1926 by researcher Goodenough (1957) to measure intelligence in children aged 3 to 15 years. It has since been utilized for other purposes by several researchers, such as evaluating drawing accuracy, which is the focus of the present study.The test can be applied across all cultures and involves analyzing the drawing according to a checklist of 51 items. It requires a white sheet of paper, a pencil and eraser, colored pencils, and can be administered individually or in groups. There is no set time limit for completing the test, but most children finish their drawings within 10 minutes. The test includes 51 items, as detailed in the following table:

Table 3 indicates the items of the Draw-a-Man Test

Items		
1. The presence of the head	18. The presence of clothes	35. The appearance of the heels
2. Having legs	19. Having two pieces of clothing	36. Kinetic compatibility of drawing lines where their connections are clear
3. The presence of arms	20. Clothes cover the body so that it is more than just two pieces	37. The appearance of movement in the drawing lines of the neck type
4. The presence of the trunk	21. The details of the clothing appear so that it is more than just two pieces	38. Clarity of the lines of the head and their compatibility with the neck
5. If the length of the trunk is longer than its width	22. If the clothes are completely complete	39. Motor coordination of the trunk
6. Shoulders appear clearly	23. The presence of fingers	40. Movement coordination of the lines of the arms and legs
7. Connection of arms and legs to the torso	24. The number of fingers is correct	41. The intersection of the face is clearly visible in its correct places
8. If the arms and legs connect to the torso in the correct places	25. The details of the fingers are clear	42. The presence of ears
9. The presence of the neck	26. If the thumb is distinct from the rest of the fingers	43. If the ears are in the right places
10. The neck lines are in line with the head and torso	27. If the palm of the hand is distinct and clear	44. The presence of eyebrows and eyelashes
11. The presence of one or both eyes	28. The appearance of the palm joint or elbow joint	45. Clarity of details of eye lines
12. The presence of a nose	29. The appearance of the knee	46. If the eyes are of the correct

	joint and foot joint	shape, such that their length is greater than their width
13. The presence of a mouth	30. Head size is proportional to the body	47. If vision is clear
14. Clarity of mouth, nose and eyes	31. The length of the arms is proportional to the torso, being longer than the length of the torso	48. The appearance of the chin and forehead
15. The presence of an open nose	32. The length of the legs should not be less than the length of the torso or less than twice its length	49. The prominence of the chin and the clarity of its details
16. The presence of hair	33. Fit feet size	50. Side drawing and partial profile
17. Clear hair boundaries around the head and face	34. The arms and legs exist in two dimensions	51. Side drawing and overall profile

A score of 1 is given for the presence of the element and 0 for its absence.

5-3-2-Simple Rey Figure Test: Designed by André Rey in 1942, this test includes a simple geometric shape with the following elements: a circle, a triangle, a rectangle, a square, two dots inside the circle, a + sign inside the triangle, an arc inside the rectangle, lines inside the arc, a slanted line dividing the square, and an = sign at the intersection of the square and the rectangle (Rey, 1959). The test aims to measure visual memory but has been employed in several studies to evaluate drawing skills, which was the goal of this study.

The test is typically administered in two phases: the copy phase and the recall phase. In this study, only the copy phase was used. The examinee is given a blank sheet of paper, the model sheet, and a pencil, and is asked to reproduce the model drawing on the blank sheet.

The test is scored based on four criteria: the presence of the essential elements, the approximate length of the four basic spaces, the precise relationships between the four basic spaces, and the positioning of secondary elements. This is illustrated through the following table.

Table 4 shows the scoring of elements in the Simple Rey Figure

Items	scoring	Items	scoring	Items	scoring
1. The existence of the circuit	1	10. Having a square point	1	19. If the number of lines in the arc is correct	1
2. The presence of the square	1	11. The presence of the sign =	1	20. Sign = within the intersection of the square and the rectangle	1
3. The presence of the triangle	1	12. The intersection of the triangle and the circle	2	21.The diagonal line in the middle of the square is placed correctly	1
4. The presence of a rectangle	1	13. The intersection of the triangle and the rectangle	2	22. The point of the square is located in the bottom right corner	1
5. The presence of two points in the circle	1	14. Intersection of the circle with the rectangle	2	23. The point of the square is large compared to the two points inside the circle	1
6. The presence of a + sign	1	15. The intersection of the square and the rectangle	2	24. The similarity in size between a circle and a triangle	1
7. The presence of the rectangular arc	1	16. The two points are inside the circle on the right	1	25. The similarity in size between a circle, a triangle, and a square	1
8. Lines inside the arc 2 or more	1	17. A sign + to the left of the triangle	1	26. Convergence in the height of a square and a rectangle	1
9. The presence of the italic line inside the square	1	18. The arc is located at the center of the base of the rectangle	1	27. The relative closeness between the four geometric shapes	1

6-Presentation, Analysis, and Discussion of Study Results:

6-1-Presentation and Analysis of Study Results:

Table 5 indicates the raw results obtained from the Draw-a-Man test for deaf children with cochlear implants and their hearing peers

Sample	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Children with cochlear implants	43	24	24	42	25	29	25	42	42	29	30	35	35	25	25
Hearing children	34	31	21	38	36	22	21	36	24	21	27	28	22	19	19

From the previous table, we notice that the scores for deaf children with cochlear implants ranged from a high of 43 to a low of 24. The highest score of 43 was fulfilled by one case, while cases four, eight, and nine scored 42. Cases twelve and thirteen scored 35, case eleven scored 30, and cases six and ten scored 29. Cases five, seven, fourteen, and fifteen each scored 25, and cases two and three scored 24.

For hearing children, scores ranged from a high of 38 to a low of 19. The highest score of 38 was fulfilled by case four. Cases five and eight scored 36, while case one scored 34. Case two scored 31 and case twelve scored 28. Case eleven scored 27, and case nine scored 24. Cases six and thirteen scored 22, and cases three, seven, and ten scored 21. Cases fourteen and fifteen scored 19.

Table 6 demonstrates the raw results obtained from the Simple Rey Figure test for deaf children with cochlear implants and their hearing peers

Sample	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Children with cochlear implants	26	26	20	28	14	18	27	27	20	29	18	13	25	27	30
Hearing children	5	16	17	23	9	26	20	21	15	18	18	22	11	24	23

From the previous table, we observe that the results among the deaf children with cochlear implants ranged from 30 as the highest score to 13 as the lowest score. Particularly, the fifteenth case scored 30 points, the tenth case scored 29 points, and the fourth case scored 28 points. Furthermore, the seventh, eighth, and fourteenth cases each scored 27 points, the first and second cases scored 26 points, and the thirteenth case scored 25 points. The third and ninth cases scored 20 points, the sixth and eleventh cases scored 18 points, the fifth case scored 14 points, and the twelfth case scored 13 points.
For the hearing children, the results ranged from 26 as the highest score to 5 as the lowest score. The sixth case scored 26 points, the fourteenth case scored 24 points, the fourth and fifteenth cases each scored 23 points, and the twelfth case scored 22 points. The tenth and eleventh cases scored 18 points, the third case scored 17 points, the second case scored 16 points, the ninth case scored 15 points, and the thirteenth case scored 11 points. The fifth case scored 9 points, and the first case scored 5 points.

Qualitative Analysis: Based on the findings, it is clear that the drawings of deaf children with cochlear implants were characterized by precision and detail. These children showed a greater focus on small details in their drawings compared to their hearing peers.
To verify the validity of the hypotheses, we calculated the Mann-Whitney U test for differences between two independent groups and obtained the following results:

Table 7 represents the results of the Mann-Whitney U test between deaf children with cochlear implants and their hearing peers in the Draw-a-Man test

Drawing a man	Sample	Mean ranks	Mann-Whitney coefficient value	Significance value (sig)	Adopted significance value
Deaf children with cochlear implants	15	18.73	64.00	0.044	0.05
Listening children	15	12.27			

From the previous table, we notice that the mean rank is 18.73 for deaf children with cochlear implants, compared to 12.27 for hearing children. The value of the Mann-Whitney U test is 64.00, with a significance level of sig=0.044 at the adopted significance value of 0.05.

Statistical Analysis
Since the significance value of the Mann-Whitney U test is sig=0.044 , which is smaller than the adopted significance level of 0.05, this demonstrates that there are statistically significant differences between deaf children with cochlear implants and hearing children in the Draw-a-Person test results. When comparing the mean ranks, we found that the value for deaf children with cochlear implants is higher than that for hearing children, showing that the differences favor the deaf children with cochlear implants.

**Table 8 illustrates the findings of the Mann-Whitney U test between deaf children with cochlear implants and their hearing peers in the Rey-
Osterrieth Complex Figure test.**

Ray's simple figure	Sample	Mean ranks	Mann-Whitney coefficient value	Significance value (sig)	Adopted significance value
Deaf children with cochlear implants	15	19.3	55.00	0.017	0.05
Listening children	15	11.67			

From the previous table, we observe that the mean rank is 19.33 for deaf children with cochlear implants, compared to 11.67 for hearing children. The value of the Mann-Whitney U test is 55.00, with a significance level of sig=0.017at the adopted significance value of 0.05.

Statistical Analysis
Since the significance value of the Mann-Whitney U test is sig=0.017, which is smaller than the adopted significance value of 0.05, this demonstrates that there are statistically significant differences between deaf children with cochlear implants and hearing children in the Rey-Osterrieth Complex Figure test results. When comparing the mean ranks, we found that the value for deaf children with cochlear implants is higher than that for hearing children, showing that the differences favor the deaf children with cochlear implants.

7-Discussion

The results of this study indicate that children with cochlear implants produce more detailed drawings than their hearing peers. This observation can be explained by several cognitive and perceptual mechanisms specific to deaf children, supported by previous studies. Firstly, the work of Bavelier et al. (2006) highlights a phenomenon of intermodal reorganization in congenitally deaf individuals, where auditory cortical areas, in the absence of sound stimuli, are repurposed by other sensory modalities, primarily vision. This brain plasticity could explain why cochlear-implanted children develop superior visual and graphic skills, especially considering that the children in this study were implanted at a relatively late age (around 4 years old), meaning they had already developed visual skills before implantation. Pavani and Bottari (2012) also demonstrated that deaf individuals exhibit heightened visual reactivity, particularly in peripheral vision, due to enhanced visual attention (Bavelier et al., 2010). These enhanced visual skills enable them to perceive and reproduce finer details in their drawings compared to hearing children.

Secondly, the realistic conception of drawing, as noted by Picard and Baldy (2011), is linked to the mental representation of body schema, fueled by external references and inherent bodily data. This ability is particularly developed in deaf children who have strong language skills, fostered by cochlear implantation and phrase comprehension, as observed by Nicholas and Geers (2007) in children implanted before the age of 5, similar to those in this study. This suggests that deaf children, with their heightened visual attention, are better equipped to capture and represent these visual details in their drawings.

Moreover, the visual perception of deaf children, according to Kovačević et al. (2020), is highly detailed, encompassing aspects such as physiognomy, movement, facial expression, body posture, and color. These aspects are crucial to the quality of the drawings, explaining why cochlear-implanted deaf children can produce more elaborate and realistic representations.

The superior quality of drawings among cochlear-implanted children compared to hearing children is also related to the complex relationship between graphomotor development and visual perception, a theme explored by numerous studies, each offering specific insights. Given that perceptual motor and visual skills, exercised through graphic exploration, obviously facilitate the mastery of handwriting (Bardot, 2003), we will explain this visual perception/graphomotor relationship based on studies focused on graphomotor skills in writing. Cornhill and Case-Smith (1996) studied the importance of visual perception in the quality of handwriting, demonstrating that visual perception plays a central role in the quality of handwriting among children. The researchers observed that children with well-developed visual perception tended to produce more legible and well-formed handwriting. This relationship is explained by the fact that visual perception allows for the accurate discrimination of letter shapes and real-time self-correction, which is essential for fluid and precise writing.

Marr et al. (2001) also highlighted the interdependence between fine motor skills and visual perception in the development of graphomotor skills. Their research suggests that for a child to be ready to write, they must not only develop fine motor skills but also their ability to perceive and interpret visual information. Thus, insufficient development of visual perception could hinder a child's ability to produce the precise movements necessary for writing.

The study by Schneck and Henderson (1990) emphasizes the importance of visuomotor integration, that is, the ability to coordinate vision and movement. Their findings show that this integration develops gradually in children and is strongly correlated with the quality of graphomotor skills. Adequate development of this integration allows the child to better control the movements necessary to trace letters and shapes, thereby improving overall writing performance.

A study by Solan et al. (2003) demonstrated that deficits in visual perception, such as visual discrimination and visual memory, can significantly impact children's writing abilities. These deficits can lead to difficulties in recognizing and memorizing letters, maintaining consistency in letter formation, and understanding letter sequences, resulting in below-average writing performance.Volman et al. (2006) explored the underlying mechanisms of writing difficulties in children, focusing on visual perception and motor skills. Their study revealed that children with writing difficulties often exhibit combined impairments in visual perception and motor skills, complicating their ability to learn and master handwriting. These children may struggle to integrate visual information with motor movements, making the act of writing particularly difficult and laborious.

Finally, although hearing impairment may affect certain aspects of cognitive functioning, such as verbal intelligence and verbal memory (Kovačević, 2012; Kovačević & Isaković, 2019), other domains like visual memory and fine motor skills, which are essential for drawing, are often better developed in deaf children. The evolution of graphic activity, according to Wallon and Lurçat (1958), depends on motor, perceptual, and representational development, all positively influenced by the enriched visual experience of deaf children.

In summary, the results of this study, which show that cochlear-implanted children's drawings are more detailed, align with a broader theoretical framework that connects brain reorganization, enhanced visual perception, and motor development to the superior quality of graphic productions observed in this population.

8-Conclusion

This study significantly contributes to comprehending the graphic skills of deaf children with cochlear implants by comparing them to those of their hearing peers. Unlike many previous studies that have primarily examined the cognitive and linguistic performance of deaf children, this research stands out for its focus on graphic activity, a relatively underexplored area. The findings demonstrate that deaf children with cochlear implants produce more detailed drawings than hearing children, with statistically significant differences, as indicated by the results of the Mann-Whitney test. These results confirm and extend the work of Bavelier et al. (2006) on intermodal reorganization and Pavani and Bottari (2012) on improved visual reactivity in deaf individuals. They also show that the visual and attentional skills developed by these children foster richer perception and better graphic representation.Thus, this study brings a new dimension to the understanding of graphic development in deaf children with cochlear implants. It emphasizes the effect of cortical reorganization and enhanced attentional processes on the quality of graphic productions, something that had not been clearly established in previous research.

The perspectives opened by this study are numerous. First, it would be relevant to deepen these findings by expanding the sample to other groups of children with hearing impairments or by integrating variables such as the age of implantation or the duration of implant use. Furthermore, the study could be extended to involve other types of graphic or artistic activities to better understand the mechanisms underlying the observed graphic skills. Finally, these findings could have practical implications in the education of deaf children with implants, by adapting teaching methods to take advantage of their improved visual skills.

In summary, this research contributes to a better understanding of the impacts of cochlear implants on the graphic development of deaf children and opens promising avenues for future studies and educational applications.

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