

Letícia do Rosário Amado

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## Musical stimulation proposal for hearing impaired children: case reports

### *Proposta de estimulação musical para crianças deficientes auditivas: relato de casos*

#### Keywords

Hearing Loss  
Cochlear Implantation  
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#### Descritores

Deficiência Auditiva  
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#### ABSTRACT

**Purpose:** To develop and to apply a musical stimulation program for children using Cochlear Implant. **Method:** The research was conducted at the Educational Audiology Outpatient Clinic, UNIFESP, and was carried out in two stages – conception of the musical stimulation activities and its application in five children using Cochlear Implant, aged between 2 and 5 years, who had been under speech therapy for at least 12 months. The study group was submitted to six sessions of musical stimulation. We used three instruments to quantify the evolution of the child: Children’s Musical Identification, Musical Skills Development and Musical Aptitude Test – all of them were designed by one of the authors. **Results:** Musical stimulation had a positive effect, thereby improving the rhythm and the melody skills of the participants. The children showed a performance over 50% in the tasks undertaken. Musical stimulation had a positive effect, thereby improving the rhythm ( $p=0.0267$ ) and the melody ( $p=0.0445$ ) skills of the participants. **Conclusion:** We conclude that it is possible to develop a musical stimulation program that can be applied to children using Cochlear Implant inserted in aural rehabilitation, who benefit from the activities.

#### RESUMO

**Objetivo:** Desenvolver e aplicar um programa de estimulação musical em crianças usuárias de Implante Coclear. **Método:** A pesquisa foi realizada no Ambulatório de Audiologia Educacional - UNIFESP e foi realizada em duas etapas – concepção das atividades da estimulação musical e aplicação das mesmas atividades em cinco crianças usuárias de Implante Coclear, com idades entre 2 e 5 anos, que estavam em terapia fonoaudiológica há pelo menos 12 meses. O grupo de estudo foi submetido a seis sessões de estimulação musical. Foram aplicados três instrumentos para quantificar a evolução da criança: Identificação Musical das Crianças, Desenvolvimento das Habilidades Musicais e o Teste de Aptidão Musical - todos elaborados pelas autoras. **Resultados:** A estimulação musical surtiu efeito positivo, melhorando as habilidades de ritmo e melodia dos participantes, e as crianças apresentaram desempenho superior a 50% nas tarefas realizadas. A estimulação musical surtiu efeito positivo, melhorando as habilidades de ritmo ( $p = 0,0267$ ) e melodia ( $p = 0,0445$ ) dos participantes. **Conclusão:** Foi possível desenvolver um programa de estimulação musical passível de ser aplicado em crianças usuárias de Implante Coclear inseridas em reabilitação auricular, as quais se beneficiaram de suas atividades.

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## INTRODUCTION

Hearing impairment is a disorder that entails serious consequences for children, reflecting on their psychosocial, emotional and linguistic development. It can delay, mainly, the development of speech and language, to the extent that it interferes with the reception of sounds and the ability to monitor one's own speech, implying difficulties in acquiring knowledge and interacting with the world<sup>(1)</sup>.

The work of speech therapy (re) habilitation aims at the development of auditory skills and oral linguistic competences, becoming fundamental in children with hearing impairment, because only the use of Cochlear Implant (CI) does not restore the ability to understand and to process sounds<sup>(2)</sup>.

Music can be a great ally in the (re) qualification of implanted children. Accordingly, the implementation of a musical therapy program would foster the detection, discrimination, identification and understanding of sounds in children with Cochlear Implant<sup>(3)</sup>.

According to the principles of neural plasticity, music can improve language competences through the activation of areas similar to those related to language processing in the brain<sup>(4)</sup>.

The skills of auditory discrimination, vocabulary, non-verbal reasoning, reading, pitch discrimination, phonological capacity, understanding, and cognitive abilities, such as attention and memory, are more significant in those who have musical training<sup>(5)</sup>. Moreover, music stimulates social cohesion by strengthening bonds, sharing emotions and promoting mental flexibility<sup>(6, 7, 8)</sup>.

There is little information available about the musical perception skills in children using Cochlear Implant. These children have difficulty in recognizing familiar songs when the lyrics are not provided. They are able to perceive rhythm, but the recognition of melodies, timbre and elements of high spectral resolution, such as frequency and duration, end up getting impaired<sup>(9, 10, 11)</sup>.

In light of the foregoing, this study aims to develop and to apply a musical stimulation program in children using Cochlear Implant inserted in aural rehabilitation.

## METHOD

This project was forwarded to the Research Ethics Committee of UNIFESP/HSP under number 1.907.753, and the Free and Informed Consent Form (Resolution 466/12 – Research Standards Involving Human Beings) was signed by parents and/or legal guardians, where the consent form was read and explained, following all the institutional standards.

This research consisted in the development and pilot application of a musical stimulation program for prelingual hearing impaired children with CI. All participants were submitted to the program and a series of questionnaires prepared by one of the authors, in order to assess the applicability and effectiveness of the proposed program.

This study was attended by five prelingual hearing impaired children aged between two and five years of age of both genders and Cochlear Implant users for at least one year, who met the following inclusion criteria: bilateral sensorineural hearing impairment of any degree and undergoing speech therapy with

auricular approach for at least 12 months. The exclusion criteria were: presence of proven neurological impairment and exclusive use of hearing aids.

The participating children were selected according to the established eligibility criteria and by means of a demographic survey that compiled data on hearing impairment such as etiology, age at diagnosis, age at surgery, device type and therapy time. All children had the operation of CI tested at the beginning of the session, through the performance of Ling sounds and all had access to speech sounds with voice detection thresholds between 20 and 30 dBHL.

In order to quantify the evolution of the child, we applied three instruments, namely:

- a) CMI – Children's Musical Identification;
- b) MSD – Musical Skills Development;
- c) Musical Aptitude Test, which was applied to children.

The questionnaires were introduced to the parents and/or legal guardians of the children in the form of interviews.

The Musical Aptitude Test was applied in the first and last session to identify the previous musicality of the child and the musicality acquired at the end of the musical stimulation in line with a scale of melody and rhythm developed by one of the authors. The CMI questionnaire was applied in the first session to identify the child's musical stimulus before the program and the MSD questionnaire was applied in the last session to identify the musicality developed after the musical stimulation sessions.

## Musical Stimulation Program

The musical stimulation program involved the aspects of rhythm and melody: frequency/timbre. Two songs were selected and presented to the children during the sessions: "*Marcha Soldado*" and "*Brilha, Brilha Estrelinha*". This selection was based on the musical pedagogical methods designed by Orff and Kodály<sup>(12)</sup>, which start from the lower descending third-party musical interval in small-scale songs for the beginning of musical learning in children, which are popular songs among children and adults. The program was composed of six stimulation sessions, where both rhythm and melody were stimulated together, since the rhythm is not taught separately from the melody, i.e., the rhythm is not worked without working the melody concomitantly, and vice versa<sup>(12)</sup>.

Rhythm is the starting point of the musical educational process and the basis on which the melody is composed. The music chosen to work with rhythm was "*Marcha Soldado*". This choice was due to the fact that this song contains simple rhythmic figures with binary compass and melody with only six notes, which begins with the lower third-party descending interval, which is part of the collective unconscious in almost all cultures, because it is present in various children's songs from all over the world. Moreover, the tonic syllable of the word "*marcha*" coincides with the first attack, along with the metric accent of the rhythm, i.e., the beginning of the song coincides with the first time of the compass.

The music chosen to work the melody was "*Brilha, Brilha Estrelinha*", because it is a song with simple melody/harmony and rhythm, composed of six notes of the Major Musical Scale

of the note Dó, which is within volume two of the five volumes for musical learning according to Orff<sup>(13)</sup>.

We held weekly sessions at the end of speech therapy sessions, where the participants were submitted at the Educational Audiology Outpatient Clinic – UNIFESP. The activities of the musical stimulation program are described in Chart 1.

After each session of the musical stimulation program, we made notes about the performance of each child, taking into account qualitative parameters. These parameters were translated into 11 specific objectives (O):

- 1<sup>st</sup> session: if the child remained with its hand on the timba during the song (O1) and if the child tried to beat the drum along with the researcher (O2);
- 2<sup>nd</sup> session: if the child tried to beat the drum along with the researcher (O3) and performed it according to the rhythm of the song (O4);
- 3<sup>rd</sup> session: if the child marched along with the researcher during the song (O5) and at the appropriate rhythm (O6);
- 4<sup>th</sup> session: if the child tried to hum the song along with the researcher (O7) and according to the melody (O8);
- 5<sup>th</sup> session: if the child knew how to lower to the bass notes and lift to the acute ones (O9) and if child tried

to hum the song along with the researcher at different heights, i.e., pitches (O10);

- 6<sup>th</sup> session: if the child knew how to point to the keyboard or say the color of the keys corresponding to the pitch on which the researcher played the song (O11).

During the stimulation sessions, each task was repeated at least three times, with or without intervals among repetitions.

Moreover, the therapist suggested that parents and/or legal guardians of the children should perform Musical Stimulation activities at home, in order to reinforce the musical stimulation and the skills worked in the program. For this purpose, the researcher performed the recording of the songs and provided it to those responsible through Bluetooth® technology. The parents were instructed to hold the activities once a day, every day, during the course of the week, before the subsequent session.

All parents and/or legal guardians received guidance on how to do homework and were invited to take part in the activities during the musical program. Regarding the parents and/or legal guardians of the children who were not able to perform the proposed activities, they were asked to, at least, put the children to listen to the audio of the music referring to the last

**Chart 1. Musical Stimulation Program and home tasks**

Session	Activity developed during the session	Activity proposed for home
1° Rhythm	The therapist sang and performed the percussion (on the timba) of the song "Marcha Soldado" (beating the hand only in the first time of each compass, which coincides with the tonic syllable) while the child should remain with the hand on the timba with the palm open, feeling the sound and the vibration of the rhythm of the song. Subsequently, the child should beat the drum along with the therapist.	The person responsible for the child should sing and clap in the rhythm of the song "Marcha Soldado" along with the child. If the person in charge did not have the skills to perform the task, she should put the audio of the song and to explain what the child should do; in this case, to ask his/her to clap simultaneously with the song.
2° Rhythm	As in the previous session, the therapist sang and performed the percussion of the song "Marcha Soldado" on the timba according to her pulse (heartbeat), and not just beating her hand on the timba in the first time. The child felt the vibration and the sound of the musical pulsation through the contact with the timba, and then should play along with the therapist.	The person responsible for the child should sing and beat in a pot/drum or the utensil that is available in the rhythm of the song "Marcha Soldado" along with the child. If the person in charge did not have the skills to perform the task, she should put the audio of the song and to explain what the child should do; in this case, to ask his/her to drum simultaneously with the song.
3° Rhythm	The child should march according to the rhythm of the song. Firstly, the therapist set an example, and then the task was performed along with the child.	The person responsible for the child should sing and march in the rhythm of the song "Marcha Soldado" along with the child. If the person in charge did not have the skills to perform the task, she should put the audio of the song and to explain what the child should do; in this case, to ask his/her to march simultaneously with the song.
4° Rhythm	The song "Brilha, Brilha Estrelinha" was introduced to the child and played on the keyboard. The child was stimulated to hum along with the therapist after being introduced to the song.	The person responsible for the child should sing the song "Brilha, Brilha Estrelinha" along with the child. If the person in charge did not have the skills to perform the task, she should put the audio of the song and to explain what the child should do; in this case, to ask his/her to sing simultaneously with the song.
5° Rhythm	The therapist worked on the notions of bass and treble. For this purpose, she played like live or dead (dead, the child should stay down, but alive the child should get up) with musical notes (lower and higher), i.e., when the therapist played a bass note, the child should get down, but when playing a treble note, should get up. Subsequently, she played and sang the song along with the child on the keyboard, holding his/her finger one octave down and one octave above, thereby enabling the child, besides listening to the difference in tones, to perceive that the same melody is played in different heights (pitches) on the keyboard. In order to help with the perception, the therapist pasted colored stickers on the keyboard buttons: blue for the low tones and orange for the high tones.	The person responsible for the child should sing the song "Brilha, Brilha Estrelinha" making a lower voice and a higher voice, asking the child to try to sing along with her. If the person in charge did not have the skills to perform the task, she should put the audio of the song on the bass/shrill versions and to explain what the child should do; in this case, to ask his/her to sing simultaneously with the audio of the song.
6° Rhythm	The therapist played the song along with the child on the keyboard, holding his/her finger, one octave below and one octave above, still with the stickers. Subsequently, the therapist played the music alone in two different heights (pitches) and asked the child to speak the color of the keyboard buttons that the therapist played, orange – treble (high) and blue – bass (low).	

Source: Designed by the author

session and to explain the activity to the child. Home tasks are detailed in Chart 1.

Finally, before starting the proposed task for each musical stimulation session, the task of the previous session was resumed, with a view to checking if the child had learned and if the home tasks had been performed.

### CMI Questionnaire (Children’s Musical Identification)

CMI was prepared based on other questionnaires<sup>(14,15)</sup>. Its main objective was to identify the musicality of children and to check if its previous existence would influence the results of the Musical Stimulation Program. The questionnaire was composed of 10 questions that evaluated the following aspects in a simple and objective way: family musicality, child musicality and family stimulation in the child musicality. The questions were introduced to the parents and/or legal guardians in the form of interviews, in order to clarify any doubts that might arise. The responses were obtained in binary categorical variables, and can assume the value of “yes” or “no”.

### MSD (Musical Skills Development)

MSD was also designed by the authors based on other questionnaires and the previous MSD questionnaire<sup>(14,15)</sup>. Its main objective was to identify the development of musical skills in the children after the sessions of the musical stimulation program. The questionnaire is composed of 10 questions that sought to evaluate the aspects of musicality of the children and the stimulation of the family in the child musicality after the program in a simple and objective way. The questions were introduced to the parents and/or legal guardians in the form of interviews, with the possibility of clarifying doubts. The responses to the questions should be “yes” or “no”.

### Musical Aptitude Test for Children

Also designed by one of the authors based on her previous experience as a musician, the Musical Aptitude Test for children had the objective of identifying the previous child musicality and consists of singing and clapping simultaneously in the song “*Parabéns a Você*”. The choice of the activity and of the music was due to the fact that the vast majority of children are stimulated from a very early age to sing and clap with this song. The child ability to coordinate actions, to clap according to the rhythm of the music and to hum the melody was evaluated. The test was introduced in a contextualized way. For this purpose, the researcher took an image and a birthday hat to the child, and then started to sing and to clap the song “*Parabéns a Você*”, asking the child to do the same. In order to perform a more accurate analysis of this questionnaire, the author used two scales, one for melody and the other for rhythm, aiming to compare the improvement of the children with the program (Chart 2).

This test was applied at the beginning and at the end of the musical stimulation program and, in each application, two marks were assigned, one evaluating the rhythm and the other evaluating the melody (the marks were assigned by the author herself); and, in order to ensure the homogeneity of the assignment of these marks, we prepared the scales shown in Chart 2.

**Chart 2. Scale of the Musical Aptitude Test for Rhythm and Melody**

Scale	Description – Rhythm
1	The child did not react or take an interest in or understand the song
2	The child understood that he/she was playing a song and that he/she should clap, but he/she did not
3	The child understood and tried to clap with the song, but in only a few parts of the track and out of rhythm
4	The child managed to get the rhythm right at some moments of the song, but he/she did not keep it during all the song
5	The child managed to clap within the rhythm and kept it throughout the song
Scale	Description – Rhythm
1	The child did not react or take an interest in or understand the song
2	The child understood that he/she was playing a song and that he/she should hum it, but he/she did not
3	The child tried to hum the song, but could not get the melody right
4	The child was able to hum the melody during some moments of the song
5	The child was able to hum the melody throughout the song

Source: Designed by the author

During the statistical analysis, the normality of the data was tested using the Shapiro-Wilk test, while the Wilcoxon Signed-rank Test was used for the statistical analysis (16). The value of statistical significance adopted for all tests was 0.05 (5%) and the R program was used to perform the analyses.

## RESULTS

The sample of this study was composed of five children using unilateral CI. This pilot study was held with the objective of checking the applicability of the musical stimulation program during the therapeutic process of the child.

In view of this, we analyzed the following clippings:

Table 1 contains information on the chronological age and the auditory age of the participants.

**Table 1. Descriptive statistics for the age range (in years) of the sample group**

	Chronological Age	Auditory Age
P1	2.7	1.4
P2	5.0	3.0
P3	3.6	1.6
P4	4.8	1.0
P5	4.9	1.8
Average	4.2	1.8
Median	4.8	1.6
Variance	1.1	0.6
SD	1.0	0.8
VC	25%	43%
Min	2.7	1.0
Max	5.0	3.0

Caption: P = patient; CV = variation coefficient; Min = minimum value; Max = maximum value; DP = Standard Deviation; P = patient

Source: Designed by the author

Table 2 contains the performance in the musical stimulation program measuring the percentage of accuracy in the qualitative parameters defined for each session and described in the methodology. Of the 10 objectives proposed in the musical stimulation program, we perceived that none of the children hummed the music along with the researcher and that P5 obtained a lower performance in comparison with the other participants.

**Table 2. Performance during the program according to the established objectives**

Session	Objective	P1	P2	P3	P4	P5	Consolidated
1 <sup>a</sup> Session	O1	Yes	No	Yes	Yes	No	60%
	O2	Yes	Yes	Yes	Yes	Yes	100%
2 <sup>a</sup> Session	O3	Yes	Yes	Yes	Yes	Yes	100%
	O4	Yes	Yes	Yes	Yes	No	80%
3 <sup>a</sup> Session	O5	Yes	Yes	Yes	Yes	Yes	100%
	O6	Yes	Yes	Yes	Yes	Yes	100%
4 <sup>a</sup> Session	O7	Yes	No	No	Yes	No	40%
	O8	Yes	No	No	No	No	20%
5 <sup>a</sup> Session	O9	Yes	Yes	Yes	Yes	No	80%
	O10	No	No	No	No	No	0%
6 <sup>a</sup> Session	O11	Yes	Yes	Yes	Yes	No	80%
<b>Performance</b>		<b>91%</b>	<b>64%</b>	<b>73%</b>	<b>82%</b>	<b>36%</b>	

**Caption:** P = participant; O = objective

**Source:** Designed by the author

Still in Table 2, we can see that P1 (chronological age of 2.7 years and auditory age of 1.4 years; she was the youngest child in the group and the one who underwent the CI surgery earlier) showed the best performance (91%). Besides the chronological age and of implantation, the family showed involvement in the proposed activities.

From Table 2, we can see that P4, the child implanted later, showed a similar performance (82%) compared with those previously implanted (91%, 64% and 73%). Only the child P5 did not evolve satisfactorily (36%), which can be explained by two factors: the high number of absences, which provoked a large spacing between the sessions of the musical stimulation program, thereby undermining the adherence and the motivation.

Table 3 shows the result obtained in the application of the Children's Musical Identification questionnaire (CMI), where we can perceive that all patients had someone in their family who regularly listened to music and that everyone would be encouraged to learn to play some instrument. Moreover, the majority of participants had some contact with music, either at

school activities or in cartoons, but the minority was, in fact, musically stimulated by the parents themselves (questions 5 and 8 in Table 3).

**Table 3. Responses obtained in the CMI questionnaire (Children's Musical Identification)**

Question	Description	Positive Responses	Sample %
Q1	Do you or does anyone in your family who is close to your child play any kind of instrument or sing (whether professional or amateur)?	2	40%
Q2	Do you or does anyone in your family who is close to your child listen to music regularly?	5	100%
Q3	Does your child often sing/dance and/or drum?	4	80%
Q4	Does your child often sing/dance and/or drum while watching a DVD or a television program or when there is some music playing?	4	80%
Q5	Do you or does anyone in your family often take (s) your child to music shows/concerts/theatrical performances?	2	40%
Q6	Does your child often watch cartoons or television programs that contain music?	4	80%
Q7	Does the school that your child attends have musical activities and/or lessons?	3	60%
Q8	Do you often sing children's songs with your child?	2	40%
Q9	Does your child have any favorite music?	2	40%
Q10	Would you encourage your child to play some musical instrument and/or sing?	5	100%

**Caption:** Q = question

**Source:** Designed by the author

Accordingly, the stimuli to which the participants were submitted came mostly from outside their homes, and few parents (or legal guardians) actually stimulated their children directly with regard to music. In addition to the point highlighted above, we have the question 4 (Does your child sing/dance and/or start drumming while watching television programs or when there is some music playing?), which showed that almost all the participants had already reacted to the music, whether drumming, dancing or singing.

Table 4 contains the result of the Musical Skills Development (MSD) questionnaire and, based on the responses obtained in this questionnaire, we perceived that most parents showed that they note the evolution of their children to the proposed program (Q7, Q8, Q9 and Q10). The children reacted positively to the program (Q1, Q2 and Q3) and 80% of the parents started singing with their children after the program (Q5). Even with these responses in the questionnaire conducted with the parents, some children still showed a less satisfactory performance during the program under study.

**Table 4. Responses to the MSD (Musical Skills Development) questionnaire**

Question	Description	Positive Responses	Sample %
Q1	Did you or anyone in your family who is close to your child start listening to music regularly after the beginning of the musical training?	4	80%
Q2	Did your child start singing/dancing and/or drumming after training?	5	100%
Q3	Is your child singing/dancing and/or beginning to drum while watching a DVD or television program or when there is some music playing after training?	5	100%
Q4	Did your child become more interested in watching cartoons or television programs that contain music?	3	60%
Q5	Do you sing children's songs along with your child more often after training?	4	80%
Q6	Will you encourage your child to play a musical instrument and/or to sing after this experience with musical training?	5	100%
Q7	Do you think your child has improved his/her musical skills after training?	4	80%
Q8	Do you think your child has improved his/her communication skills after training?	5	100%
Q9	Did you perceive that your child felt more excited during musical activities?	4	80%
Q10	Would you recommend this musical training to other children?	5	100%

**Caption:** Q = question

**Source:** Designed by the author

Table 5 shows the evolution in the Musical Aptitude Test. This test was applied at the beginning and at the end of the musical stimulation program and, in each application, two marks were assigned, one evaluating the rhythm and the other evaluating the melody. In total, each participant obtained four marks, two before the program and two at the end, which were compared to each other.

**Table 5. Evolution in the Musical Aptitude Test**

Musical Aptitude Test	P-value
Rhythm (Before vs. After)	0,02667*
Melody (Before vs. After)	0.02667*
Wilcoxon Signed-rank Test	
Statistical significance = 5%	

**Source:** Designed by the authors

In general, we noted an improvement in both rhythm and melody, where the performance in the tasks related to rhythm was superior compared with the melodic tasks (Table 5). This fact was also noted in the specific objectives (Table 2); because, in the last session involving the rhythm (session 3), all the proposed objectives were achieved by all participants. In the last session of melody (session 6), the proposed objectives were achieved by four children.

Finally, we noted that both rhythm and melody improved statistically, i.e., the musical stimulation program had a positive effect, thereby improving the rhythm and the melody skills of the participants of the pilot study held on the basis of this program (Table 5).

## DISCUSSION

The musical stimulation program was developed with the objective of being a pleasant facilitator in the auditory rehabilitation of the implanted children, besides being a means of bringing these children closer to their parents and/or legal guardians, thereby facilitating the adherence of these parents to the treatment.

In order to check the feasibility of the use of this program, we performed a pilot study with five families who were engaged in the speech therapy process and were invited to take part in the application of the musical stimulation program.

The literature has highlighted that the earlier the child is implanted, the better the chances of success in its hearing development (17, 18). Given the above, the auditory and chronological ages of the participants (Table 1) were compared with their accuracy percentages in the specific objectives of each session (Table 2), in order to monitor some performance profile, which was not found, i.e., we did not find influence of the age of CI on the results obtained in this study.

In Table 1, we identified that two of the five children were implanted after the age of 3, one with 3 years and 1 month (P5) and another with 3 years and 8 months (P4). Studies have shown that children implanted before the age of 3 achieved results in the evolution of communication faster in comparison with children operated at a later age (19,20).

The participation of the parents influences the evolution of the child using CI. Some authors applied a musical stimulation method (BabyBeats), having as one of the main objectives the improvement of early interaction between parents and hearing impaired children, where they obtained a very positive result: the authors stated that the parents felt more confident to play and to sing with their children, thereby establishing a closer relationship between them. In the present study, we have noted that the accomplishment of the musical stimulation program brought parents closer to the treatment of their children, since they needed to hold some tasks at home.

Added to this information, we should cite the findings with the CMI and MSD questionnaires, which are shown in tables 3 and 4. Only 40% of the parents or family members reported that they used to take their children to music shows/ concerts/ theatrical performances or used to sing children's songs with their children and only 40% of the children have a favorite song. However, 100% of the parents said they would encourage their children to play some musical instrument and/or to sing. Regarding the questionnaire applied after the musical program, we noted that the percentage of parents who started singing with their children increased from 40% to 80%, besides the fact that 100% of the parents reported that their children improved their communication skills and that they would recommend the program to other children. During the musical stimulation

program and, as seen in Table 2, evolution in musical activities happened, both in rhythmic and melodic skills, and it can be said that greater evolution in rhythmic skills was found compared with melodic ones (Table 5).

One explanation for the minor evolution in melody may be the great difficulty of hearing impaired children in discriminating, recognizing and reproducing the different frequencies. These results are in accordance with the pertinent literature, whose studies have stated that Cochlear Implant users are able to perceive the rhythm as well as individuals with normal hearing sensitivity, but the recognition of melodies, timbre and duration are impaired (10,11,20).

Although the Cochlear Implant is a device that assists the patient in discriminating frequency and intensity for speech intelligibility, it still does not provide the exact resolution of these acoustic parameters, which is necessary for musical perception.

Several researchers have highlighted that tasks involving rhythm activate the left hemisphere of the brain in the lower frontal areas, Broca's area, extending to the neighboring insula, i.e., they activate regions responsible for speech. However, melody, which is composed of height and timbre, is processed in the right hemisphere of the brain. Thus, the musical functions are complex activities that stimulate various regions of the brain, being interesting tasks for the (re) habilitation, because they can stimulate the brain in both its hemispheres, including the region of speech. The pertinent literature has reinforced that musical training has an influence on structural changes in the auditory and motor areas of the brain, thereby favoring brain plasticity (25,26,27). In turn, musical stimulation encompasses all these characteristics, which are related to pitch discrimination, timbre, semantic identification of melodies, as well as temporal and sequential processing of sounds (8,21,22).

The reviewed literature was unanimous in pointing to the effectiveness of the use of musical stimulation programs for the (re) habilitation after CI surgery. All studies showed positive results, showing that even a short period of musical learning/stimulation already promoted benefits for patients (3,19,23,24), being that the same benefit was perceived in this study.

As for the applied questionnaires, future surveys should be conducted with the aim to validate their use, thereby enhancing them so that they can be used by more professionals in the area at stake. The same can be said about the musical stimulation program, thereby seeking to validate its effectiveness in other sample groups and refining it with testimonials and feedback offered by parents, in addition to objective measures of evolution such as, for example, electrophysiological evaluation of hearing.

It is important to comment that music itself serves as a context for speech therapy activities, thereby captivating children and encouraging them to take part actively during the sessions with fun. Moreover, music can be a way to increase interactions between parents and children, thereby broadening the sources of auditory stimuli within the households and fostering the evolution of children.

There is a need for further studies using the musical stimulation program developed in this work, so that other children are evaluated and stimulated to use music in their daily lives and during their therapeutic process.

The availability and the interest of parents in stimulating their children musically was the main factor that influenced the performance of the study participants. We perceived the availability and the interest of parents when analyzing the questions and the doubts raised by them during the sessions, besides the comments made about the evolution of the children from one session to another.

Another important point for future studies would be the use of objective measures before and after musical stimulation, so that the effectiveness of this program in the development of the auditory skills of children could be quantified. Moreover, it would also be important to use quantitative questionnaires for the participation and the adherence of parents to the proposed program.

## CONCLUSION

This study complied with its objective, since we have developed a feasible musical stimulation program to be applied to children using Cochlear Implants inserted in auricular rehabilitation. After the musical stimulation program, we noted an improvement in the perception of rhythm and greater interest of families in stimulating the musical skills of their children.

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#### Authors' contributions

*LRAP: Researcher of the work. She was responsible for establishing the procedures used during the research, in addition to applying them; JHSM: Assistant researcher. She organized and corrected the manuscript for publication; DG: Orientation of the work. She performed the orientation and the research along with the other researchers.*