



Audiology - Communication Research

ISSN: 2317-6431

Academia Brasileira de Audiologia

Araújo, Sílvia Regina Siqueira de; Vieira, Sheila de Souza; Salvato, Carolina de Campos; Soares, Alexandra Dezani; Chiari, Brasília Maria
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Audiology - Communication Research, vol. 23, e1955, 2018
Academia Brasileira de Audiologia

DOI: 10.1590/2317-6431-2017-1955

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Characterization of musical perception in cochlear implant users

Caracterização da percepção musical em usuários de implante coclear

Sílvia Regina Siqueira de Araújo¹, Sheila de Souza Vieira², Carolina de Campos Salvato¹,
Alexandra Dezani Soares², Brasília Maria Chiari²

ABSTRACT

Purpose: To evaluate the musical perception of adults with cochlear implant using the Munich Music Questionnaire (MUMU). **Methods:** Cross-sectional research with a quantitative approach, approved by the institution's Research Ethics Committee (Opinion n° 1,626,211). Twenty-one post-lingual adults who were cochlear implant users for at least one year participated in the study. The data collection instrument applied was the Munich Questionnaire, which covers questions about participation in musical activities and about the habits of listening to music in relation to musical styles, different instruments, the listening environment and the use of assistive devices. The data were computed in absolute and relative values and descriptive statistics were used to characterize the sample. **Results:** It was possible to observe that there was improvement in the frequency of music heard after cochlear implantation. Of the participants, most respondents did not connect the music directly to their processor. Most patients listen to music for pleasure and to relax, and they can mostly sense the rhythm. The instrument with the highest frequency of detection was the piano, followed by the drums. The musical genre referred to with great satisfaction was techno and religious. Of the 10 patients who played instruments before hearing loss, 4 played again after implantation and 3, who did not play, began to play after cochlear implantation. **Conclusion:** It was possible to observe that the use of the cochlear implant provided an improvement in the users' musical perception, reflecting an improvement in the quality of life. Therefore, rehabilitation should include within the auditory training the development of musical abilities.

Keywords: Cochlear implantation; Music; Questionnaires; Quality of life

RESUMO

Objetivo: Avaliar a percepção musical de adultos usuários de implante coclear, utilizando o Questionário de Música de Munique (*Munich Music Questionnaire* – MUMU). **Métodos:** Pesquisa transversal, de abordagem quantitativa. Participaram do estudo 22 adultos pós-linguais, usuários de implante coclear há, pelo menos, um ano. O instrumento de coleta dos dados aplicado foi o Questionário de Munique, que abrange questões sobre a participação em atividades musicais e a respeito dos hábitos de ouvir música, em relação aos estilos musicais, aos diferentes instrumentos, ao ambiente de escuta e ao uso de dispositivos auxiliares. Os dados foram computados em seus valores absolutos e relativos e foi utilizada estatística descritiva para caracterizar a amostra. **Resultados:** Foi possível observar que houve melhora na frequência de música ouvida pós-implante coclear. Dos participantes, a maioria respondeu não ligar a música diretamente ao seu processador. A maioria dos pacientes mencionou que ouvia música por prazer e para relaxar e que conseguiam perceber, principalmente, o ritmo. O instrumento com maior frequência de detecção foi o piano, seguido da bateria. O gênero musical referido com grande satisfação foi música para dançar e religiosa. Dos 10 pacientes que tocavam instrumentos antes da perda auditiva, 4 voltaram a tocar após a implantação e 3, que não tocavam, começaram a tocar, após o implante coclear. **Conclusão:** Foi possível observar que o uso do implante coclear propiciou melhora na percepção musical dos usuários, refletindo benefício na qualidade de vida. Por isso, a reabilitação deve incluir, dentro do treinamento auditivo, o desenvolvimento de habilidades musicais.

Palavras-chave: Implante coclear; Música; Questionário; Qualidade de vida

Study carried out at Universidade Federal de São Paulo – UNIFESP/EPM – São Paulo (SP), Brasil.

¹Curso de Fonoaudiologia, Universidade Federal de São Paulo – UNIFESP - São Paulo (SP), Brasil.

²Departamento de Fonoaudiologia, Universidade Federal de São Paulo – UNIFESP - São Paulo (SP), Brasil.

Conflict of interests: None.

Author's contributions: SRSA main researcher, research elaboration, chronogram elaboration, literature review, data collection, data analysis, text, article submission and formalities; SSV research elaboration and article text correction; CCS assistant researcher and data collection; ADS assistant researcher and data collection; BMC advisor, research elaboration, chronogram elaboration, data analysis, article text correction, approval of the final version.

Funding: Research derivative from the National Council for Scientific and Technological Development (PIBIC-CNPq) under process number 122274/2016-4.

Corresponding author: Sílvia Regina Siqueira de Araújo. E-mail: silvia.siqueira@yahoo.com.br

Received: December 11, 2017; **Accepted:** September 10, 2018

INTRODUCTION

The discovery of hearing impairment is an impacting moment, and can generate negative feelings, such as anguish, sadness, fear, and frustration. The withdrawal of sound from the individual's life cause them to isolate themselves from daily activities, since there are limitations in communication⁽¹⁻³⁾. It can be said that hearing impairment isolates the person from other people, depriving them in many situations of social, professional, academic and family life.

Currently, there are hearing aid devices, with the cochlear implant (CI) being one of the technological advances of the last decades. It directly stimulates the auditory nerve through small electrodes that are placed inside the cochlea. It can be used in different age groups, by patients with severe and/or profound sensorineural loss who did not benefit from a personal sound amplification product (PSAP). It is an equipment that benefits the individual with hearing loss in language development, improvement of the perception of speech sounds and perception of music.

The use of CI and/or PSAP brings physical, psychological and social benefits that improve the life quality of the users^(4,5).

Mainly, the cochlear implant was designed to improve speech perception^(5,6). However, technological advances and users desire to enjoy music, entertainment and leisure activities have motivated studies that seek to improve the patients' musical perception.

Music is complex and wide, including many elements variety as rhythm, melody, timbre, pitch, and harmony⁽⁷⁻¹¹⁾. It is inserted in the daily life, in the entertainment, fun and relaxation, being able to help the creativity and the expression of feelings. In previous studies, it was possible to observe that the frequency, in hours per week, of listening to music decreased after cochlear implantation, however, the music remained of great importance in the life of the patient^(11,12). One of the strategies used to improve the identification of songs is the use of lane (letters and/or rhythm)^(13,14).

There are some objective instruments of evaluation of musical perception for CI users, as *MACarena Software*⁽⁸⁾, *PMMA* - Adapted Primary Measures of Musical Audiation⁽¹¹⁾, and *Mu.S.I.C. test*⁽¹⁴⁾. However, there are few instruments of additional evaluation to know the habits and satisfaction of the user, as the *Munich Music Questionnaire*, also known as MUMU. Few studies are related to the habits and recognition of the need for musical perception in cochlear implant users in Brazil. In the period from 2000 to 2010, only one research was found on the subject in the country⁽¹⁵⁾.

Thus, the present study aimed to evaluate the musical perception of adults using cochlear implants, using the Munich Music Questionnaire.

METHOD

This is a quantitative cross-sectional study in which the Munich Music Questionnaire was applied. The study was carried out at the Hearing Impaired Center of the Federal University of São Paulo. The project was approved by the Ethics and Research Committee - CEPUNIFESP, under number 1,626,211. All participants signed the Informed Consent Term.

Twenty-two adult individuals, of whom 13 women and 9 men, were evaluated under the following inclusion criteria: over 18 years of age, with hearing loss in the post-lingual period, with at least one year of cochlear implantation, in follow-up by the cochlear implant team of the Hearing Impaired Center of that institution. The users who met the criteria above and who returned to follow up the rehabilitation in the center of CI from May 2016 to April 2017 participated in the survey. Individuals with other deficiencies registered in the medical record were excluded.

The Munich Music Questionnaire was created in 2002 and translated and adapted to Brazilian Portuguese in 2015.

The Munich Music Questionnaire was specially developed for the adult population with hearing loss acquired in the post-lingual period and users of CI. It contains 25 questions to record the habits of listening to music, in relation to musical styles, different instruments, the listening environment, the use of assistive devices and participation in musical activities, in different periods of the patient's life. The questionnaire has been used as an additional measure to objective tests of musical perception, such as *MACarena Software*⁽⁸⁾, *PMMA*⁽¹¹⁾ and *Mu.S.I.C. test*⁽¹⁴⁾, being an important instrument to evaluate the aspects of the musical appreciation in implanted post-lingual adults.

The questions 1, 2, 3, 14, 15, 19, 20 and 21 deal with three periods: before hearing loss; after hearing loss, but before the use of CI, and after CI surgery. Questions 17 and 18 include the three periods cited and the time when the patient was a child.

Questions were answered with "yes" (Y) or "no" (N), or following a multiple choice rating scale. On some issues, more than one item may be ticked.

Participants answered individually the questionnaire during a cochlear implant follow-up session. The evaluator was available to clarify any doubts but did not interfere with the participants' answers.

The data were computed in their absolute and relative values and analyzed by means of appropriate statistical treatment. For the analysis of the questions, frequency and percentage distribution tables were constructed for each response category. Descriptive statistics were used to characterize the sample.

RESULTS

Based on the established criteria, the responses of the 22 adult CI users were analyzed. The participants were attended during the routine of follow-up in the CI service, from September 2016 to March 2017. The mean age of participants was 44 years, 21 years the minimum age and 71 years the maximum age, being 13 women and 9 men.

Regarding the etiology of hearing loss, 10 individuals had unknown etiology, 6 due to meningitis, 3 due to otosclerosis, 2 due to measles, and 1 due to Meniere's disease. The average hearing loss time was approximately 21 years. Of the participants, 3 used bilateral CI and 18 unilateral CI, of which, 8 also used PSAP in the other ear. Regarding the implants brand, 50% were users of Med-EL, 31.81% of Cochlear and 18.19% of Advanced Bionics. Participants' individual information (gender, age, etiology of hearing loss, age at implantation, time of hearing loss, time of cochlear implant use, cochlear implant use, CI model and brand) are shown in Table 1.

In question 1, "How often did you listen and/or listen to music?", was possible to observe that, before the hearing loss,

40.9% of the participants always listened and 27.2%, never. After hearing loss, only 9.1% always listened and 50% said they did not listen at all. With the cochlear implant, 31.8% started to always listen, improving in relation to the period when they presented hearing loss (Table 2).

In question 8, “When did you start listening to music regularly after receiving your cochlear implant?”, 59.07% reported starting to listen to music regularly within the first month of use of the CI (Figure 1).

In question 12, “Which instruments can you detect without difficulty?”, The majority of the participants reported to detect without difficulty the piano (77.72%), the drums (68.18%), the violin (59.1%), the electric guitar (54.55%) and/or accordion (50%) (Figure 2).

In question 18, “What instruments have you played or play at this time?”, 8 patients reported playing instruments during childhood and 10 patients who played before the HL, being the keyboard the most played instrument during these periods. After the CI, of the 10 patients who played instruments before HL, 4 returned to play and 3, who did not play, began to play (Table 3).

In question 22, “Have you received any kind of out-of-school music education (singing and/or instrument classes)?”, Most participants (77.27%) mentioned not having received and among the 5 adults who received musical education, 60% had more than 3 years of study in this area (Table 4).

According to the answers to the questions 24 and 25, most users trained to listen to music with the cochlear implant (68.2%), mainly listening to familiar music, repeatedly (60%), and reading the lyrics while listening (53.3%) (Table 5).

Table 1. Characteristics of individuals included in the research

	Gender	Age (years)	Etiology	Implanting age	HL time (years)	CI usage time	CI use	Brand	Model	Nº of electrodes off
1.	F	51	Otosclerosis	48 years and 10 months	10	2 years and 2 months	CI+PSAP	Cochlear	Freedom	0
2.	M	38	Meningitis	33 years and 6 months	30	4 years and 6 months	CI+CI	Cochlear	Freedom	0
3.	F	50	Unknown	47 years and 5 months	6	2 years and 7 months	CI+PSAP	Med-El	Sonata	-1
4.	F	27	Unknown	25 years e 10 months	20	2 years and 2 months	CI+ PSAP	AB	HiRes 90k	-1
5.	M	38	Meningitis	28 years and 3 months	11	9 years and 9 months	CI	Med-El	Pulsar	-2
6.	F	64	Meningitis	60 years and 7 months	4	3 years and 5 months	CI	Cochlear	Freedom	0
7.	F	39	Unknown	35 years and 6 months	31	3 years and 6 months	CI+PSAP	AB	HiRes 90k	0
8.	M	32	Meningitis	12 years and 10 months	21	19 years and 2 months	CI+CI	AB	HiRes 90k	0
9.	M	66	Unknown	57 years and 8 months	20	8 years and 4 months	CI	Med-El	Pulsar	-1
10.	F	45	Otosclerosis	42 years and 11 months	19	2 years and 1 month	CI+PSAP	Cochlear	Freedom	-1
11.	F	25	Unknown	22 years and 1 month	12	2 years and 11 months	CI	Med-El	Sonata	-3
12.	M	65	Unknown	58 years and 9 months	36	6 years and 3 months	CI	Med-El	Sonata	0
13.	F	35	Meniere's disease	32 years and 2 months	22	2 years and 10 months	CI+PSAP	Cochlear	Freedom	0
14.	F	53	Meningitis	46 years and 10 months	14	6 years and 2 months	CI	Cochlear	Freedom	0
15.	M	41	Unknown	34 years and 10 months	22	7 years and 2 months	CI	Med-El	Sonata	-2
16.	F	53	Unknown	49 years and 6 months	35	4 years and 6 months	CI	Med-El	Sonata	0
17.	F	30	Unknown	26 years and 10 months	14	3 years and 2 months	CI	AB	HiRes 90k	0
18.	M	41	Measles	39 years and 8 months	24	1 year and 4 months	CI+PSAP	Med-El	Sonata	0
19.	F	21	Unknown	19 years and 4 months	14	1 year and 8 months	CI	Med-El	Sonata	0
20.	M	56	Measles	47 years and 11 months	46	8 years and 1 month	CI+PSAP	Cochlear	Nucleus 24	-3
21.	M	71	Otosclerosis	64 years and 6 months	38	7 years and 6 months	CI	Med-El	Sonata	-1
22.	F	32	Meningitis	14 years and 8 months	18	17 years and 4 months	CI+CI	Med-El	Rondo	0

Subtitle: CI = Cochlear Implant; PSAP = Personal Sound Amplification Product; HL = Hearing Loss; AB = Advanced Bionics; F = Female; M = Male

Table 2. How often do you listen and/or listened to music?

	Always (n) (%)	Frequently (n) (%)	Occasionally (n) (%)	Rarely (n) (%)	Never (n) (%)	Total (n)	Total (%)
Before HL	9 40.90	5 22.73	1 4.55	1 4.55	6 27.27	22	100
Presented HL	2 9.10	4 18.18	4 18.18	1 4.54	1 5.00	22	100
With CI	7 31.81	7 31.81	4 18.18	2 9.10	2 9.10	22	100

Subtitle: CI = Cochlear Implant; HL = Hearing Loss; (n) = N = Number of individuals

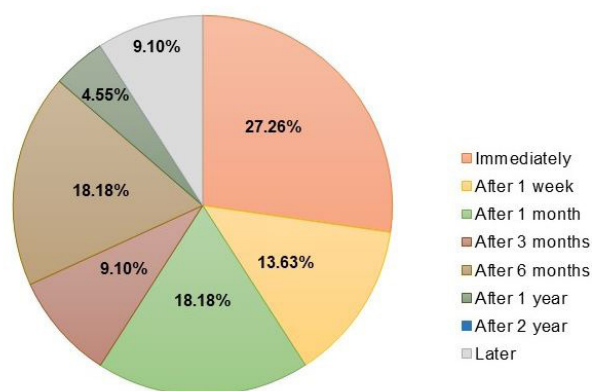


Figure 1. When did you start to listen to music regularly after implanting your cochlear implant?

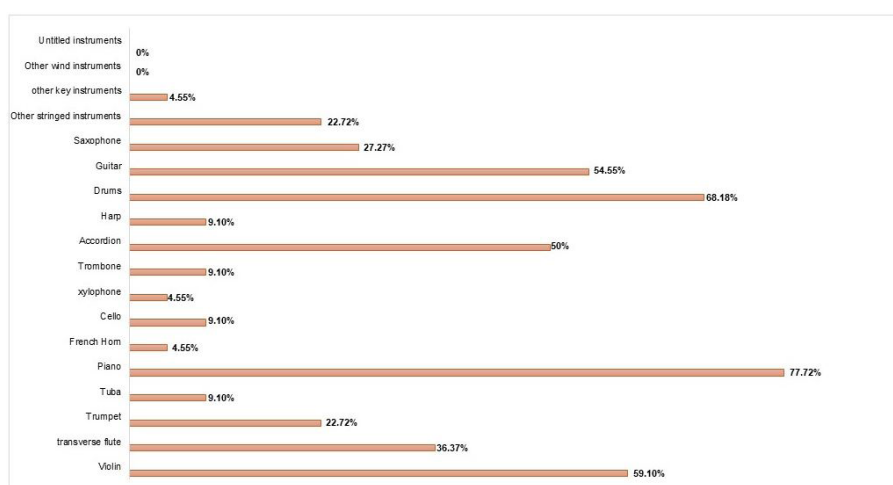


Figure 2. Which instruments can you identify without difficulty?

Subtitle: Inst. = Instrument

Table 3. Which instruments did/do you play?

	Childhood (n) (%)	Before HL (n) (%)	Presented HL (n) (%)	With CI (n) (%)
Transverse flute	1 12.5	2 20	0 0	1 14.28
Piano	2 25	2 20	0 0	4 57.14
Keyboard	3 37.5	4 40	1 25	2 28.57
Electric guitar	1 12.5	2 20	1 25	0 0
Violin	0 0	0 0	0 0	1 14.28
String Inst.	0 0	2 20	1 25	3 42.85
Wind Inst.	2 25	2 20	0 0	1 14.28
Unnamed Inst.	2 25	2 20	1 25	0 0

Subtitle: Inst = Instrument; HL = Hearing Loss; CI Cochlear Implant; (n) = Number of individuals

Table 4. Did you receive any kind of music education outside school (singing and/or instrument lessons)?

	(n)	(%)
No	17	77.27
Yes	5	22.73
Total	22	100

Subtitle: (n) = Number of individuals

Table 5. How did you trained to listen to music with your cochlear implant?

	(n)	(%)
Listened to familiar music repeatedly	9	60
Listened to unknown music repeatedly	7	46.6
Listened and read the music	8	53.3
Had music lessons	1	6.6
Read and played the music	3	20
Played repeatedly familiar music without reading it	5	33.3
Trained to read the music in my rehabilitation	4	26.6

Subtitle: (n) = Number of individuals

DISCUSSION

In Brazil, only one instrument that allows to know the musical activities of users of cochlear implant was identified, the Munich Music Questionnaire⁽¹²⁻¹⁵⁾. This instrument was created in 2002, translated and adapted to Brazilian Portuguese in 2015. It was chosen because it approaches aspects of the individual user of CI and their relationship with music in an objective way, in the different moments of life.

In this study, a decrease in the frequency in which the individuals implanted heard music, when comparing the period before and after CI^(11,12). Despite the decrease in this frequency, music played a major role in the lives of most participants before and after hearing loss.

It was observed that 95.45% of the patients did not hear the music with the aid of the speech processor. This result becomes questionable and limiting, since the technology of the device can be a facilitating factor in the appreciation of music.

Most users listen to music for pleasure and to relax^(9,12) and they begin to listen to music regularly in the first few months after activation, proving that this is the most important moment to encourage, start, or have begun training in musical skills.

The elements of music such as rhythm, melody, timbre and pitch are still challenging aspects for most users. In the study, 81.82% of those implanted responded that they could hear the rhythm element during music^(7,8,10,14). The instrument that most users enjoy listening to is the piano, followed by the electric guitar⁽¹⁶⁾.

The musical genres less heard among the users were opera and classical, and it may be influenced by the local culture⁽¹²⁾. In another study, were found religious and techno genres⁽¹⁶⁾.

Of the ten patients who played instruments before the hearing loss, four played again after implantation^(17,18). In addition, three that did not play, began to play after the CI.

Most individuals implanted did not sing before the HL; however, in the period after HL with the cochlear implantation, the frequency of most users increased from “never” to “occasionally”. Hypothetically, this increase has the auditory feedback of the voice itself.

Only 22.73% of the patients received musical education before HL. According to the literature, individuals who had previous musical experience obtain better recognition of musical elements⁽¹⁹⁾.

The majority of those implanted (68.2%) trained to listen to music with the device, being the most used strategies to hear, repeatedly, familiar music and to listen reading the song lyrics. In the literature, there is evidence that familiarity with music helped in the recognition of excerpts and the improvement of

the musical experience post-CI^(20,21). Train auditory recognition of musical instruments⁽²²⁾, listen specifically something of the music to understand⁽²³⁾; and recognize songs together⁽²⁴⁾ are facilitators for the best performance.

It is important to consider the variability of results found in the clinical population and also that numerous factors are capable of impacting the auditory performance with the CI and, consequently, the musical appreciation. In this sense, the combined analysis of the questionnaire results and other clinical information of the professionals that attend this population may contribute to a better understanding of the insertion of the music in the daily activities of the users of CI.

CONCLUSION

It was possible to know the profile of CI users attended at the institution and to observe that the use of CI improved their perception of music and quality of life.

Returning to the thought of Aldous Huxley “After silence that which comes nearest to expressing the inexpressible is music.”

Appreciating music is something inherent to the human being and its lack can imply isolation and failure in personal and professional life. This research allowed to conclude that there are few users of cochlear implants who continue with their previous musical habits. However, it is possible to start or resume engaging with music, hearing, listening, singing, or playing an instrument. Pre-implantation and post-implantation auditory rehabilitation is necessary and should include the development of musical skills for the best musical appreciation, thus rescuing another aspect of the sound world.

ACKNOWLEDGEMENTS

To the patients, for the collaboration in participating in the research and in sharing some of the experiences of their lives.

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