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A study on the perception, learning experiences, and preferences in music among hard-of hearing adults

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Abstract

The purpose of this study was to investigate the music perception, learning experiences, and preferences of adults with hard-of-hearing and to examine how these factors vary depending on the type of rehabilitative assistive devices they use. A total of 107 adults with hard-of-hearing participated in a questionnaire consisting of 25 items related to music perception, learning experiences, and preferences with desires for learning music. The participants demonstrated a relatively high ability to perceive and identify music sounds, although they experienced difficulties in fully appreciating music while using rehabilitative assistive devices. Despite these challenges, participants expressed a strong desire to engage in music learning, with a particular interest in elements that foster enjoyment, rhythm, and tactile-based learning. Significant differences were observed between groups wearing different types of rehabilitative assistive devices and those not wearing devices, particularly in terms of the recognition of emotional content in songs ($P = .003$), music preference ($P = .019$), and perception level of music sounds ($P = .000$). In addition, significant differences were found in the consideration of self-learning function ($P < .05$) and listening to songs function ($P < .05$) when developing music-learning devices based on the use of rehabilitative assistive devices. Based on these research findings, priorities for the development of music-learning devices for adults with hard-of-hearing and relevant technological considerations have been proposed.

Abbreviations: BD = bimodal device, CI = cochlear implant, HA = hearing aid, HH = hard-of-hearing, NA = non-assistive device.

Keywords: assistive device, hard-of-hearing, learning experience, music perception, music preference

1. Introduction

This study primarily focused on addressing the following research questions: "How do adults with hard-of hearing (HH) perceive music? What are the learning experiences of adults with HH? What differences exist in music perception and preference between HH adults using different rehabilitation assistive devices?" Guided by these questions, this study aimed to develop technologies and pedagogies that enhance musical accessibility and enjoyment for adults with HH.

A dictionary definition of music refers to it as a temporal art that involves the expression of ideas or emotions using one's voice or musical instruments based on the different characteristics of sound, such as high and low, long and short, and strong and weak.[1] According to this dictionary definition, music involves listening to and learning sounds, as well as using one's voice or an instrument. Therefore, music can be considered as a multisensory activity that engages hearing to perceive sounds, vision to observe instruments and musical scores, and touch to manipulate and play instruments.

According to the Korean Sign Language Act, a deaf person is defined as a person with communication disability due to hearing loss or deafness. It is often assumed that deaf people cannot hear the music. However, the process of receiving and perceiving sound is difficult, and the imagery processes that occur in the brain and the ability to understand after perceiving music are no worse than those experienced by hearing people.[2]

Nasresfahani et al[3] has shown that adults and children with cochlear implants (CIs) tend to have higher levels of music appreciation and do not differ from hearing people in terms of the perceived importance of music, participation in musical activities, and enjoyment of singing along with music. Wright and Uchanski[4] examined the relationship between music recognition ability and music enjoyment and found that CI users rated music as more enjoyable than hearing people. However,

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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no correlation was found between music recognition and enjoyment.

Migirov et al[5] found associations between CI users' duration of hearing loss, age, duration of CI use, and music-related variables. Older participants with more years of CI experience demonstrated better chord identification, and those who liked the sound quality of their CI and had a longer duration of hearing loss tended to have higher music appreciation scores.

Participating in music has a positive influence on high quality of life and satisfaction with health.[6–8] Research has shown that music has a profound effect not only on the psychological and emotional aspects of human beings but also on their spiritual aspects.[9] As a result of investigating the music education experience of hard-of-hearing participants, the benefits of music include peace of mind, stimulation of various emotions, healing of the body and mind, and stress relief.[10]

The experiences of CI users (aged 18–81) regarding music and quality of life, and found that music contributes to many aspects of physical, psychological, and social well-being, and that the positive effects of music on quality of life are similar to those that have previously been reported among hearing people. Meanwhile, difficulties in music perception and enjoyment among adult cochlear implant users have been reported to have a negative impact on quality of life by causing unpleasant feelings and limiting participation in music-related daily activities.[11] HH participants had significant difficulty perceiving the pitch, melody, and timbre of music. HH participants with CIs had poor music perception due to reduced perception of temporal and spectral information. The inaccurate and poor music perception of HH participants with hearing aids (HA) was due to damage to the cochlea and distorted transmission through the hearing aid.[12,13]

Studies of music learning in HH individuals has focused on auditory training using music. This is because using music for auditory training has the advantage of accelerating training progress, as music does not focus on meaning in the same way as speech does.[14] Studies have reported the effectiveness of auditory training[15–17] and studies have shown improvements in tone perception after auditory training in HH participants with HA.[18–21] Recently, various methods of music auditory training for cochlear implant users have been introduced, and studies have been conducted on the effects of training in terms of speech perception, cognition, and psychology.[22,23] Music auditory training has shown significant effects on speech perception and working memory.[24]

Although there has been some previous research examining music perception and learning in HH individuals, the existing research mainly focuses on cochlear implant users.[3–5,25–27] Despite growing research on music perception and enjoyment among HH individuals, there remains a significant gap in understanding how HH adults, particularly those who do not use rehabilitation assistive devices, experience music. Although numerous studies have explored music learning as a form of rehabilitation therapy and assessed its effectiveness, there has been limited research on how HH adults engage in music perception, learning experiences, and preferences.

Unlike infants and children, who often receive music rehabilitation under the guidance of a primary caregiver, young and middle-aged adults have more independent and active lives. Consequently, their engagement with music can differ significantly, which directly affects music perception, music-learning experiences, and music preferences. In this study, music perception refers to the ability to recognize and interpret musical elements such as pitch, rhythm, harmony, and timbre. Music-learning experience involves the process of acquiring and developing musical skills and knowledge. Additionally, music preference reflects individual tastes toward specific genres or styles of music.

With this background, the purpose of this study was to investigate the music perception, learning experiences, and preferences of HH adults. This study aimed to analyze the differences based on the specific rehabilitation assistive devices used. This study collected the requirements for HH adults and provided basic data on music-learning methods. These results are expected to provide an important foundation for guiding the preparation of music-learning methods for HH adults while collecting music-related information from adult participants. Based on the purpose of the study, the following hypotheses were proposed: First, HH adults who use rehabilitation assistive devices will have a higher level of music perception compared to those who do not use such devices. Second, HH adults will have differences in their music-learning experiences. Third,

Table 1

Sampling and data collection.

Category	Description
Target participants	Adults with hard-of-hearing using HA, CI, BD, and NA
Sample size determination	G*Power 3.1.9.7 ($\alpha = 0.05$, effect size = 0.5, power = 0.8) Required sample: 102 Adjusted for dropout (+5%): 107
Total responses collected	109 (2 excluded due to duplication) - final sample: 107
Recruitment method	Purposive sampling, snowball sampling
Data collection method	Online survey via Google Forms (estimated completion time: maximum 30 min)
Survey duration	October 28 to November 11, 2020
Ethical approval	Approved by the Institutional Review Board (IRB) of Kangnam University (approval no. KNU_HR2020011)

BD = bimodal devices, CI = Cochlear implants, HA = hearing aids, NA = non-assistive devices.

Table 2

Demographic information of the participants.

Category		Response type	Number (N)	Percentile (%)
Sex	Male	Single (N = 107)	40	37.4
	Female		67	62.6
Age group	20s	Single (N = 107)	36	33.6
	30s		38	35.6
	40s		27	25.2
	≥50s		6	5.6
Education	High school	Single (N = 107)	35	32.7
	College/University		54	50.5
	Graduate school		18	16.8
Rehabilitation assistive device	HA	Single (N = 107)	57	53.3
	CI		28	26.2
	BD		12	11.2
	NA		10	9.3
Cochlear implant transplantation period (yr)	1 to 5	Single (N = 40)	8	20.0
	6 to 10		8	20.0
	11 to 19		7	17.5
	20 to 29		5	12.5
	30 to 39		7	17.5
	≥40		5	12.5
Hearing aid wearing period (yr)	1 to 5	Single (N = 56)	33	58.9
	6 to 10		17	30.4
	11 to 19		3	5.4
	≥20		3	5.4
Rehabilitation experience	Auditory rehabilitation	Multiple (N = 164)	41	25.0
	Auditory training		42	25.6
	Language rehabilitation		81	49.4

BD = bimodal device (HA + CI), CI = cochlear implant, HA = hearing aid, NA = non-assistive device.

HH adults will show differences in music perception and preferences depending on whether or not they use rehabilitation assistive devices.

2. Materials and methods

2.1. Participants and selection

This study surveyed adults with HH who use HA, CI, bimodal devices (BD), and non-assistive devices (NA).

2.2. Sample size determination and sampling procedure

The required sample size was calculated using G Power 3.1.9.7, with a significance level of 0.05, an effect size of 0.5, and a statistical power of 0.8. To account for the possibility of inadequate responses or dropouts, the expected sample size was increased by 5% (i.e., by 5 participants to 107). Participants were recruited using purposive and snowball sampling methods. Initially, 41 participants from a prior research project, "Development of Human Enhancement Technology for Auditory and Muscle Support" (Korea Electronics and Telecommunications Research Institute [ETRI], 2017–2019), were invited to participate. They received an explanation of the study and a consent form via email or online messenger. Subsequently, they referred additional eligible participants who were invited through snowball sampling. The survey was conducted online using Google Forms, and participants were given a maximum of 30 minutes to complete it. The details of the sampling and data collection process are summarized in Table 1. A total of 109 participants responded to the survey, but 2 responses were excluded due to duplication, resulting in a final sample of 107 participants (Table 2).

2.3. Ethical consideration

Ethical approval for this study was obtained from the Institutional Review Board of Kangnam University (approval number: IRB No. KNU_HR2020011).

2.4. Measurement

The questionnaire used in this study was systematically developed based on the results of the "Development of Human Enhancement Technology for Auditory and Muscle Support" research project, conducted by the Korea ETRI from 2017 to 2019. This study identified key challenges and areas for improvement in music-learning among HH adults, which informed the core framework of the questionnaire. The questionnaire was developed through a structured process (Table 3).

The questionnaire was structured into 4 sections comprising 25 questions, including general information about the respondents. The first section, General Information, included demographic and background information about HH adults. In the second section, Music Perception, examined various auditory attributes, including sound clarity, resonance, ability to distinguish different musical instruments, and familiarity with musical concepts. In the third section, music-learning experiences, exposure to different musical genres, the starting point of music education, and the duration of learning experiences were examined. In the final section, music preferences, investigated multiple aspects of musical engagement, including preferred musical activities, challenges encountered in musical activities, use of rehabilitation assistive devices during music learning, types of assistive devices used, difficulties experienced while learning music with assistive devices, desire for melody change perception, song preference concerning melodic modifications, skill areas to improve through music learning, necessity for sensory music-learning devices, and importance of technical aspects in sensory music-learning devices.

2.5. Data analysis

The data collected in this study were analyzed using the statistical software (SPSS 21.0 version; IBM Corp., Armonk). The frequencies and proportions of the data were analyzed using simple frequency analysis and multiple-response frequency analysis in cases involving 1 or multiple responses. Based on these results, a cross-tabulation analysis was conducted to analyze the relationship between the groups' music-learning experiences and their preferences, according to the characteristics of the rehabilitation assistive devices of HH adults. The chi-square test of independence was used to verify the statistical significance of the results of the cross-analysis, and Fisher exact test was used when an expected frequency of <5 accounted for more than 20% of the total cells. Moreover, the requirements related to the preferred music-learning methods among the rehabilitation aids used by the HH adult groups were verified in detail using a 1-way analysis of variance (ANOVA) to compare the means between the groups.

3. Result

3.1. Music perception

In terms of musical sound perception, 43% of the respondents reported being able to hear a faint melody, 22.4% reported hearing some vibrations, 20.6% reported hearing well, and 7.5% reported not being able to hear at all. In terms of how the sound felt, that is, the emotional response elicited by the music, 46.7% of respondents rated it as "like" followed by 35.5% who

Table 3

Questionnaire development process.

Process	Details
Primary source	Developed based on the research project "Development of Human Enhancement Technology for Auditory and Muscle Support" (2017–2019).
Literature review	Analyzed existing research on music perception, learning experiences, and preferences.
Expert review/FGI	Conducted on August 1, 2020, to refine readability, response format, and questionnaire structure. Consulted 3 specialists with over 8 years of experience in audiology, speech therapy, and music therapy. Validated questionnaire appropriateness and content. - J. H. Kim, Ph.D. in Audiology: Clinical audiologist specializing in hearing aid technology and auditory rehabilitation in the Department of Otorhinolaryngology at Hallym University Sacred Heart Hospital - Y. J. Lee, M.A. in Speech-Language Pathology: Speech-language pathologist at Chungeum Rehabilitation Center - J. H. Chang, M.A. in Clinical Music Therapy: Music therapist at Samsung Sorimom Child Development
Final validation	Reviewed by a professor specializing in social work with individuals with disabilities and validated the final questionnaire, ensuring its relevance to the target population and applicability in social work and rehabilitation settings.

FGI = focus group interview.

rated it as "just okay," 9.4% who were "not sure," and 7.5% who rated it as "dislike." In terms of distinguishing between the sounds of the instruments, 48.6% of participants were able to do so, whereas 34.6% were not. Regarding music perception, 54.2% reported some knowledge of music, 29.9% reported limited knowledge, and 15.9% reported extensive knowledge (Table 4).

3.2. Music-learning experiences

The study participants reported that the most common method of music education they received was listening to music (29.2%), followed in descending order by singing songs (24.2%), playing musical instruments (23.8%), and physical expression (17.8%). On average, participants began their music education by the age of 10 years, with the highest percentage (51%) in the 6 to 10 age group. Schools were the most common setting for music learning, with 42.6% engaging in music education. The next most frequently reported settings were music academics (26.1%), home-based learning (15.3%), and private lessons (9.7%). Respondents who had studied music for more than 1–2 years had the highest number of responses (28.0%), followed by those who had studied music for less than 1 year (20.6%). In terms of music education, 46.7% of the respondents ranked listening to music as their top priority, followed by 19.7% who ranked physical expressions as their top priority, 19.6% who ranked playing a musical instrument as their top priority, and 11.2% who ranked singing as their top priority (Table 5).

3.3. Music preference

In terms of music preference, listening to music (appreciation) was ranked as the favorite musical activity by 65.4% of respondents. Playing an instrument and physical expression activities were tied to the most common second-place priority (13.1%). According to the survey results, singing was ranked as the least favorite musical activity, with 38.3% of respondents selecting it as their least favorite. Creating music and playing an instrument were also among the least favorite activities, with 20.6% of respondents choosing creating music and 16.8% of the respondents choosing playing an instrument as their least preferred. The survey also found that 81.3% of respondents used an assistive device to learn music, with HA being the most common (67.8%), followed in descending order by CIs (24.1%), and BD (6.9%). Regarding the experience of difficulty when learning music with an assistive device, 65.4% of participants reported experiencing problems, whereas 34.6% did not. The results showed that 70.1% of participants wanted to experience changes in their melodies. Moreover, 10.3% of the participants expressed a desire to experience such changes, but lacked confidence in their opinions, while 10.3% were unsure. Only 5.6% of the participants responded negatively. In terms of whether they would like to sing melodic changes, 43.0% responded positively, 29.0% expressed interest, but lacked confidence, and 15.0% were unsure. According to the survey, the top 3 skills that respondents wanted to improve through music learning were enjoyment (36.5%), rhythm (31.8%), and confidence (18.7%). Moreover, 80.4% of the respondents expressed interest in learning music through tactile devices. Based on a 5-point Likert scale (with Cronbach α at.929), the technical elements deemed important for tactile music-learning devices were as follows: visual indication of pitch (average score of 4.37), rhythm accuracy (4.26), self-learning (4.18), and melody accuracy (4.16) (Table 6).

3.4. Comparing music perception and preference in 4 groups

As shown in Figure 1A, a chi-square test of independence was conducted to determine the association between the rehabilitation assistant devices worn by HH adults and their ability to identify the feeling of the song. As an expected frequency

Table 4

Music perception.

Question	Response type	N (%)
How well can you hear the music?		
I can't hear it at all	Single (N = 107)	8 (7.5)
I can perceive some vibrations.		24 (22.4)
I can hear faint melodies.		46 (43.0)
I can hear it well.		22 (20.6)
Other		7 (6.5)
How do you feel about the resonance of sound?		
Like it.	Single (N = 107)	50 (46.7)
Just okay.		38 (35.5)
Dislike it.		8 (7.5)
Not sure.		10 (9.4)
Other		1 (0.9)
Can you distinguish between different musical instruments?		
Yes	Single (N = 107)	18 (16.8)
Somewhat		52 (48.6)
No		37 (34.6)
How well do you know music?		
I know a lot.	Single (N = 107)	17 (15.9)
I know a little.		58 (54.2)
I don't know much		32 (29.9)

Table 5

Music-learning experiences.

Question	Response type	N (%)
What musical learning experiences have you had?	Multiple (N = 281)	
Singing		68 (24.2)
Playing a musical instrument		67 (23.8)
Listening to music (appreciation)		82 (29.2)
Physical expression activities		50 (17.8)
Composition		9 (3.2)
Other		5 (1.8)
When did you first begin learning music?	Single (N = 104)	
1 to 5		21 (20.2)
6 to 10		53 (51.0)
11 to 19		21 (20.2)
20 to 29		5 (4.8)
≥ 30		4 (3.8)
Where did you engage in music learning?	Multiple (N = 176)	
Home		27 (15.3)
School		75 (42.6)
Music academy		46 (26.1)
Private lessons		17 (9.7)
Other		11 (6.3)
How long have you been involved in music learning?	Single (N = 107)	
<1 year		22 (20.6)
1 to 2 years		30 (28.0)
3 to 4 years		15 (14.0)
5 to 9 years		15 (14.0)
≥ 10 years		13 (12.2)
N/A		12 (11.2)
In which area do you feel you have a good understanding in music learning?	Single (N = 107)	
Singing		12 (11.2)
Playing a musical instrument		21 (19.6)
Listening to music		50 (46.7)
Physical expression activities		21 (19.7)
Composition		0 (0)
Other		3 (2.8)

Table 6

Music preference.

Question	Response type	N (%)	
What is your favorite music activity?	Single (N = 107)		
Singing		6 (5.6)	
Playing a musical instrument		14 (13.1)	
Listening to music (appreciation)		70 (65.4)	
Physical expression activities		14 (13.1)	
Composition		1 (0.9)	
Other		2 (1.9)	
What is the most challenging music activity to you?	Single (N = 107)		
Singing		41 (38.3)	
Playing a musical instrument		18 (16.8)	
Listening to music (appreciation)		17 (15.9)	
Physical expression activities		8 (7.5)	
Composition		22 (20.6)	
Other		1 (0.9)	
Do you wear assistive devices during music learning?	Single (N = 107)		
Yes		87 (81.3)	
No		20 (18.7)	
If yes, which assistive device do you wear during music learning?	Single (N = 87)		
Hearing aids		59 (67.8)	
Cochlear implants		21 (24.1)	
Bone conduction devices		6 (6.9)	
Other		1 (1.2)	
Did you have any problems or difficulties when wearing assistive devices during music learning?	Single (N = 81)		
Yes		53 (65.4)	
No		28 (34.6)	
Do you want to feel changes in melody?	Single (N = 107)		
Yes, I want to feel them.		75 (70.1)	
I want to feel them, but I'm not confident.		11 (10.3)	
I don't know.		11 (10.3)	
Not at all.		6 (5.6)	
Other		4 (3.7)	
Do you want to sing changes in melody?	Single (N = 107)		
Yes, I want to sing them.		46 (43.0)	
I want to sing them, but I'm not confident.		31 (29.0)	
I don't know.		16 (15.0)	
Not at all.		11 (10.2)	
Other		3 (2.8)	
What skills do you want to improve through music learning?	Single (N = 107)		
Rhythm		34 (31.8)	
Singing		7 (6.5)	
Confidence		20 (18.7)	
Enjoyment		39 (36.5)	
Other		7 (6.5)	
Do you think it is necessary to learn music through a sensory music-learning device, feeling the music through touch?	Single (N = 107)		
Yes, it is necessary.		86 (80.4)	
No, it is not necessary.		21 (19.6)	
Which technical functions should be considered for a sensory music-learning device?		(mean)	(sd)
Visual display for pitch recognition function	Single (N = 107)	4.37	.98
Tempo control function		3.99	1.29
Rhythm accuracy verification function		4.26	1.18
Melody accuracy verification function		4.16	1.22
Listening function		4.13	1.21
Singing function		3.78	1.29
Self-learning function		4.18	1.14

of <5 accounted for 68.8% of all cells, Fisher exact test was used to determine the probability of significance. The results showed that the difference was statistically significant (Fisher exact test = 21.457, $P = .003$). In summary, this study found a correlation between the use of rehabilitation aids and the ability to perceive the emotions conveyed in music. The results indicated that the groups using HA, CI, and BD were more likely to report being able to perceive emotions in music, whereas the group without rehabilitation assistive devices reported the lowest ability to do so. As shown in Figure 1B, a chi-square independence test was conducted to determine the association between the rehabilitation assistive devices worn by the HH adult group and music preference. An expected frequency of <5 accounted for 56.3% of all cells, thus indicating the presence of a statistically significant difference (Fisher exact test = 17.282, $P = .019$). The groups using HA, CI, and BD reported the highest frequency of "interesting" responses, while the group without assistive devices (NA) had the highest frequency of responses stating "music is not interesting", "interesting", or "not sure" (Fig. 1B). A chi-square test of independence was conducted to investigate the relationship between rehabilitation assistive devices worn by HH adults and their ability to perceive musical sounds. An expected frequency of <5 was observed in 56.3% of all cells, indicating a statistically significant difference (Fisher exact test = 50.584, $P = .000$). The group comprising participants using HA, CI, and BD reported the highest frequency of ability to hear faint melodic notes, whereas the group comprising participants without assistive devices (NA) reported the highest frequency of inability to hear anything (Fig. 1C).

Table 7

Comparison of technical considerations of tactile music-learning devices.

Categories	HA	CI	BD	NA	F
Visual display for pitch recognition function	4.35	4.46	4.83	3.70	2.631
Tempo control function	4.05	3.57	4.75	3.90	2.529
Rhythm accuracy verification function	4.19	4.39	4.50	4.00	.496
Melody accuracy verification function	4.07	4.39	4.50	3.60	1.470
Listening function	4.05	4.25	4.83	3.40	2.860*
Singing function	3.70	3.96	4.33	3.00	2.265
Self-learning function	4.16	4.36	4.67	3.20	3.630*

BD = bimodal device (HA + CI), CI = cochlear implant, HA = hearing aid, NA = non-assistive device.
*$P < .05$.

The results of research on technical considerations for creating tactile music showed statistically significant differences in the ability to teach oneself and listen to music. Specifically, the bimodal device (BD) group had the highest mean scores for all technical considerations. The study found significant differences in the ability to listen to songs between bimodal device (BD) and non-assistive device (NA) groups. Significant differences were also found in the ability to teach oneself between the cochlear implant (CI) and non-assistive device (NA) groups as well as between the bimodal device (BD) and non-assistive device (NA) groups (Table 7).

4. Discussion

Currently, there is a growing interest in making music accessible to individuals with hard-of-hearing. Music is a crucial element in auditory speech rehabilitation for people with hard-of-hearing, and several studies have assessed its effectiveness. However, there has to this point been a dearth of research examining how adults with HH perceive and prefer music in their daily lives. The current study aimed to fill this gap by surveying 107 HH adults to investigate their perceptions of musical sounds, music-learning experiences, and preferences. In summary, this analysis indicates that the HH adult group could recognize musical sounds and distinguish between pitches. However, their responses to questions regarding the emotional tone of music

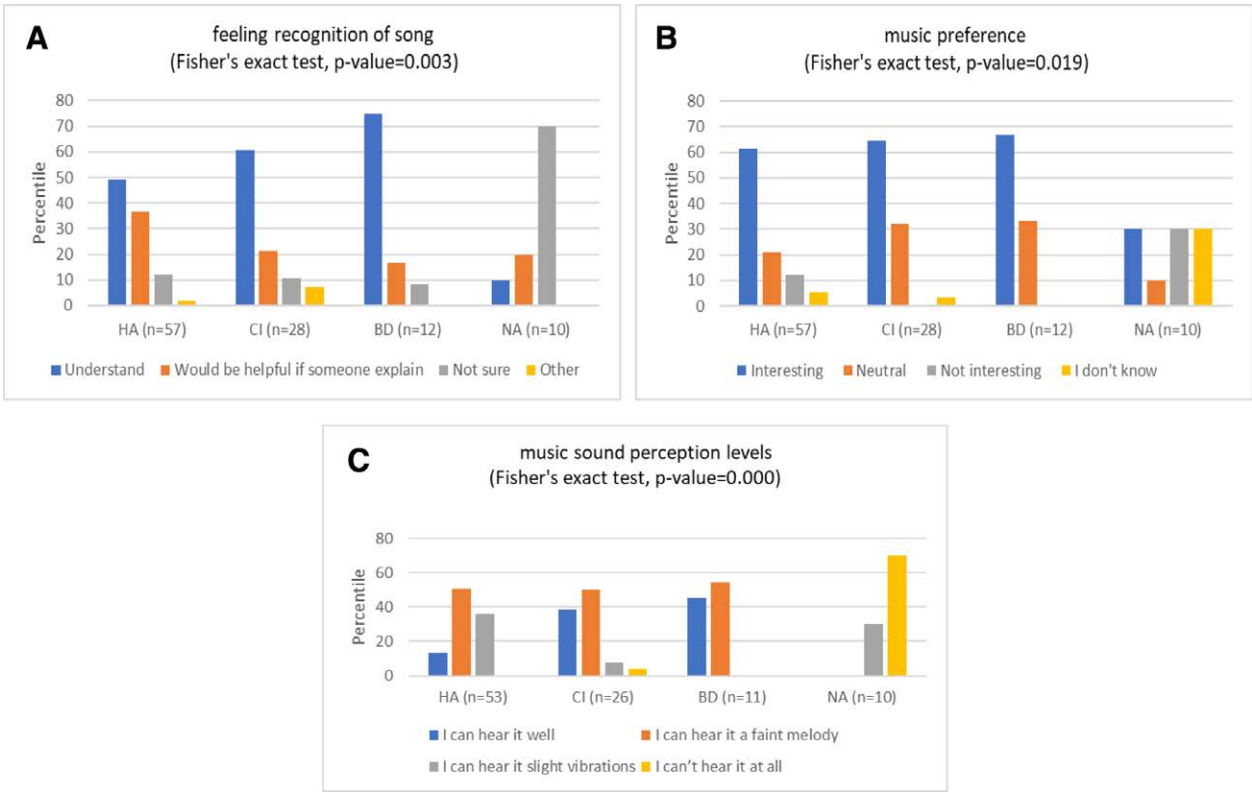

Figure 1. Comparison of the number of music perception and preference by assistive device type. Fisher exact test was conducted to determine statistically significant differences among groups. (A) Feeling recognition of songs: the ability to recognize emotions in music varied significantly across groups. BD participants showed the highest percentage of understanding emotions in music, while NA participants had the highest proportion of "not sure" responses, indicating challenges in recognizing musical emotions. $^{**}P < .01$; (B) music preference: HA, CI, and BD participants demonstrated a higher proportion of interest in music compared to NA participants. $^{*}P < .05$; (C) music sound perception levels: BD, HA, and CI participants reported highest frequency of ability to hear faint melody, though NA participants mostly indicated that they could not hear music sound at all. $^{***}P < .001$. BD = bimodal device (HA + CI), CI = cochlear implant, HA = hearing aid, NA = non-assistive device.

were higher than those for other questions. This suggests that they are better able to distinguish between fast and slow music than nuances of sound, feeling, or instrumentality. This study found that the preferred types of music learning were listening to music, singing songs, and playing musical instruments, with listening to music being the most popular type. Music learning was typically reported to have begun between the ages of 6 and 10 years, and it took place at school, music academy, and home. The high rate of hearing aid use while listening to music reflected the prevalence of hearing aid use among the participants in this study. However, it is important to scrutinize the use of HA while learning music, given that 65.4% of the respondents reported experiencing difficulties in learning music while wearing them. Moreover, the survey revealed a high desire (over 70%) to feel changes in the melody and 43% of respondents expressed a desire to sing actual changes in the melody. The most important areas of improvement in music are enjoyment and rhythm.

5. Conclusion

Based on these findings, this study has practical implications for learning and education regarding music for adult learners with hard-of-hearing. Content should be developed to enable adults to enjoy music according to their needs. The respondents in this study showed a high preference for listening to music and popular songs, as well as a desire to sing along with melody changes in songs and to recognize such changes in melody. This result is consistent with previous findings[3–5,10,28] indicating that HH adults have a strong desire to enjoy music. These findings also highlight the pressing need to develop content and technology that cater to HH adult. Moreover, for HH adults who use rehabilitation assistive devices, there is a need for alternative methods of music learning and ways to make music more accessible to them based on their devices. The results of this study show that even HH adults who use assistive devices experience difficulties with music, which is consistent with the findings of previous research.[11,13]

These difficulties include issues concentrated on ambient noise, unbearable pain caused by amplified sounds, and headaches. Therefore, while wearing assistive devices may be beneficial for using music, it is recommended that various methods be used to develop alternative ways of learning music that are compatible with such devices to increase access to music. It is also necessary to develop methods for increasing music accessibility in HH individuals who do not use assistive devices. This study identified difficulties in the thoughts and experiences of HH adults who did not use assistive devices, such as lack of enjoyment and difficulty in perceiving the feeling of music. This suggests that they may have a lower ability to recognize or identify music than those with CIs, HA, or BD. Consequently, they may have fewer opportunities to enjoy music because of the differences in hearing. Therefore, it is essential to offer music-learning opportunities that utilize senses such as touch and vision, which can serve as substitutes for hearing. Educational measures should also be developed to increase opportunities for music enjoyment. When creating music-learning devices, it is important to consider visual cues, self-learning functions, and accuracy-checking functions. It is also necessary to establish measures for motivating and engaging adult learners. Finally, a limitation of this study is that it is difficult to generalize the results because of the small sample size of HH adults. Further practical research

and continuous development of alternative methods and opportunities for engaging with music are needed.

Author contributions

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