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Technological and Rehabilitative Concerns: Perspectives of Cochlear Implant Recipients Who Are Musicians

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Abstract

In these perspectives, we share the experiences of eight cochlear implant (CI) recipients who are musicians, and their efforts within and outside of audiological appointments to achieve satisfying music experiences. Their experiences were previously shared in a panel discussion as part of the 3rd Music and Cochlear Implant Symposium hosted at The University of Cambridge, United Kingdom. Following the symposium, the panel members and moderator developed and completed a follow-up questionnaire to facilitate a formal analysis of the following questions: (a) What forms of support for optimizing music exist within clinical CI appointments, including counseling, mapping, assessment, and rehabilitation? (b) What forms of support do CI users who are interested in music desire? (c) What self-initiated approaches can be used to improve music perception, enjoyment, and participation? Using qualitative methodology, the questionnaire data were coded, aggregated into themes, and then into core categories. The primary themes that emerged from the data were (a) limited levels of support for optimizing music outcomes within normal clinical appointments, (b) difficulties in current mapping and assessment in relation to music perception, and (c) limited availability of clinically sponsored training/rehabilitation for music. These CI recipients then recommended clinical protocol changes and described self-initiated rehabilitation. These findings were examined in relation to literature on clinical practices for CI users, auditory rehabilitation, and patient-centered care, emphasizing best practices and barriers to audiological care. The data as related to healthcare trends were conceptualized and developed into a proposed Reciprocal Model for Music Rehabilitation (RMMR).

Keywords

cochlear implants, musicians, aural rehabilitation, patient-centered care, music rehabilitation

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Introduction

Cochlear implants (CIs) are auditory prostheses designed primarily to support spoken communication in persons with severe to profound hearing loss. While CI users on average have good speech perception in quiet, CI users have significantly poorer music perception (e.g., pitch, timbre) and music enjoyment than people with normal hearing (Gfeller, Oleson, et al., 2008; Gfeller, Driscoll, et al., 2019a; Limb & Roy, 2014; Looi et al. 2012). These perceptual difficulties in turn undermine music production, such as playing instruments or singing, especially when the individual is required to stay in tune with other musicians (Gfeller et al., 2019a). Unfortunately, group data indicate that music perception and enjoyment do not typically improve significantly as a

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matter of mere CI experience over time (Gfeller et al., 2010; Limb & Roy, 2014; Looi et al., 2012).

Interestingly, despite the CI's limitation in conveying pitch and timbre, some CI users enjoy listening to or making music (Gfeller, Christ, et al., 2000; Gfeller, Driscoll, et al., 2019a, Gfeller, Mallalieu, et al., 2019b; Looi et al., 2012). Particular aspects of music perception or production can improve as a function of focused training (Gfeller et al., 2001; Looi et al., 2012; Plant, 2015). In addition, there are outliers among CI users who have achieved remarkable success on music perception, enjoyment, and production through persistent self-initiated practice over months or years (Gfeller et al., 2019a).

Evidence for improvement through training undergirds recommendations in the *Clinical Practice Guidelines: Cochlear Implants* (American Academy of Audiology, 2019) that training for enhancement of music appreciation should be a part of CI care beyond basic programing (Section 10). These guidelines call for "the provision of materials targeting music perception and appreciation for recipients who wish to improve music-perception abilities." (p. 81) Unfortunately, CI users report that training programs designed for adult CI users are not readily available outside of selective research protocols (Gfeller et al., 2019a). Thus, it would appear that these recommendations are not yet commonly applied in clinical care.

Considering that music outcomes do not improve as a function of ongoing CI use, and that research-based training protocols are available to relatively few CI users, how might clinical programs help optimize music outcomes for a larger proportion of CI users? Are there barriers that prevent more widespread adoption of music training? What sorts of materials targeting music should comprise music training? Are there particular approaches that CI users have found practicable and beneficial? What forms of music support do CI users, themselves, desire?

On September 15th and 16th, 2021, the 3rd Music and Cochlear Implant Symposium was hosted at The University of Cambridge, United Kingdom. A global community of researchers, clinicians, and CI users converged to discuss basic science and rehabilitative aspects of music and cochlear implants. A panel of eight CI users who have achieved impressive levels of musicianship shared lived experiences that have contributed to or impeded their music involvement and enjoyment. The first author of this paper served as the panel organizer and moderator. This paper shares the perspectives of these panelists, who are co-authors of this manuscript. In this paper, the CI user panelists will be referred to collectively as the CI 8.

While a host of factors can influence music outcomes, these perspectives focus on the following broad questions: (a) What forms of support for optimizing music exist within clinical CI appointments, including counseling, mapping, assessment, and rehabilitation? (b) What forms of support do CI users who are interested in music desire? (c) What self-initiated approaches have these CI recipients used to improve music perception, enjoyment and participation? The perspectives of CI 8 will be discussed in relation to existing literature on aural rehabilitation and patient-centered practices, which together form the basis for a proposed Reciprocal Model of Music Rehabilitation (RMMR) for CI Recipients.

Materials and Methods

In this paper, the CI 8 share perspectives regarding efforts to optimize music outcomes, both within and outside of clinical appointments. This systematic analysis of CI 8 perspectives reflects patient-engaged and qualitative research methodologies. A growing trend in medical research, patient-engaged research acknowledges that patients possess extensive knowledge and insights about healthcare through lived experiences (Clancy & Collins, 2010; Domecq et al., 2014; Forsythe et al., 2017; Frank et al., 2014; Sheridan et al., 2017). Patient-engaged research complements researcher-driven studies, which tend to focus more on basic science and endpoint outcomes examined through hypothesis testing (Philips et al., 2012; Pisoni et al., 2017). Principles of patient-engaged research encourage patient involvement at every stage in research planning, facilitation, and dissemination (Domecq et al., 2014; Hickam et al., 2013).

The use of qualitative research in health care has risen markedly in the past 25 years (Bradley et al., 2007; Mather et al., 2018). Specific to audiological care, qualitative methods have been used to examine real-life experiences of CI users. Examples of topics studied include listening effort (Hughes et al., 2018), aural rehabilitation (Glade, 2018; Harris et al., 2016), and the impact of CIs on music experiences (Bartel et al., 2011; Dritsakis et al., 2017; Gfeller, Driscoll et al., 2019a; Gfeller, Mallalieu et al., 2019b).

Qualitative research is particularly effective in revealing *patients' own* experiences of medical conditions and health care practices, as opposed to categories pre-determined by researchers. This includes questions related to natural settings, such as coping with health issues and healthcare protocols in everyday life (Bradley et al., 2007; Creswell, 2014; Mather et al., 2018).

There is no singularly acceptable way to conduct qualitative research; moreover, many experts argue against a uniform approach (Bradley et al., 2007; Creswell, 2014). However, several general features characterize this methodology as used in health services research. Research questions are examined through words rather than numbers. In addition, participants often comprise a purposive sample of individuals who share particular characteristics targeted in the study. The data consist of narratives in which participants are encouraged to share their experiences in depth; the participants' own words are liberally reported as part of the results. (Bradley et al., 2007; Creswell, 2014; Savenye & Robinson,

1996). Rather than *a priori* hypothesis testing, research questions are broad and exploratory in nature. Qualitative researchers generate theories or patterns of meanings from views of the participants (Miles et al., 2014)…. The resulting themes can elucidate previously unidentified issues for future hypothesis testing (Bradley et al., 2007; Creswell, 2014).

Data collection methods are designed to yield rich and detailed responses as opposed to easily quantifiable numerical values or categories. Focus groups, in-person interviews, and semi-structured (open-ended) questionnaires are commonly used (Creswell, 2014; Krueger & Casey, 2009). On-line questionnaires are a reasonable alternative to in-persons methods when seeking input from a geographically diverse population. Furthermore, on-line research has communicative advantages for studies involving persons with hearing loss. During in-person focus groups, accuracy of responses can be compromised by competing talkers or noise, difficulty understanding unfamiliar accents or vocabulary, or errors occurring in closed captioning. On-line responses can also reduce transcription errors that can arise from in-person interviews (Tates et al., 2009).

Table 1. Overview: Sequence of Data Generation Methods Prior to, During, and Following the Symposium.

Pre-symposium panel preparation
- Email introduction of CI 8 panelists and basic guidelines for panel session
- Email inquiry from panel moderator: "Please share 2-3 of your experiences with music and CIs"
- Email narratives returned to the moderator (first author)
- Moderator assigned the themes/topics to narratives; shared with CI 8 group via email; individuals reviewed accuracy of narratives and themes
- CI 8 came to consensus on key themes/topics to share at panel

Symposium panel
- Each CI 8 member shared 2 experiences based upon 4 chosen topics
- Questions posed to panel by symposium attendees; group discussion
- Notes taken by panel moderator
- On-going discussion among panelists and with symposium attendees at symposium

Post symposium questionnaire
- Individual questionnaires developed and disseminated to gather greater depth of information on 4 topics from all CI 8 members
- Each CI 8 member completed and returned to moderator/ first author completed questionnaire
- First author used 4 panel topics as preliminary framework for deductive coding
- Additional codes yielded through inductive coding
- Codes, including intensity and frequency returned to CI 8 for member checking.
- Narratives/analyses completed, with on-going input from CI 8

In qualitative research, large quantities of verbal data are generated, consequently not all data can be shared in the results. Data analysis involves coding of the text into meaningful units, which are then aggregated into categories and themes; these categories and themes are interpreted for relationships and core concepts. A variety of approaches has been used for coding and analyses. Some methods (e.g., grounded theory) use inductive methods in which the data emerges through an iterative process. More deductive approaches begin coding with an organizing framework of concepts or themes, often based upon issues well known in the literature. Integrated approaches employ both deductive and inductive approaches, with a start list of codes providing an initial organizing framework (Bradley et al., 2007).

In some types of qualitative research, the core concepts that emerge from the data are subsequently examined in relation to theories or models from related literature (Bradley et al., 2007; Creswell, 2014; Saldana, 2013; Savenye & Robinson, 1996; Strauss & Corbin, 1994). The combining of themes, core concepts, and related literature are often conceptualized through schematic diagrams or models. The following portions of this paper describe in further detail the procedures specific to the development of this paper.

Sequence of Data Generation

In contrast to many research initiatives, these perspectives were not produced by a pre-existing group of scholars with an *a priori* research agenda. Rather, the initial aim of the CI 8 group was to share their lived experiences in a panel discussion at the 3rd Music and Cochlear Implant Symposium. The decision to submit written perspectives for a journal did not occur until after the symposium itself. An overview of the sequence for data generation appears in Table 1, and is described below.

Because the CI 8 lived in eight different locations, including five different countries, most of the process occurred on-line. Prior to the symposium, the moderator (chosen by the symposium organizers) contacted the panelists via email to share guidelines for a 45-min panel session to take place at the symposium. In an effort to organize comments while encouraging full participation, the moderator (first author) sent an email asking each panelist to "Think about one or two key points about your experiences with music and CIs you would like to explain or emphasize?" Subsequent responses were shared among the panelists, and an interactive email "conversation" ensued. After approximately one week of open email discussion, the first author consolidated all the responses and organized them into four primary topics: (a) training and rehabilitation, (b) help for new CI users, (c) the role of technology and research in improving music, and (d) assessments and communication with CI professionals. These topics were approved by the CI

Table 2. Hearing History.

	Age of onset	Age, severe/ profound loss	Unilateral/ bilateral loss	Details of Loss: Etiology, progression, type, configuration, etc.
CI 1	late 20s	50	bilateral	Early onset presbycusis due to pregnancy
CI 2	congenital	22	bilateral	Sensorineural, genetic hearing loss
CI 3	early 30s	57	bilateral	Genetic defect (DFNA21)
CI 4	congenital	0	bilateral	Deep bilateral neurosensory hearing loss - auditory neuropathy
CI 5	13	Late 40s	bilateral	Otosclerosis at age 13 causing bilateral conductive hearing loss, advancing to bilateral mixed hearing loss, failed stapendectomy surgeries on R ear leading to Meniere's symptoms in R ear, transcanal labrynthectomy R ear at age 27, totally deaf R ear for 24 years before CI at age 51, left ear progressive SN hearing loss and implanted 8 months after R side
CI 6	L: 35; R: 43	40	bilateral	Ménière's disease: deaf on L, 50% loss on R L began declining age 35; R began declining age ~43 HA for R age 45; age of deafness of L ~40
CI 7	28	28	unilateral	Single Sided NHL
CI 8	15	62	bilateral	Cerebral spinal meningitis age 15 considered likely cause of gradual loss that went unnoticed until late 40s early 50s; identified as CI candidate in 2012; delayed implant for 7 years due to reports of poor outcomes listening to and playing music. Eventually relented after speech recognition became such isolating barrier to "getting along"; following activation in January 2019, went without adjustments/mapping until July 2020 due to Covid-19; been "muddling through" with music ever since, but play every day hoping for best.

Table 3. Hearing Device Use.

	Age, 1st hearing device	Age/year. implanted	CI Make/Model	ALDs used
CI 1	32	65 years (2014)	Cochlear Nucleus 7	Mini mic, TV streamer, hearing loop where fitted
CI 2	4	1st: 46 years (2014) 2nd: 48 years (2016)	2 Cochlear Nucleus 6 processors: CI24RE; CI512	Mini mic, PhoneClip, TV streamers
CI 3	37	57 years (2013)	MED-EL, symphony, mid-length electrode array	Audiolink (streamer)
CI 4	1 year 3 months	1st: 1 year, 7 months (2007) 2nd: 3 years, 5 months (2009)	MED-EL, Pulsar CI 100 (standard electrode), Sonnet 2 MED-EL, Sonata ti 100, Sonnet 2	None
CI 5	21	1st: 51 years (2015) 2nd: 51 years (2015)	MED-EL, R: concerto, medium array MED-EL, L: synchrony, flex28 array	None
CI 6	45	48 years (2018)	AB L: Q90 Naida	Widex "Beyond 440"
CI 7	30	30 years (2015)	AB R: Q90 Naida	None
CI 8	52	70 years (2019)	Cochlear Nucleus 7	Mini mic

Table 4. Residence, Instruments Played, Musician Status.

	Country	Instrument(s) played	Musician: Status
CI 1	UK	Recorder, cello, piano, voice	Amateur
CI 2	Finland	Piano	Amateur
CI 3	Netherlands	Piano, viola, recorder, guitar, voice	Professional pianist, teacher, conductor
CI 4	Romania	Piano	Amateur
CI 5	USA	Clarinet & saxophone, (post CI) piano	Amateur
CI 6	USA	Double bass, piano, ukulele	Professional
CI 7	USA	Piano	Trained professionally, but not employed as musician
CI 8	USA	Guitar	Professional

Table 5. Music Training.

	Musical training prior to implantation	Musical training post CI
CI 1	As child, young adult: recorders, cello, singing, piano, Vocal and instrumental ensembles Completed standardized music education certificate testing in UK (music theory skills) at age 16	"More from Music" program. https://morefrommusic.org/login. Includes listening to online exercises scales, arpeggios, instruments and genres; composing; self-assessments in rhythm, melodic intervals; distinguishing instruments scales and arpeggios. Self-initiated exploration: listening to concerts, "educational" programs about composers and genres on TV (with visual input), singing practice with tuner or more complex accompaniment; ensemble percussion playing
CI 2	As child: Brief recorder and guitar lessons, piano lessons at age 11–16	Several years of short weekly piano lessons. Self-motivated otherwise.
CI 3	Piano lessons since 9 years old. Recorder and guitar playing. Conservatory of Amsterdam (1973–1980). Viola at Conservatory since 1973, but not until graduation. Singing in choirs, etc.	Viola lessons, singing lessons, auditory exercises. A lot of piano practicing, playing ensemble. Listening to radio, YouTube in all kinds of styles, going to concerts.
CI 4	None [implanted as infant]	4 years of intense verbal auditory therapy with deepening of the nuances and inflections of the verbal message; 9 years of piano lessons based on understanding music with the help of resemblance to verbal communication (theater), aiming to improve rhythm, melody and musical interpretation by expressing feelings transmitted by each musical phrase.
CI 5	Viola lessons age 8; Clarinet lessons and orchestras ages 9–18; Saxophone lessons & orchestras ages 14–18; Piano just started	Piano lessons for a short time; continued piano playing; Frequent playing of scales on the piano; Auralia Pitch Comparison app; Melodic Contour Identification app; Meludia online program
CI 6	Private lessons since age 9; bachelors and masters in performance	AB's rehab online program; listening to music with a score; playing instruments with tuner on stand. Singing with instrument to match pitch using tuner to verify
CI 7	Undergraduate degree in piano performance	Brief use of on-line training app from CI company; discontinued because no improvement
CI 8	Self-taught	None

8, and each panelist chose two of the topics to focus on during the panel discussion.

The panel discussion during the symposium served as a focus group of sorts with real-time interactive discussion. After each panelist shared their key points, questions were posed by the audience. Notes were taken by the panel moderator throughout the session. A refined understanding of the four topics occurred as a result of the interactive discussion.

Following the symposium, via email, the panelists chose to formalize and expand their panel comments by preparing and submitting their perspectives for a special-focus issue of *Trends in Hearing*. This required the development of a system for collection and analyses of their experiences and points of view. The CI 8 members and moderator prepared a questionnaire based primarily on the four topics chosen for the panel discussion. The panel moderator (first author) facilitated dissemination and collection of those data. A more detailed description of the research process, which specifies various co-author contributions, is available in Supplemental Appendix A.

Participant-Co-Authors

Qualitative research methodology uses purposive sampling, that is, individuals possessing characteristics relevant to the questions at hand (Creswell, 2014). As noted earlier, the individuals comprising CI 8 were invited to serve in a panel discussion, which took place as part of the 3rd Music and Cochlear Implant Symposium. The eight individuals were selected by members of the symposium's organizing committee, based upon videos demonstrating their exceptional musicianship and insightful verbal descriptions of their musical experiences. While differing in a number of factors such as home country, hearing history, or age, they share a deep passion for music, and strong commitment to focused musical practice; this level of music engagement is rare among CI users (Gfeller et al., 2019a; Looi et al., 2012). The first author, who moderated the panel, has conducted research on music perception, enjoyment, and training of pediatric and adult CI recipients since 1989.

Tables 2–5 present demographic information for the CI 8 regarding music experiences, country, hearing history, and device use. The eight CI users were from five different countries, and received their implants and follow-up care from eight different centers. While some protocols for candidacy, CI surgery, and follow up have been standardized, some aspects of care differ as a result of healthcare delivery practices across the globe (e.g., socialized medicine, reimbursement policies, etc.) as well as from one center to the next. These differences were reflected in the experiences of the CI 8 (e.g., access to rehabilitation, specific professionals responsible for programing, reimbursement, etc.).

An important shared characteristic among the CI 8 as noted in Tables 4 and 5 is the high level of formal music training. CI 8 comprises a combination of professional and avocational musicians whose proficiency with pitch-based production is well beyond the capabilities reported in CI research literature (for reviews, see Limb & Roy, 2014 and Looi et al., 2012). Consequently, the perspectives and experiences of the CI 8 do not generalize to more typical CI users with regard to motivation, music training, or outcomes.

A unique aspect of this paper is that the CI 8 are co-authors as well as a source of data submitted and reported. Ethical guidelines for human research typically require protection of the identity of participants in a study. Because patient-engaged research encourages deep involvement of patients at all stages of the research process, there can be a blurring of categories of researcher and participants; issues regarding confidentiality require special consideration. In order to ensure an ethical process, the first author submitted a Human Subjects Research Determination application to the IRB committee of the University of Iowa. This application comprised (a) plans for data collection, analyses and dissemination, (b) a description of the active involvement of the CI 8 cohort in the research process, and (c) the desire of the CI 8 members to be named as co-authors. The IRB committee waived the need for a formal IRB application; that letter of confirmation was submitted to the journal editor.

Although the procures used for this paper were not subject to IRB guidelines, the first author sent to each individual in CI 8 an email invitation to complete the on-line questionnaire. This stipulated that they were free to decline participation entirely or any portion of the questionnaire. Each member of CI 8 sent the first author electronic documentation of their wish to be listed as a co-author.

The Development of Research Questions and Questionnaire Items

A more detailed account of the choice of research questions and data collection process appears in Supplemental Appendix A. As noted earlier, the primary topics covered in these perspectives were established by the CI 8 panel and moderator prior to the symposium. That interactive process yielded four topics they considered important to satisfactory music outcomes: training and rehabilitation; helping new CI users to adjust and cope; technology, research, and assessment; and communication with audiologists. Those basic topics, which served as initial categories, were further conceptualized through the panel discussion held on September 15th, 2021.

Following the symposium, via email communication, the CI 8 decided as a group to prepare a document that would more formally and thoroughly convey their lived experiences beyond what could be discussed in a 45-min panel session. Two of the CI-8 co-authors developed a questionnaire for demographic data regarding music background and hearing histories, and collected and summarized those data, which appear in Tables 2–5. Three co-authors (two CI 8 members

and the first author) collaborated to create a questionnaire focusing on the broad research questions (see Supplemental Appendix B). The CI 8 co-authors chose the first author to organize the dissemination, collection, and analyses of the questionnaires. The questionnaires were completed independently, and returned to the first author for subsequent analysis.

Data Analysis

The questionnaires yielded 789 lines of data comprising 10,514 words. Data analysis involved an integrative approach, utilizing an iterative combination of deductive and inductive coding (Bradley et al., 2007). The following steps were used to discover emergent concepts: (a) reading for overall understanding, (b) coding the data, (c) developing the code structure, (d) finalizing the code structure, and (e) proposing themes or core concepts. After reviewing the resulting themes and core concepts, these were examined in relation to relevant published studies and theories to understand more fully the relationships among the codes and themes. Additional detail regarding these steps follow.

Reading for overall understanding: The questionnaire data were first read carefully multiple times by the first author and a second independent reader (a research assistant not involved in the study) to get a general sense of the data. This process helps to identify emergent themes without losing sight of connections between concepts and context (Bradley et al., 2007).

Coding the data: This involved line-by-line analysis in which each unit of meaning (e.g., paragraph, sentence, phrase, words) was assigned a conceptual label or code to define meaning, actions, and to reveal relationships between codes. The responses were coded independent of the individual questionnaire items because responses can apply to multiple questions (Bradley et al., 2007; Creswell, 2014).

A second independent reader coded 50% of the narratives as part of verification and validation of the analysis. While there was a strong level of agreement on coding, those codes that differed were discussed and resolved. A total of 516 codes were assigned to the narratives from the first round of line-by-line coding.

The initial coding included a deductive component, with preliminary codes based upon the four topics chosen by CI 8 for the symposium panel. Deductive approaches can be helpful in generating themes or theories in health service research and can help reveal relationship codes (links among the codes), participant perspectives (e.g., positive, negative or indifferent views), participant characteristics (e.g., musical background, auditory history), and setting codes (e.g., clinical, research, or self-initiated experiences) (Bradley et al., 2007).

Inductive coding during the line-by-line process revealed ideas or attitudes that did not fit naturally within the initial four topics presented during the in-person panel discussion. Thus, inductive coding in conjunction with deductive coding generated additional codes that emerged directly from the data.

Consistent with qualitative methodology, responses that fit under multiple codes were included under each relevant code. For example, several CI 8 members described appointments in which a CI professional told them that enjoyment of music is not possible with a CI. This was coded as an attitude or belief on the part of the CI professional about CIs and music. However, research data confirms that some CI users do indeed enjoy music (Gfeller et al., 2019a; Looi et al., 2012); therefore, this was also coded as lack of knowledge. When relevant, codes were also categorized as having positive (+) or negative (–) valence, depending upon whether the code had a positive or negative relationship to satisfactory outcomes for music or other attitudes and experiences of the CI user.

Developing and finalizing the code structure. After the initial coding process, the codes were aggregated into more abstract, high-level categories referred to as themes (Bradley et al., 2007). For example, coded units about wanting better pitch perception or better timbre quality were grouped under a higher-level theme of "desired perceptual changes to device."

The primary interpretation in qualitative research emerges from the narrative content. However magnitude coding (frequency and extensiveness) can help to identify the most prominent and important themes (Saldana, 2013). Frequency (number of occurrences) and extensiveness (number of respondents) of responses were calculated (Attride-Stirling, 2001; Miles et al., 2014; Saldana, 2013). For example, in this study, one CI user described in considerable detail a music-training program involving multiple professionals offered by her CI center. That resulted in a frequency of 18 under the theme, "support from the CI center." However, because those 18 codes were from only one CI 8 member, the extensiveness was calculated as one. In this instance, the combination of frequency and extensiveness indicates a strong level of support for music rehabilitation, but only for one individual within one center. Thus, center support that included multiple professionals and layers of rehabilitation would not be considered a common occurrence for the entire CI 8 cohort. The codes and their groupings into themes appear in Supplemental Appendix C as they fit within the three core categories. The frequency and extensiveness is reported for each code in order of highest to lowest occurrence within each theme.

Proposing themes or core concepts. The next step was the conceptualization of the most prominent themes and the relationships among themes into core categories (sometimes called central concepts) (Creswell, 2014; Hughes et al., 2018). A core category is a main theme or process that subsumes and integrates all lower-level categories. The themes making up a core category recur frequently in the data, are at the center of the study, and naturally appear from the data (Creswell, 2014; Hughes et al., 2018). The following

three core categories emerged: (1) support for optimizing music within clinical CI appointments: experienced and desired, (2) mapping and assessment in relation to music: experienced and desired, and (3) training/rehabilitation options to optimize music: experienced and desired.

A draft of the core categories was shared electronically with the CI 8 members to validate the data content and themes. This process is called member checking. In response to the feedback from the CI 8 members, the first author reviewed all the codes and themes, and made several adjustments to the core categories. For example, one CI 8 contributor expressed concern that Core Category 1 did not sufficiently convey those instances when audiologists are actively supportive of musical aspirations. Core Concept 1 was revised to reflect that concern. The three core concepts and themes with sub-themes are described below.

Coding Results

A full accounting of the core categories, themes and codes appear in Supplemental Appendix C, including magnitude coding for the codes and themes. The following section summarizes the findings of each core category and presents a sampling of quotes that illustrate major concepts. In these results, because specific titles and job descriptions vary from one center or country to the next, the general term, "CI Professionals" is used to describe audiologists, speech-language pathologists, otolaryngologists, research scientists, programmers, engineers and others who are involved in the clinical care of persons with cochlear implants. The number and types of professionals involved in post-implantation support varied considerably across the CI 8 membership.

Three Core Categories emerged from the iterative process of coding and developing the code structure; each is described below.

Core Category 1 was represented by 150 codes: 99 codes for existing and 51 codes for desired forms of support. These are the themes associated with Core Category 1:

I. Existing support:
(a) Music coverage: attitudes, interests, and motivation of CI Professionals (54 codes)
(b) Constraints in appointment time and coverage (25 codes)
(c) Lack of knowledge about music and CIs (20 codes)

II. Desired support
(a) Provide 2-way discussion of music that addresses individual differences (15 codes)
(b) Balance realistic expectations with patience and encouragement (14 codes)
(c) Address and assess needs and progress over time (10 codes)
(d) Share information about music and CIs (10 codes)

Existing support for optimizing music outcomes. Five of the CI 8 were served by one or two audiologists/programmers associated with their implant team for hookup, mapping, and follow up appointments for all of their care. Two of the CI users, whose own centers did not address music concerns, were referred to a research center for individualized mapping intended to optimize music perception. One CI user was invited to participate in multi-session music training programs sponsored by her CI center in cooperation with a research center; this occurred in addition to her "normal" audiological appointments.

The experiences of this group of CI users indicated limited support for optimizing music as part of regular clinical CI appointments (hookup, mapping, follow-up appointments). Six of the CI 8 described their centers/clinics as offering no support for music outcomes. The primary impediment to clinic support was perceived lack of interest and motivation regarding music. A number of quotes illustrate these concerns: "The attitude of audiologists towards music needs to change, and time needs to be allowed to provide the best services." "I didn't receive any support for music." "I didn't have any specific guidance or advice about music perception or enjoyment." "If my audiologist were equally invested in or excited about music with CIs, I'd feel more inclined to make more of an effort [to describe what I'm hearing], but usually I feel like music is considered a peripheral concern—a 'nice-to-have' rather than a necessity."

Several quotes suggest a presumption that optimizing music is unimportant or not possible. "My general impression has been that a poor musical experience is basically the expectation, and therefore not really considered a problem—and consequently not really worth exploring in too much detail." Four of the CI 8 were told that enjoyment of music was not possible. For example, "My ENT said 'music with a CI is not possible. Nobody is able to enjoy music, so you won't either.'" Another stated, "I commented on how great music was sounding with my CI … The surgeon responded by saying, 'That is impossible.'"

Support for music outcomes, while not the norm within this group, was sometimes available from centers that conduct music-related research, or from specific CI professionals who seemed intrinsically motivated to encourage better music outcomes. One CI user described motivational support from an audiologist who "celebrates every music WOW moment at our appointments and by email exchanges in between appointments."

Another of the CI 8 stated that her audiologist "appreciated that my tuning was all over the place and was sympathetic, but could not offer help. It was good that she took me seriously." This same CI user was grateful to receive a handout of "tips" for enjoying music. At six months, she was invited to participate in an in-person and on-line program to enhance music, which was sponsored by a

university-based hearing center outside of her normal audiological appointments.

Constraints in access to clinical support. A second theme within Core Category 1 was lack of opportunity for support due to constraints in appointment times and insurance coverage. That is, the system for scheduling and billing limited the time for counseling of music-based concerns. Four of the CI 8 attributed lack of rehabilitation or mapping appointments to lack of insurance coverage (12 codes). "After the first year, making an appointment … is difficult if not impossible. This is because of limited insurance coverage of extra fittings."

Thirteen codes reflected frustration that appointments were too short and so infrequent to preclude time for addressing music outcomes. Quotes illustrating this concern include: "There is no time to spend on music within the limited rehabilitation time." "Hospitals seem to have a set per-patient time per year. Bilateral users get the same time as unilateral users." "After the first few weeks, we just have short annual appointments where nothing tends to be done—they just run the tests and tick the box to say that we've been seen."

Limited knowledge about music and CIs. A third theme within Core Category 1 was that CI professionals lacked knowledge in offering support for music outcomes. All the CI 8 users were very grateful for the high quality support for speech, but their inquiries regarding music were typically unaddressed or minimized. The CI professionals seldom suggested useful resources, were unable to answer basic questions, or would simply say that music can't be enjoyed or improved. Examples of quotes that reflect this theme include: "They have no knowledge about how to work with music." "There is no knowledge related to music rehabilitation. They have perfected their methods of language and less on the musical side." "The discussion is effective when addressing speech quality. It is not effective when addressing musical quality." "There is a lack of skilled therapists for rehab." "When I asked a clinic audiologist what I could do about singing, she said that was the hardest thing to do, but could offer no advice." "I don't think they have any experience working with musicians and CIs."

Desired clinical support for music. Of those changes desired for better clinical care, the most frequent was for more 2-way communication. Five CI 8 members emphasized the importance of the CI professional initiating the topic of music to convey the attitude that music is also a worthwhile goal for implant benefit. "I usually worry that I'm being a nuisance by bringing it [music] up, or taking up too much time talking about it." "Hopefully, one day, hearing and appreciating music can also be a big part of what cochlear implants are all about." "Just proactively discussing music up front at all would be a good start." "I think having the audiologist initiate that conversation can be important because users might not bring it up … because they get the impression that the audiologist has other priorities."

Several CI 8 members acknowledged that music will not be important to all CI users, therefore, a basic question at intake could help with setting individualized clinical priorities: "Audiologists should first ask how their patients feel about music. Not everyone is interested in trying to get a great musical outcome." Furthermore, specific interests should be ascertained: "What sorts of music do you like? What are your aims? Do you want to play/sing/listen?"

The second most common desire was for CI Professionals to help the CI user to balance realistic expectations of challenges with encouragement that music can improve with patience and persistent practice. "Difficulties should not be glossed over.. progress might well take years rather than weeks." "They should encourage CI users to embrace music, while at the same time, being patient with it." "An understanding that music is a much more complex auditory signal than speech and will take its own CI journey." "While I agree that music will not sound as normal as it did with natural hearing, I think we are losing the opportunity to work on making it as good as it can be with the CI."

A third desire was that CI Professionals would share information about music and CIs, such as research findings, practice tips and exercises, use of assistive listening devices (ALDs), stories of other CI users, and music experiences to try (e.g., concerts, videos, etc.). "They need to inform CI users of all available CI rehabilitation, whether that be apps or the possibility to join a music class." "Audiologists should provide and be able to demonstrate the benefits of listening to music through wireless devices such as the MiniMic or TV Streamer." "It would be helpful to talk about both what we know and don't know about music." "They could discuss with their clients how to get used to the new sounds of music, and how to practice listening."

Another common theme for desired support was addressing the changing needs of the CI user over time. The user's capabilities and needs and thus priorities will vary over time, thus music should be assessed on an ongoing basis. Quotes illustrating changes over time include: "what are your aims? Ideally this discussion could be revisited as it might change over time."

"We need specific repeatable tests. … to measure whether we are making things better or worse." "At the second tuning, 3 days after, [I] was offered some instrument identification help. I refused this as I couldn't hear words at this stage. Six months: offered a workshop on getting to grips with music." "Make a baseline of what you can hear when you start. … try it again six to 12 months [later] to assess your progress." "I am still struggling mightily acclimating to the [mapping] changes [after one month]." While Core Category 1 focuses on basic counseling and management of hearing loss, the following category focuses on optimization of the technology.

Core Category 2 was represented by 190 codes: 127 codes for existing and 63 codes for desired approaches to mapping and assessment. The following themes comprise Core Category 2:

I. Existing mapping and assessment:
(a) Problems with current mapping methods for music (76 codes)
(b) Problems in CI Provider/User Communication (29 codes)
(c) Individualized mapping can enhance music (12 codes)
(d) Lack of testing for music outcomes (10 codes)

II. Desired support
(a) Desired perceptual changes to the device/processor (28 codes)
(b) Desired testing to track progress (17 codes)
(c) Desired improvement for mapping process (13 codes)
(d) Desired self adjustments for processor use (15 codes)

The experiences of this group indicate that standard mapping and assessment protocols are usually unrelated to or marginally effective for music perception and sound quality. Exceptions exist, but those tend to be in conjunction with grant-funded research protocols that allow extensive time for individualized mapping and testing of each electrode.

Problems with current mapping procedures. The most common concern was brief appointments or difficulty scheduling mapping adjustments after the first year (e.g., no visits to adjust or refine the MAP in 5 years). "After first year rehabilitation, there are no more appointments." "Out of the box quick 1 h appointment." "[music-specific] adjustments are available by participating in research studies but not available at the clinical level at this time."

Another common concern was the frequent use of standardized maps that, while efficient to program, have no connection with perceptual outcomes for music. "They follow the same format every time, and that feels pretty perfunctory." "The biggest thing is [they] never seem remotely interested in getting to a place of satisfaction for me." "the out of the box 'music' program was terrible. I still don't use it. … the audiologist didn't seem able to adjust based upon [my feedback]" "The audiologists need more information to measure outcomes and make informed adjustments." "It is common to hear a CI audiologist express that music enjoyment varies greatly among CI users. End of story."

While the CI 8 members acknowledged that CIs do not restore normal hearing, they offered comparisons with mapping for speech: "If we discuss speech quality. … there are mapping adjustments that are known to help and these changes are made right away. … That is not the case for music." In response to a request to reduce some pre-processing that suppresses dynamic changes, "I was told there wasn't an option." "Can't each frequency be adjusted to volume and other adjustments?" "I couldn't help but think that the question of how the features might affect the experiences of listening to music was something that just wasn't taken into consideration in the design or development process."

Disappointing attempts to improve maps for musical sounds were attributed in part to lack of knowledge or procedural problems. "CI audiologists have not been taught how to adjust MAPs for music quality nor pitch." "My audiologist tried to make a 'music' setting in the CI. This was hard because there were no possibilities to try it out in the hospital [no music stimuli were tried during mapping]. At the end, I never use the adaptations he made because they make the piano sound like bells and indistinct." "They have no ability to play music in the room (even recorded music). … it was up to me to test these in the wild and then report back at the next appointment."

Problems in provider-patient communication during mapping. The CI 8 members emphasized one particular impediment to better maps for music: communication problems between the CI Professional and CI Recipients during the mapping process. In essence, the CI Professional and the CI User-Musician represent two fields of expertize that use different vocabularies: "I would report to them what music sounded like, what I felt it was lacking, and sometimes the audiologist understood and sometimes they didn't." "I describe tone ranges, and can translate that into Hertz ranges. I can describe tone quality, but that seems subjective to many audiologists." "describing it as 'AWFUL' is not very helpful." "While we lack a shared language about sound quality and music, it is hard to communicate about what you need as a musician." "It's frustrating because it's hard to describe sound in general, and music in particular. I've no idea whether the language I'm using is understood the same way by my audiologist, since there isn't really a standardized vocabulary." "I don't think we have the vocabulary to describe many parameters except simple things like 'too loud,' 'too quiet,' 'screechy,' 'echoey.' Trying to describe the sound of anything heard through a CI to a person with normal hearing is comparable to asking someone to paint the Mona Lisa with a broom."

Paired with the problem of no shared vocabulary is the problematic relationship between changes in map parameters and subsequent changes in musical percepts. The CI Professional has a finite set of possible mapping parameters, which may not translate readily into particular musical sounds: "There is no way to discuss music quality with my CI audiologist that leads to recommended MAP changes." "The biggest challenge in coming up with the right mix of expertise to 'fix' the problem is a lack of common *understanding* of the problem … and a common vocabulary to describe it to one another." "It's easier to answer the 'how does it sound' question if you have some grasp of what it's possible to alter. … Tell us what can be changed and demonstrate what those changes might sound like, so that we know what we can realistically ask for."

One of the CI 8 posited a step toward linking mapping parameters with musical percepts: "I actually think that real progress in the development of meaningful communication between implanted musicians and CI audiologists will most likely only happen through collaboration with musicians

with just one CI [single sided deafness] who have clear recall of what music is supposed to sound like."

The difficulty of describing musical sounds in relation to mapping is exacerbated by the lack of testing for music perception (10 codes). Six of CI 8 noted the lack of tests that could potentially inform mapping or determine benefits of various settings.

Benefits of individualized mapping for music. Some CI Professionals may presume that mapping changes are unable to improve music perception or appreciation. "I asked a manufacturer's audiologist about improving music through maps and he suggested I was being too purist and implied that [music practice apps] would cure all." The prior paragraphs of this article would seem to reinforce the notion that current technology does not allow for substantive improvements in musical sound quality. Is technical enhancement of music a lost cause?

Four of the CI 8 group reported meaningful improvements to music as a result of individualized mapping changes, suggesting that such adjustments *could* offer some CI users enhanced music outcomes. Two of those adjustments were the result of longer and more individualized mapping sessions than typically provided within normal clinical care.

> "After 7 years of using a CI, a new audiologist (senior engineer) completely transformed my map, making music sound far better than before. The biggest difference to this mapping session was (a) that the audiologist spent 2.5 h with me and didn't waste a minute of that and (b) he was methodical and assured---so measured every electrode, rather than just a few and extrapolating the rest. With the new maps, I'm able to hear the lyrics and to discern the individual instruments more clearly. The music feels warmer, almost wrapping me in a comforting blanket."

Another CI 8 member stated,

> "The audiologist usually takes about an hour or an hour and a half, during which the audiologist adjusts my devices, and I try to explain to her what I would like to be improved or what bothers me … . After, I try the new setting … in the end, if I'm satisfied, I stick to those settings, and if not, this whole process continues until I become satisfied."

Two other CI 8 members received specially adjusted maps as part of research protocols:

> "After participating in a … study which uses CT scans and their software to determine any electrodes that are stimulating an area of the cochlea which is overlapping and then turns off targeted electrodes, there was an immediate improvement in musical pitch for me. I wish this was available to all CI users at all CI centers."

One of the CI 8 who was invited to a research lab focusing on music stated: "I am grateful for the interest and skilled attention that [the research team] brings to this effort."

Desired changes to CI technology. The CI 8 shared suggestions for improved technology, mapping and music assessment. Changing CI technology to improve the conveyance of fine structure is a major challenge that will require collective and sustained effort in the field. The CI 8 members offered a wish list of sorts: their priorities, as dedicated musicians, for future research and engineering initiatives. They prioritized better representation of pitch and normalized interval ratios and timbre/sound quality. They also recommended the development and increased use of more "musical" tests of pitches, scales, interval ratios, and melodies in order to track progress or to assess technical upgrades.

Desired improvements to the mapping process. This theme included 13 coded items. The CI 8 group recommended demonstrating examples of possible changes, testing out mapping adjustments during the sessions with musical stimuli (familiar and unfamiliar music, recordings of real music) and musical scores (for musicians). They speculated about bypassing complete reliance on verbal descriptions by having controls that the CI user could adjust during mapping: "Once the electronic tuner in a processor determined that a note is in tune, but the implanted hears it out of tune, is it possible for the implantee to adjust the signal sent to the auditory nerve until the implantee hears the note in tune?"

> "Couldn't patients be given a list of standard terminology and explanations, so that they and the audiologists are using terms consistently? Would pictures work better than words for some of these things? Perhaps even a flowchart of questions? The goal should be to ask questions that will result in informed adjustments based upon the answers. Tell us what can be changed and demonstrate what those changes might sound like, so that we know what we can realistically ask for."

Several suggested the use of musical stimuli or music notation during mapping: "I think musicians should listen to music they know and report on what they hear (if this even yields a difference)" "Depending on the skills of the CI user, it might involve showing them the music so they can point out what is not appearing correctly or what is missing altogether."

CI user control over sound parameters. One CI 8 member expressed the desire for some control over her CI while listening to music in everyday life.

> "I think an amazing idea … to help CI users would be a phone application that could give CI users the possibility to [make] some very detailed adjustments in their CIs. I would like to adjust some very fine details, but there should always be a

way back to the basic setting … this can help me. … change what I want to hear depending upon the situation."

Upgrades in CI technology and mapping are important goals. However, processing of fine structure important to pitch and timbre perception poses difficult challenges. Thus, training and rehabilitation remain at the forefront of optimizing music outcomes for CI users. That is the focus of Core Category 3.

Core Category 3 was represented by 174 codes: 31 codes for existing and 56 codes for desired approaches to training and rehabilitation. Self-directed training devised by the CI 8 accounted for an additional 87 codes. Core Category 3 included the following themes:

I. Existing support for training/rehabilitation
(a) Support from CI center (18 codes)
(b) On-line apps found by CI users (13 codes)

II. Desired support for training/rehabilitation (56 codes)
III. Self-directed training devised by CI 8 members (87 codes)

Existing support for training. This group of CI users has relied primarily on self-directed training that they "invented" or modified from traditional music pedagogy to address their individual needs. Access to center-supported music rehabilitation was uncommon.

In the CI 8 cohort, only one individual had the opportunity to participate in a formal music training program for CI users, *More from Music* (https://morefrommusic.org/), which is an interactive music awareness program offered by the University of Southampton Auditory Implant Service and members of the UK National Cochlear Implant Users Association. The strong impact of this experience is reflected by the frequency of codes (18) about this program. Her experiences included in-person workshops and music-making opportunities as well as on-line exercises. Five of the CI 8 had found on-line apps developed by CI manufacturers that focused on specific music tasks (e.g., pitch, melodies, timbre); four indicated some modest benefit.

Given the impressive musical skills of the CI 8 despite the lack of easily accessible training programs, one might question whether clinical support for optimizing music is actually necessary. Consider, however, that the CI 8 are outliers in a large and ever-growing population of CI users, many of whom have disappointing experiences with music (Gfeller, Jiang, et al., 2010; Gfeller, Driscoll, et al., 2019a). Furthermore, these CI 8 users required strong self-efficacy and persistence toward self-initiated training, a characteristic unevenly distributed in the general population (Gfeller et al., 2019a; Harris et al., 2016). The CI 8 suggested that a larger proportion of CI users may be able to achieve more satisfactory music outcomes with easier access to quality training programs or apps; this motivates their recommendations, which follow.

Desired clinical resources for training. As the CI 8 described their own experiences in relation to other CI users, they encouraged clinics and manufacturers to provide training and rehabilitation programs that are in person as well as on line. The largest proportion of CI 8 emphasized the value of peer support and easy access to other CI users who are interested in music, who can offer testimonials, tips, and motivation. "Low barrier ways to connect with others on similar journeys could be helpful for maintaining motivation." Peer support could include making music as well as on-line conversations. "Support groups for people with CIs who are on their own music & CI journeys. Learning from each other and supporting each other is very beneficial."

These highly successful CI users offered suggestions for researchers, clinicians or manufacturers interested in developing training programs: The structure of the programs should be well organized, progress from easy to difficult exercises, provide feedback on progress, use multisensory input, possess good sound quality, and encourage the use of context. The following quotes illustrate these recommendations: "For me an app is like a course which should have a natural start, progression and clear end … I want to feel like I'm on a journey with an expert guide, not just dumped in the middle of a bustling city without a map." "Apps that start at easy musical levels and slowly advance using quality audio for various instruments would be helpful." "Use visual as well as auditory approaches." The musical experiences should also cover a broad repertoire of music sounds, genres, and real-music situations found in everyday life. "A broader range of [musical experiences] has really been helpful to me to regain enjoyment."

Self-directed training. Given the lack of readily available training programs, the following insights on self-directed training suggest options that could be adopted or modified by clinicians, researchers, or other CI users. These musicians have created exercises and engaged in real-life music experiences that resulted in satisfactory music making despite the daunting challenges of electric hearing. These self-initiated training methods were developed primarily through modifications of music lesson pedagogy and sustained through intrinsic motivation and persistence.

Supplemental Appendix C lists in order of frequency and extensiveness the self-directed training approaches. The major recommendations from CI 8 are for extended practice in music listening and playing that requires active involvement with the sounds; these should include a variety of sounds, musical genres and forms of participation. The multisensory and fully active process of playing instruments seems particularly advantageous. "Honestly, just playing my instruments was really helpful to me." "I'm highly motivated to play every day … just like before I was implanted."

Four of the CI8 commented on the benefits of playing piano, which offers visual and tactile as well as auditory input. Practice routines and formal lessons that offer structure and ample repetition are important: "Returning to playing the piano—taking lessons and practicing daily." "Playing my piano, practicing scales, singing simple songs." "If you've never played an instrument, start playing one! Take lessons with an understanding teacher and try to inform him/her what is difficult and why."

Perhaps as important as the specific types of exercises are the motivational considerations. Improved music perception and enjoyment takes time, patience, and persistence. How do these CI users sustain their efforts, despite the degraded signal and incremental improvement? A number of quotes from the narratives offer insights into the psychological aspects of motivation, patience, and persistence.

Building variety into practice can increase motivation: "listening to all kinds of music a lot and just appreciating the aspects of the music that were accessible at the time." "Enjoy music in various ways—streaming directly, listening through speakers, attending live events, listening in the car."

Those CI users with residual hearing employed acoustic input to complement the electrical hearing. "I'm so thankful for the hearing I do have on the one side." … I focus on the music … and push the sound from my implant out of the way."

Music training requires attention, focus and effort: "I avoid practice when tired or stressed." "Have a rest. Allow your brain to consolidate when you have gotten too intense in practice." "Doing this in shorter spurts more often throughout the day can be helpful. I felt I was mentally tired after doing some of the training, and then it was time to take an auditory rest for a while." "I have specific 'practice times,' and 'enjoying time.'"

The following quote illustrates the importance of a positive attitude toward the process of music training:

> "Persevere. Your brain plasticity will get there, and it is not an overnight change …. Take things slowly, start with simpler material, don't test yourself on the largest ensemble work or things that are completely foreign to you. And I found it really helpful to simply marvel at the process of observing my own perception change slightly from week to week. It's an opportunity to be new to a sense again."

These core categories reflect the lived experiences of the CI 8. These experiences have occurred within the context of a complex system of healthcare practices impacted by fiscal and caseload realities.

The next phase in preparing these perspectives was the examination of the codes and themes in relation to relevant literature. This process was aimed at a deeper understanding of the themes, categories, and their interrelationship. These relationships were then conceptualized into a framework or model of the phenomena of optimizing music for CI users.

Generating a conceptual framework of music rehabilitation for cochlear implant users

Examining the themes and concepts in relation to existing studies and theories. Literature on several topics or concepts emerged as relevant to the categories and themes from the data: (a) conceptualization of clinical care for CI recipients as developed by a task force of the American Academy of Audiology (2019), (b) aural rehabilitation practices and access, and (c) patient-centered care (sometimes referred to as person-centered care).

As noted earlier in this paper, the "*Clinical Practice Guidelines: Cochlear Implants*, prepared by the Academy of Audiology Task Force (American Academy of Audiology, 2019) calls for "Care Beyond Device Programming" (Section 10, pages 81–83). "To realize maximum benefit from the device, cochlear implants require consistent follow-up and intervention beyond cochlear implant programming." This section includes seven recommendations, including:

> 4) "Training for enhancement of music appreciation.
>
> a. Materials targeting music perception and appreciation are available and are shown to be beneficial and should be implemented with recipients who wish to improve music-perception abilities with their cochlear implant" (p. 81).

In addition to these clinical recommendations, consider music from a functional standpoint: music is a prevalent auditory signal in everyday life, thus CI recipients are likely to encounter music on a daily basis. Furthermore, music enjoyment has been associated with mood regulation and enhanced quality of life (Bartel et al., 2011; Dritsakis et al., 2017; Gfeller et al., 2019a). Thus, better perception of music seems consistent with issues such as quality of life and active social involvement (Dritsakis et al., 2017). From a basic science perspective, given the challenges associated with electric hearing and the acoustic components of music, one can also argue that music listening represents a valuable research and clinical stimulus in relation to signal optimization.

The data from the CI 8 suggest that optimizing music outcomes remains a relatively rare occurrence within clinical audiological care. Why is that the case? To understand these themes more fully, let us consider them in the context of current trends in audiological practice, rehabilitation, and patient-centered care.

While a key function of audiologists is the assessment of hearing and provision of hearing devices (hearing aids, cochlear implants), aural rehabilitation (AR) falls within the scope of practice of both audiologists and speech-language pathologists (SLPs) (American Speech-Language-Hearing Association, n.d.). Aural rehabilitation (a.k.a. audiological rehabilitation) is described as "the reduction of hearing-loss-induced deficits of function, activity, participation, and quality of life through

sensory management, instruction, perceptual training, and counseling" (Boothroyd, 2007, p. 63). Counseling, information, and training are listed under professional roles and responsibilities of audiologists and speech-language pathologists (American Speech-Language-Hearing Association, n.d.).

Aural rehabilitation is described as important to management of hearing loss (e.g., American Cochlear Implant Alliance, 2017; Boothroyd, 2007; Cochlear ProNews, 2020; Glade, 2018; Harris et al., 2016; Plant et al., 2015). However, barriers exist to adequate provision of adult AR (Cochlear ProNews, 2020; Harris et al., 2016; Spangler et al., 2015). A technocentric model of audiological care that focuses exclusively on the provision and fitting of hearing devices can miss broader outcomes in listening, communication, and functional wellbeing in everyday life—living with hearing loss (Cochlear ProNews, 2020; Montano & Spitzer, 2014; Spangler et al., 2015).

According to Montano and Spitzer, AR should use a "person-centered approach to assessment and management of hearing loss that encourages the creation of a therapeutic environment conducive to a shared decision process" (Montano & Spitzer, 2014, p. 27). Also referred to as patient-centered care (Bardes, 2012; International Alliance of Patients' Organizations, 2006), a person-centered approach is respectful of peoples' needs and preferences and includes shared decision-making and goal setting. Key elements essential to delivering person-centered care in an audiological environment are empathy, active listening, open-ended questions, shared goal setting and decision making, and understanding individual preferences (American Speech-Language-Hearing Association, n.d.; International Alliance of Patients' Organization, n.d.).

According to Spangler et al. (2015), many audiologists and SLPs are eager to provide comprehensive AR services that include counseling and training. However, they may be reluctant, or even unable to do so because of limited or absent reimbursement, limited collegiate preparation in AR (Spangler et al., 2015), and time constraints in patient appointments (Cochlear ProNews, 2020; Dunn, 2018). In other words, hearing professionals may be de-incentivized or unprepared to offer more comprehensive aural rehabilitation.

According to Barker et al. (2018), one approach to enhancing aural rehabilitation for adults is the use of a model called the Behavior Change Wheel. This model (often referred to as COM-B) suggests that building particular clinical behaviors in a treatment protocol requires capability (C), opportunity (O), and motivation (M) to build particular clinical behaviors (B). In a shared therapeutic process, the presence or absence of these components for both patient and caregiver would influence quality of care.

Capabilities refers to skills, abilities, proficiencies, knowledge, attention, decision processes, and behavioral regulation (Barker et al., 2018). In the context of music rehabilitation, capability on the professional side could include sufficient knowledge of music and CIs to convey accurate and helpful information. For the CI user, capability might include factors such as ability to use online apps or the auditory profile of the individual and access to specific sounds.

Opportunity includes environmental context and resources, norms, social influences, and conformity (Barker et al., 2018). In this context, on the professional side, opportunity to offer rehabilitation is influenced by scheduling, billing, and other policies in one's work place. On the CI user side, opportunities for the CI user are highly influenced by the availability of clinical services, special access to research programs, and other factors such as commuting distance, and competing life demands.

Motivation refers to beliefs about capabilities and goals (e.g., can music be enhanced?), optimism, reinforcement, incentives, and rewards for the target behaviors (Barker et al., 2018). In this context, this refers to the beliefs regarding music and rehabilitation on the part of both CI professionals as well as CI users.

These three components are interdependent. For example, motivation can be influenced by or influence opportunity and capability, and vice versa. In using this model, the problems or target behaviors need to be identified and the desired changes determined. If one aspires to a shared process (as in person or patient-centered care), the COM-B model should take into account capability, opportunity, and motivation of both the care providers and the CI users. A deficit in any of these components on either side of the partnership can undermine access to and quality of care.

For example, if an audiologist has an unmanageable caseload, and/or they cannot receive reimbursement, this undermines both *opportunity* and *motivation* to provide AR that extends beyond basic device fitting and trouble shooting. This in turn undermines the patient's *opportunity* to receive optimal AR. Specific to music, an audiologist who is highly skilled with regard to speech, but whose professional preparation has not included even basic knowledge of music and hearing devices would lack the *capability* to counsel or suggest resources specific to music goals. Finally, *motivation* to engage in a shared treatment process, which addresses the unique needs and preferences of each client, provides a foundation for patient access to effective AR.

Taking into account the themes that emerged from the narratives of the CI 8, and factors identified in published studies, we propose for CI users and CI professionals a RMMR. This model represents the interaction of various factors that can undermine or enhance music rehabilitation for adult CI users. It can be used in professional self-reflection or program reviews to develop more patient-centered approach to CI services for for music-centric CI users. The RMMR is described below.

The Reciprocal Model for Music Rehabilitation for Cochlear Implant Recipients

The RMMR has at its center the three components of clinical support that emerged from the CI 8 data: Counseling (Core

1), Technology (Core 2) and Training (Core 3). These components also reflect related literature regarding aural rehabilitation (Boothroyd, 2007). The RMMR model calls for a three-pronged approach to Music Rehabilitation, as opposed to focusing only on technical solutions.

An important theme that emerged from the CI 8 data was the importance of an on-going 2-way relationship (reciprocal) between the CI User and CI Professionals in order to optimize technology and facilitate counseling and training. This is also consistent with literature on person-centered care in AR (Bardes, 2012; Montano & Spitzer, 2014). The RMMR represents the reciprocal nature of rehabilitation by positioning the CI Professionals and the CI Recipients on either side of the three components of rehabilitation. The strength of reciprocity is reflected by the curved arrows that link the professionals and CI users.

The solid bi-directional arrows above and below the Music Rehabilitation process represent strong reciprocity in determining treatment aims (e.g., "a new audiologist completely transformed my map, making music sound far better than before.") and effective 2-way communication (e.g., "[in mapping,] the audiologist adjusts my devices and I try to explain to hear what I would like to be improved. . the process continues until I become satisfied.").

The dashed arrows show 1-way protocol-driven decisions (e.g., "out-of-the box quick 1- hour appointments;" "They follow the same format every time, and that feels pretty perfunctory." "After the first year rehabilitation, there are no more appointments.") and 1-way communication (e.g., "It is common to hear a CI audiologist express that music enjoyment varies greatly among CI users. End of story." "While we lack a shared language about sound quality and music, it is hard to communicate about what you need as a musician.").

Both the data from the CI 8 users as well as related literature (e.g., American Academy of Audiology, 2019; Gfeller, Driscoll, et al., 2019a; Gfeller, Mallalieu, et al., 2019b) emphasize the dynamic (changing) nature of rehabilitation (e.g., discussion of aims "could be revisited as it might change over time."). For example, the "*Clinical Practice Guidelines: Cochlear Implants*, (American Academy of Audiology, 2019) states, "To realize maximum benefit from the device, cochlear implants require *consistent follow-up and intervention beyond cochlear implant programming*."

To represent this dynamic component of the rehabilitative process, a red arrow is positioned above the Music Rehabilitation box in the RMMR. The CI 8 data indicate that these changes include patient progress, relationships with CI providers, and technological changes. These changes over time interact with protocol-driven vs. patient-centered approaches to care. A patient-centered approach would base professional services to a greater extent on the evolving needs, progress, and unique circumstances of the individual CI user; this contrasts with a protocol-driven uniform schedule of standardized treatments and tests. For example, as one of the CI 8 noted, her initial percepts required her to focus exclusively on spoken communication. Her desire to improve music emerged several months post hookup. Fortunately, her CI professional inquired about music in each appointment, and she eventually enrolled in a music training program. In contrast, several CI 8 members were unable to get appointments to resolve perceptual problems for music after the initial year of standard follow-up sessions.

In the RMMR model, the component, "CI Profesionals" refers to any subspecialty of professional involved in rehabilitation (e.g., audiologist, speech language pathologist, research scientist, CI company representative, etc.). The specific titles of these individuals vary from one country to the next. Furthermore, per the CI 8 data, the specific professional assigned to provide mapping, counseling, or training may also vary from center to center. In some centers, one professional may have primary responsibility for all aspects of rehabilitation, while other centers may enroll a multi-disciplinary team, including consultations from CI company representatives.

The CI 8 members interacted primarily with one professional (e.g., an audiologist) to address all their needs, including inquiries about music. Only one CI 8 member was offered access to multi-session music training that involved a team. Ideally, in order to strengthen the "capability" component of professional services in the RMMR model, one professional may coordinate rehabilitation, but the provider of rehabilitation may vary depending upon the patient needs, and which professionals are best suited toward rehabilitative aims.

Within the RMMR, the components of the COM-B model of Barker et al. (2018) are positioned between Music Rehabilitation and the CI Professionals and CI Users. That is, the presence or absence (+ or −) of capability (C), opportunity (O), and motivational (M) factors stands between the professionals, the CI user, and rehabilitation; this influences access to and quality of rehabilitation. The lines between C, O, and M represent the interactive nature of these factors; for example, a person who is highly motivated is more likely to seek opportunities for music rehabilitation than someone who has limited motivation.

The + and – symbols for the various components illustrate that any one of these factors can either enhance or undermine music rehabilitation. For example, an audiologist may be intrinsically motivated (+M) and interested in helping a patient to optimize music listening (e.g., "my audiologists celebrates every music WOW moment"). However, a burdensome caseload, lack of insurance coverage, or inadequate clinic support may limit the opportunity (−O) to discuss music or possible resources. On the other side of the equation, a CI recipient who considers a CI to be "a cure," and is unmotivated (−M) to engage in training, will undermine the best intent of a capable (+C) and motivated (+M) audiologist.

Yet another scenario is an audiologist who is dismissive (−M) or uniformed (−C) about music-related concerns (e.g., "My ENT said … nobody is able to enjoy music, so you won't either."), which can diminish the CI user's motivation and opportunity for improved outcomes. In short, the clinician-patient interaction is likely to be more effective when there is reciprocity in treatment aims, including 2-way communication, motivation, capability and opportunity on both sides to address the individual needs and aspirations of the CI user.

Let us consider core categories of the CI 8 in relation to the RMMR. For this particular cohort, 87 codes were categorized as self-directed training. This implies a high level of motivation and capability within the CI 8. However, only 31 codes represent rehabilitative opportunities from the center or use of apps. Furthermore, 18 of those codes are from one individual. This scenario suggests a lack of reciprocity between the clinics and these highly motivated CI users: the onus rests squarely on the shoulders of these CI users.

Using the RMMR as a framework for analyzing the effectiveness of rehabilitation for music-centric CI users, if the work place policies or insurance coverage do not support provision of counseling (e.g., short pro-forma sessions), the 2-way process is weakened. What can be done to restore greater opportunity on the professional side? One approach might be to "outsource" or refer the CI user to outside opportunities for music rehabilitation. This might include sharing information about externally developed on-line (e.g., Iowa Head and Neck Protocols, 2022) or nearby resources. For example, the busy audiologist might have at hand a ready link to on-line training programs, or connect the CI user with a research center focusing on music.

In using the RMMR, it is important to consider: (a) the diverse characteristics and life experiences of individual CI users and their aims (e.g., what kinds of music engagement, if any, are important to a given CI user, CI protocols within their country/center), (b) practical steps that could increase capability, opportunity, and motivation of busy caregivers and CI users, (c) the dynamic nature of rehabilitation, and (d) those aspects of the shared therapeutic process that can either support or undermine quality of and access to music rehabilitation.

Discussion

These perspectives report the attitudes and experiences of a unique group of CI recipients who have achieved or restored remarkable levels of musicianship following implantation. While some aspects of their post-surgical care differ as a result of varying practices and policies from one CI center/country to the next, they share concerns regarding (a) limited music-specific support as part of typical clinical protocols, (b) problems with the mapping process, and (c) the need for more and well-designed forms of music training.

The perspectives of the CI 8 suggest an imbalance between the motivations of CI users who have strong interest in music and the capabilities and opportunities in typical clinical care to support satisfactory music outcomes. This imbalance is more concerning when one considers that CIs can have direct costs of more than three times the cost of knee replacements, yet the typical adult CI recipient in the US does not have access to rehabilitation programs. This is especially true for more challenging listening tasks such as music or speech in background noise (Gfeller et al., 2019a; Harris, et al., 2016). Cochlear implants do not cure hearing loss or replicate normal hearing; needs and challenges will not end at the test booth door.

It is also worth noting that half of the CI 8 were professional musicians or trained to be so; yet, they received little or no exceptional care to deal with this vocational disability. One might compare this situation to rehabilitation in sports medicine for a professional athlete who sustains a significant physical injury. Or consider the concept of para-athletics, in which a challenging and interesting parasport is available to persons with disabilities through extensive rehabilitation and accommodations.

Examining this imbalance within the context of current health provision protocols, there are a number of barriers that must be addressed in order to establish a better balance. Of particular concern is limited access to individualized mapping or rehabilitative counseling. Presumably, this reflects fiscal and system pressure associated with healthcare delivery. According to Dunn (2018), more than 50% of audiologists have 90 min or less to conduct audiograms, speech testing, mapping, and device trouble shooting. It is likely that many audiologists feel strapped for time to address concerns associated with speech, not to mention music. The most motivated and supportive audiologist may be unable to offer the support for music they consider appropriate.

According to Spangler et al. (2015), professional and consumer advocacy are needed to increase access to AR services for speech. Restructuring billing models for audiological care is one step toward expanding what can be a technocentric approach to enhanced audition, and addressing more fully the impact of hearing loss in daily life, including professional or avocational involvement in music.

In the meantime, how can a busy CI Professional carve out time for counseling on music? One approach is strategic provision of basic music information for those CI users who have identified themselves as interested in music. The busy audiologist who is in step with professional guidelines for person-centered care would first inquire about life interests such as music. For the music-centric CI user, the audiologist could provide a list of quality web links or provide handouts of resources (e.g., support groups) that help to establish realistic expectations, while also offering suggestions for optimization. This might include informational websites (e.g., https://medicine.uiowa.edu/iowaprotocols/music-and-hearing-loss-hearing-devices-and-music-testing-music-perception-improving-music-enjoyment) (Iowa Head and Neck

Protocols, 2022), apps, or existing programs created by research centers (e.g., *More for Music Program*), advocacy and support groups, or CI manufacturers.

Recalling CI 8 comments about peer support and sharing goals, to increase opportunity for rehabilitation, a clinic might offer an annual or semi-annual on-line or in-person workshop or presentation for CI users who have been identified in assessment as desiring better music enjoyment. In a one or two hour event, the CI team could address a host of questions and concerns that might take too much time during individual sessions. If the clinic happens to have a CI users who enjoys music, that person might agree to be part of the program or conversation. This could contribute to motivation as well as capability. Some CI users might be willing to pay a modest one-time fee for the opportunity to optimize their music experiences. This sort of patient-centered event could result in high patient contact at low cost.

Another potential barrier is the lack of collegiate preparation for AR in general, and those broader needs beyond technology (Spangler et al., 2015). Some university programs may offer only one course in AR. Audiologists already have a very full curriculum; curricular components specific to music or music rehabilitation are likely to be brief or offered only in specialty seminars for the professional with personal interest in music. As noted earlier, CI professionals and musicians represent two very different areas of expertise with different vocabulary, skills sets, and expectations. How can this gap in expertise, interest, vocabulary and priorities be bridged?

In most clinics, particular caregivers have developed specialties; patients with specialized needs are scheduled with the clinic's specialist. No single caregiver can address all patient needs. In a practice with several CI professionals, one or two individuals might take on the challenges of learning more about music through conferences, webinars, research articles, or on-line materials (e.g., Iowa Head and Neck Protocols, 2022). That individual would ideally be assigned to patients who have indicated during their intake/assessment that music plays an important part in their life. Perhaps the "music" expert on the team might provide occasional consultations as part of regular appointments.

The reality is that no clinical center can specialize in all aspects of hearing. Considering music as a collective challenge to CI professionals, particular clinics and researcher centers might become "centers of excellence" for serving the needs of music-oriented CI recipients. These centers might set up collaborative arrangements (adopt a patient-musician) with the primary ENT and audiologist to facilitate enrollment in research protocols, special workshops, or on-line classes. Another option might be a private pay "concierge" approach to music rehabilitation in which a CI professional offers music-centric support as a consultant, in much the same way that an individual would pay a music teacher for private lessons.

What works for enhancing services for music-centric CI users will likely differ depending upon healthcare policies and practices from one country or CI center to the next, as well as the needs and aspirations of the CI user. For example, the most substantial music training program reported by one CI 8 member, *More from Music* involved collaboration of the University of Southampton Auditory Implant Service and members of the UK National Cochlear Implant Users Association. Two CI users from the United States benefitted from referral for short-term participation in research protocols involving mapping parameters for music perception.

These sorts of collaborative initiatives involve logistics. Perhaps panels or informal conversations at professional meetings might include dedicated discussions on various strategies and incentives for enhancing music rehabilitation, including collaborative arrangements that are a good "fit" for unique circumstances of various healthcare systems.

Other sources of support are family members and other CI users. The CI 8 emphasized the benefits of practical suggestions and moral support from other CI users; they desire more easily accessed support groups or internet communication. A busy CI professional might direct the CI user to CI users groups as sources of motivation, information, and to complement their own counseling efforts.

Because music presents such significant challenges for electric hearing (Limb & Roy, 2014; Moreno & Bidelman, 2014), additional research is needed to enhance music rehabilitation. The perspectives of the CI 8 highlight several agendas for future research. For example, Core Category 2 describes problems and desired changes in the mapping process. Research that investigates mapping parameters for music percepts, patient-controlled input during mapping, and more "standardized" terminology to enhance communication in the mapping process could enhance the technology component of music rehabilitation.

The CI 8 data also suggests patient-centered aims for music training research. The CI 8 desire training that (a) progresses from easy to difficult exercises, (b) offers feedback on progress, (c) uses multisensory input, including a variety of musical sounds, (d) possesses good sound quality, (e) assists with real-life music and meaningful listening situations, and (e) encourages use of context. They also described successful forms of self-initiated training (see Supplemental Appendix C) that might be investigated in future music rehabilitation research. These CI 8 perspectives offer clinicians and researchers food for thought in designing music training for other music-centric CI users.

The experiences of these CI 8, who have achieved impressive musicality, highlight challenges in devising music training that results in functional musical skills. *As is true for musicians with normal hearing*, high-level musical skills achieved by the CI 8 required committed practice over years. How does one develop a music training program that replicates the intensive, extended and complex process of music instruction, along with motivation to persist? The complexity and longitudinal nature of developing musicianship might be likened to literacy and

literary enjoyment. Such skills present significant challenges in relation to more typical short-term research designs and methodological options.

An additional challenge is establishing research aims and methodology in relation to patient-centered care, given the diversity of patient profiles. CI users differ on a host of audiological, lifestyle, and motivational factors. As noted previously, the musical aspirations and commitment to training of the CI 8 are not typical for CI users. Prior research (Gfeller et al., 2019a) revealed that more typical CI users want to listen to music for enjoyment, and would prefer music training comprising a maximum of 2–3 weekly training sessions over a period of a few weeks. What sorts of functional outcomes can be realistically achieved under those parameters?

Given the diverse aspirations of CI users, research in the development and assessment of music training ideally should encompass a variety of aims and approaches. This would include modest, short-term improvements and practical accommodations, as well as more advanced skills for improved pitch accuracy, improved sound quality, and use of context. Factors related to access, persistance and motivation also deserve research attention. This includes various formats (e.g., on-line, group workshops, individual lessons), motivational factors (e.g., social support, behavioral feedback), different aspects of functional benefit (e.g., going to a concert, playing an instrument, singing at religious services), and diversity of musical stimuli (e.g., real world music, controlled music patterns). These factors should be examined from a patient-centered perspective as well as in relation to important theoretical constructs.

Related to the diversity of CI users is the diversity of musical sounds and experiences. Music comprises an enormous universe of complex, dynamic sound combinations (various styles, forms) and forms of involvement (listening, playing instruments, singing, etc.). Thus, research focusing on music training will require complementary multidisciplinary and multi-centered studies that examine specific aspects of the complex, multifaceted nature of music training (Gfeller, 2012; Gfeller, Driscoll, et al., 2019a; Gfeller, Mallalieu et al., 2019b; Gfeller et al., 2001). A notable challenge in designing patient-centered music training is obtaining sufficient funding, given the diverse patient aims, along side the many important goals associated with speech, language, cognition and other CI concerns.

It is important to acknowledge that the perspectives of the CI 8 and the first author have limitations and should be discussed. The CI 8, as a purposive sample, does not represent the diverse population of CI users. The CI 8 has unusually high levels of musical training and interest. Nor do their service providers comprise a representive sample of all professionals or models of practice worldwide. Thus, the generalizability of their perspectives are most relevant to persons with similar characteristics and life experiences.

Although a second independent coder and member checking were used in an effort to verify and validate the analyses, the questions and analyses were subject to the viewpoints of

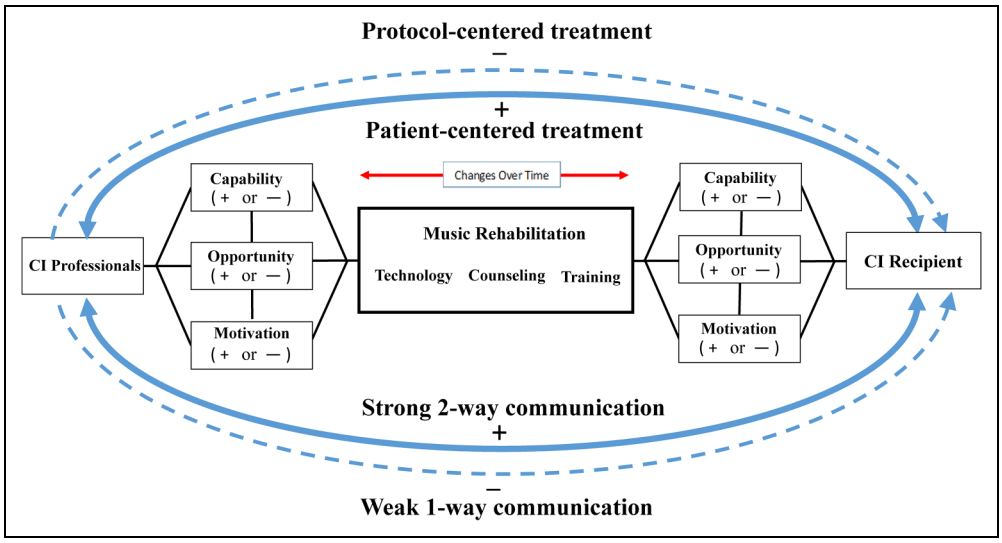

Figure 1. The reciprocal model of music rehabilitation for cochlear implant recipients.
The term, *CI Professionals* includes audiologists, speech-language pathologists, researchers, representatives of CI manufacturers, programing engineers, or other counselors that contribute to the rehabilitation of CI users. One or more of these professionals may provide services to a CI user at various stages following implantation. *Changes over time* refers to the dynamic nature of healthcare delivery, current knowledge, as well as ongoing changes in CI users and their circumstances (e.g., auditory profile, familial, social, environmental, aspiration, needs, etc.). The solid and bi-directional arrows represent stronger reciprocity between the CI Professionals and CI Users. The dashed one-directional arrows represent 1-way decisions (highly standardardized protocols) on treatment and limited 2-way communication. + and –signs indicate positive or negative valence for factors that consequently enhance or undermine reciprocity toward more satisfactory music outcomes.

the authors, whose perspectives on CIs and music cannot fully represent the range of important perspectives on this topic. Consistent with qualitative methodology, this study was not intended to provide objective "truths" confirmed through hypothesis testing. Further research is needed to test the impact and applicability of the themes that emerged from this sample to other subgroups within the larger population of CI providers and recipients.

In closing, through the voices of these remarkable CI 8 users, we see a glimpse of the challenges faced in order to enjoy satisfactory music experiences. Their intrinsic motivation and persistence in the face of technical limitations to electric hearing are impressive and inspiring. However, their themes and quotes also revealed a real sense of frustration, even as they feel pride in their accomplishments. They want their passion for music to be taken seriously within their audiological care. Within the context of patient (person) centered care, these desires represent the unique needs of the individual in relation to emotional wellbeing and integration into society. Thus, they deserve attention and a concerted clinical effort. The RMMR model offers a framework for professionals and CI users to consider and identify factors that could result in more patient (person)-centered care in relation to music as well as speech perception.

The disappointments expressed about clinical services should also highlight the real pressures faced by CI professionals within healthcare practices and in terms of individual resources and capabilities. Establishing a shared process of patient-centered care, while promoted as the standard for care, does not happen without concerted effort and support by the larger clinic organization. The professional serving on the front lines of patient care needs opportunity as well as incentives to follow best practices. They need work conditions that facilitate opportunity, capability, and motivation. The RMMR provides a conceptual framework through which one can analyze those factors on both the provider and user sides that are either contributing to or impeding best practices.

Interestingly, the impediments to rehabilitation for music are also a problem for speech outcomes. Not all CI users will make adequate gains in speech perception through mere exposure over time (Pisoni et al., 2017). Perhaps the professional and consumer advocacy that could enhance access to music rehabilitation might have implications for speech rehabilitation as well.

Changes in healthcare norms are not easily achieved. What sorts of professional initiatives are required to provide a more satisfactory environment for music and other forms of aural rehabilitation? Change will require the same sort of persistence and ingenuity in overcoming barriers that the CI 8 have demonstrated in their efforts to achieve rewarding experiences with music.

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Author Contributions

KG coordinated data gathering, management, coding, and analyses. JV, RM, MN, SS, YC, GM, TM, and AN all contributed to (a) the development of the research questions and key topics, included in the questionnaire, (b) questionnaire data regarding experiences of CI users, and (c) feedback on the validity of the codes and core categories that emerged from the data. KG communicated with the IRB to the status of this project. JV, RM, and KG had primary responsibility for the development of the open-ended questionnaire, JV and MN developed, disseminated, and organized the data in Tables 1–4. KG developed the conceptual model of music rehabilitation, but JV, RM and MN provided input on the conceptual model. KG served as the primary writer for the manuscript, though all authors contributed to the article content, and reviewed analyses of the data and article content. RM provided intensive proofing of the manuscript. All authors contributed to the conceptualization of the manuscript and protocol for gathering information.

Declaration of Conflicting Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Ethics Statement

Ethical review and approval was not required for the study on human participants in according with the local legislation and institutional requirements. However, the co-authors, who contributed data to the paper, also provided their written informed consent for participation and for the publication of any potentially identifiable data included in the article. For further information, please see the correspondence from the IRB.

Data Availability Statement

The raw data supporting the conclusions of this article will be made available by the authors without undue reservation to any qualified researcher.

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Supplemental Material

Supplemental material for this article is available online.

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