Published in final edited form as:

Cochlear Implants Int. 2015 May ; 16(3): 137–146. doi:10.1179/1754762814Y.0000000103.

Family involvement in music impacts participation of children with cochlear implants in music education and music activities

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Abstract

Objective—Children with cochlear implants (CIs) participate in musical activities in school and daily lives. Considerable variability exists regarding the amount of music involvement and enjoyment. Using the Music Engagement Questionnaire-Preschool/Elementary (MEQ-P/E), we wanted to determine patterns of musical participation and the impact of familial factors on engagement.

Methods—Parents of 32 children with CIs (16 preschool, 16 elementary) completed a questionnaire regarding the musical involvement of their child with an implant and a normal-hearing (NH) sibling (if one existed). We compared CI children's involvement to that of their NH siblings as well as across groups of children with and without CIs. Correlations between parent ratings of music importance, demographic factors, and involvement of CI and NH children were conducted within and across groups.

Results—No significant differences were found between children with CIs and NH siblings, meaning children from the same family showed similar levels of musical involvement. When compared at the same developmental stage, no significant differences were found between preschool children with and without CIs. Parents who rated the importance of music as “low” or “middle” had children (NH and CI) who were less involved in music activities. Children whose

parents rated music importance as “high” were involved in monthly to weekly music activities with 81.25% reporting daily music listening.

Conclusion—Despite a less-than-ideal auditory signal for music, preschool and school-aged CI children enjoy and are involved in musical experiences. Families who enjoy and spend a greater amount of time involved in music tend to have children who also engage more actively in music.

Keywords

children; cochlear implants; music

Introduction

Cochlear implant (CI) technology has resulted in significant improvements in speech perception for individuals who are profoundly deaf; yet, in music perception tasks, recipients of CIs are still significantly less accurate than listeners with normal hearing (NH) (Looi, 2008). Moreover, children who are born deaf and receive implants have a different musical experience from those who lose their hearing after birth (Olszewski, Gfeller, Froman, Stordahl, & Tomblin, 2005). Their representations of sounds, including speech and music, include only what they have heard through their implant whereas those who have lost their hearing later have a memory and mental representation of how various stimuli sound (Olszewski, et al 2005). While speech perception scores of CI recipients can reach the level of their NH peers in quiet listening situations (Kirk, Pisoni, & Miyamoto, 1997; Diamond et al., 2013), the same cannot be said for the perception of music, particularly pitch and melody (Gfeller et al., 2008; Gfeller, Jiang, Oleson, Driscoll, & Knutson, 2010; Olszewski et al, 2005). Despite the difference in performance, children with CIs often enjoy music; however, the link between enjoyment and participation has not yet been ascertained. Familial involvement has been shown to have a positive impact on executive function and speech performance. The same has not been evaluated for children with CIs regarding music.

Age-appropriate music involvement for children

During preschool years, children are exposed to music during many activities such as songs and finger plays, which teach children about body parts, introduce pre-academic skills, and provide guidance for moving within an environment. Children with NH are often involved in informal music activities as part of a regular preschool program, as well as in play with parents and siblings; activities incorporated into routines such as getting dressed, bathing and bedtime. In elementary school, NH children are involved in general music classes and ensembles that are encouraged by their parents and teachers, as well as peers (e.g. school dances, choirs, bands, etc.). Moreover, many NH elementary school children begin taking private lessons in piano or string instruments, though some specialized methods of teaching may begin in the preschool years. The participation of children with CIs does not always follow the same path as NH children because more time is often dedicated to reaching language milestones, delayed by receiving an implant at 12 months of age or later.

Music and cochlear implants

While enjoyment of music remains elusive for many postlingually deaf adult CI users who compare sound quality to experiences prior to deafness, congenitally deaf children with CIs only know how music sounds through their implants. Thus, many describe the quality of the sounds differently from their adult counterparts. In other ways, however, adults and children with CIs are similar in their perceptions of music. Stordahl (2002) compared responses of children with CIs to children with NH on appraisal and recognition of music stimuli. Stordahl found children with CIs were significantly less accurate than children with NH on recognition. Children with CIs also rated the non-classical items as significantly less “likeable” than their NH counterparts. In a study by Olszewski et al (2005), adults and children with implants were able to accurately recognize four melodies in a closed-set response task (4AFC) when they were presented in either an audiovisual format with lyrics or an audio format that included sung lyrics. The similarities disappeared when the lyrics were removed from the stimuli. Children with CIs were no longer able to recognize the same melodies and dropped to chance level of performance, whereas their adult counterparts were significantly more successful in recognition by relying on the rhythmic cues presented. The adult CI users’ performance dropped when only the melodic line was presented intact and the rhythmic information removed. Adults and children with NH were able to successfully identify the melodies within each format.

Despite well-documented limitations in perceptual accuracy for pitch and timbre, many children with CIs are involved in music, formal or informal, including music classes in preschool and elementary school. Often their participation is due to educational requirements; others have individualized education plan (IEP)-related therapies that may take the place of a music class. Darrow and Gfeller (1991) reported more than 60% of children in grades K-12 who have hearing impairments attended local public schools, with 45% being mainstreamed into their classrooms. As a result, more children with CIs may be receiving some structured music education; more than children who attend schools for the deaf or who receive additional therapies during the time usually dedicated to music education.

In another study, Gfeller and colleagues (1998) surveyed parents of preschool (n=7, 2-5 years of age) and elementary school (n=33) children (K-6 grade) with CIs about their children's involvement and responses to music, methods of communication, and placement in school (e.g. mainstream, special classroom, etc.). The authors then analyzed the information by correlating the ratings of music participation with scores on speech and language measures. The parents of the preschool-aged children reported activities consistent with children who have NH. Four of the parents reported their children showed motor responses to music: two attempting to sing along and four smiled when music was played and seemed to enjoy the sounds. For the elementary school-aged children, only 7 of the 33 had established a preferred style of music. Parents listed specific structural features of the music to which their children gravitated; music that included strong beat or rhythm, quiet intensity level, or moderate tempo were the most commonly reported. These characteristics, which are effectively transmitted via CI, resulted in improved music enjoyment. Analyses of speech measures with music attitude and involvement were not significant, but significant

correlations were found between the child's general attitude and involvement with music and a global oral competency rating called a "clinical performance rating."

Effect of family involvement

The impact of family environment is an important factor to consider in performance of CI recipients. Holt and colleagues investigated the effects of family environment on the outcomes of children with CIs in the areas of executive function and spoken language skills (Holt, Beer, Kronenberger, Pisoni, & Lalonda, 2013; Holt, Beer, Kronenberger & Pisoni, 2013). The authors found families of children with CIs were different than families of children with NH, but not in clinically significant ways. They noted that protracted periods of language development can be related to family environment and that increased interventions could translate to better family dynamics, thereby increasing the potential for development in speech and language avenues. Additionally, families who placed emphasis on achievement had children with fewer problems in executive function and working memory. Families who displayed high emphasis on organization had children with fewer problems related to inhibition (Holt et al., 2012).

Gfeller and colleagues (2012) evaluated how musical activities of adolescent CI users attribute to the extent of involvement and appreciation in part to the familial environment (Gfeller, Driscoll, Smith, & Schepelerle, 2012; Darrow, 1993). Adolescents whose families were more involved in music placed higher personal value on music and were more likely to be involved in extracurricular musical activities or lessons. The effect of family involvement in music with participation of the child with a CI has not yet been explored systematically for preschool and school-aged recipients. It is important to know if involvement in music by the preschool and elementary school population is shared by the family or if the children form these appreciations on their own as part of their social and emotional development because lack of involvement in music is often blamed on the quality of sound delivered via the implant rather than external factors such as interest and exposure.

The purpose of our study was to examine the effect of familial involvement on the experience and involvement in music of children with CIs. We asked the following questions: (a) Do children with CIs, whose families place more value in music-based activities, reflect the family's value in their own involvement?; (b) Will two children, from the same family (one NH and one with CI), show similar involvement in music based upon the value placed upon it by the parents?; and (c) Does the implant play a role in music involvement and enjoyment?

Method

Participants

Parents of preschool (n=16) and elementary school-aged children (n=16) with CIs were administered an electronic questionnaire regarding their child's involvement in and enjoyment of music. Parents were sent invitation letters (in compliance with Human Subjects research regulations) in which the web address of the questionnaire and accompanying password was provided. Parents who did not respond to the invitation or

whose invitation letters were returned were approached and invited during their child's annual programming visit to the otolaryngology clinic. The websites required passwords so that only those we approached would be able to provide answers and no outside or unverifiable participants could respond through a general internet search.

Measure: Music Engagement Questionnaire: Preschool and Elementary (MEQ-P/E)

The primary measure for this study, the Music Engagement Questionnaire (MEQ-P/E), was developed to examine musical engagement as well as social, educational or familial factors that may influence music involvement. The majority of the questions were adopted from Darrow's 1993 study but rephrased to evaluate a younger target audience (Darrow, 1993). The Darrow study included no questions regarding audiological status, use of CIs, concurrent use of hearing aids, or additional questions examining device usage (see Appendix). Our questionnaire was formatted into two parts: Part I applied to the child with the CI and Part II asked similar questions regarding a NH sibling closest in age. Limits were set regarding NH age ranges that would be compared with children with CIs. For example, one child 3 years of age might have a sibling over the age of 18. This NH sibling's data would not be collected for comparison. Due to the young age of the children we wished to evaluate, only parents/guardians completed the questions to provide more accurate information

Initial versions of the questionnaire were provided to audiologists in the clinic who had or worked with small children. They provided feedback regarding clarity and length of questionnaire. We altered the document in response to that feedback.

Questionnaire items appear in Appendix A. The MEQ-P/E included items regarding device usage (Q2-4). It also addressed the following aspects of musical engagement: (a) age at which the child began attending to musical stimuli (Q6); (b) extent and type (e.g., singing, listening, etc.) of involvement in formal music instruction (Q7 -9, 24-25); (c) attitudes and reactions toward music (Q10-14, 26); (d) child's reaction to music since receiving their implant (Q15); (e) resources sought out for child regarding music (Q16-17P); (f) overall importance of music in the child's life and in their household (Q18P). The final question, asked if there were NH siblings in the home and ended or continued the questionnaire. If the parent answered "yes," the second section would populate; if "no" was selected, the questionnaire would conclude.

Parents who had children in preschool were asked to provide responses regarding a NH sibling when they were in preschool. Parents of elementary-school aged children were asked to reflect in the same manner for the NH sibling. If the parents had more than 2 NH children, they were asked to provide replies about the sibling closest in age to their child with the CI. Part II contained five questions, with three questions mirroring items 7 through 9 of the previous section.

Socioeconomic status was not taken into account for this study, though we acknowledge a higher SES is positively associated with musical training and musical activity in the home (Hargreaves, 1986). To encourage the participation of individuals while offering the least amount of discomfort, SES information was not collected.

The responses to the question on the frequency of the child's participation in music activities were coded on six-point ordinal frequency scales with the options “never,” “occasionally,” “monthly,” “weekly,” “daily,” and “don't know.” The Fisher's exact test was applied to these ordinal variables to test for significant differences in frequencies of engagement between the preschool-aged and elementary-aged children. The Fisher's exact test was suitable for computing exact probabilities with this set of data because of the small sample size (Hays, 1981).

The McNemar's test was applied to test the null hypothesis that there would be no significant differences between the CI children's and their NH siblings' frequency of engagement in music activities. Results indicated no significant differences between the CI children's and their NH siblings' frequency of engagement in music activities. Although the test presumes that the observations are independent, it is common for the observations to be linked. In other words, the responses of the children with CIs matched those of their siblings with NH during the analysis (Kenny, 1987).

All response data were imported into SAS (version 9.3) for analysis. Significance levels for the McNemar's and Fisher's exact tests were set a priori at alpha level 0.05. Nominal data such as the number of parents with a child with NH in the family were illustrated using percentages. Means and standard deviations were used to describe ordinal data such as age of the child and respondents' ranking of their child's interest in music.

To further evaluate the responses, parent ratings of music importance were categorized into “low”, “middle”, and “high” levels. Correlations between parent rating, demographic information (age, months of use), and music activities for each group were conducted.

Results

Preschool-aged Children

Children with cochlear implants—A sample size of 16 parents (3 males, 13 females) of preschool-aged children with CIs completed the survey. Out of the 16 children, three (18.75%) also wore contralateral hearing aids. The average age of the children was 3.20 ± 1.22 years (range 1.5 to 5 years). Parents gave an average rating of 7.88 ± 1.71 on a scale from 1 (not very important) to 10 (very important) to rank their perception of the importance of music in the household. One parent rated the importance of music as “low” (3), three provided a “middle” rating (6-7), and the remaining 12 provided a “high” ranking (8-10, average 8.58). The parents reported that their child started paying attention to music when they were about 1.81 years old ($SD = 1.03$, range = 1 – 4 years). A majority of the parents (75%) commented that their child became gradually more interested in music over time following implantation. The rest of the respondents (25%) reported that their child was immediately more interested in music after implantation. Of the children who used contralateral hearing aids, two had rated musical importance in the “middle” category; one rated musical importance as “high”.

Siblings with normal hearing—Out of the 16 parent respondents, 12 (75%) had at least one child with NH in the household. Half (50%) of the siblings who were closest in age to

the child with a CI were between the ages of 3 to 10 years old. Approximately 78% of these siblings were involved in music when they were in preschool and 33% of them were currently still involved in music.

Elementary-school-aged Children

Children with cochlear implants—A sample size of 16 parents (1 male, 15 female) of elementary-school-aged children with CIs completed the survey. The average age of the children was 9.88 ± 1.36 years (range 7 – 12 years). Three out of the 16 children also utilized a hearing aid in addition to their CIs. The parents gave a mean rating of 7.44 ± 2.03 on a scale from “1” (not very important) to “10” (very important) for ranking the importance of music in their household. Again, in this population, one parent provided a “low” ranking (2), three provided a “middle” ranking (5), and the remaining 12 ranked music as highly important (8-10, average 8.5). All three children with contralateral hearing aids were in the “high” ranking group. Seven (41.2%) parents commented that their child gradually became more interested in music over time after implantation, although one parent commented that his/her child's interest in music was not dependent on the implant. Another parent felt that his/her child's reaction to music did not seem to be different compared to children with NH.

Approximately 47% of the respondents reported that their child enjoys music very much and would independently request music or was engaged when music was present in the environment. The other parents (53%) commented that their child's enjoyment of music is dependent on the types of music and musical instruments. In particular, the parents commented that their child showed less preference for “hard rock, loud music, rap music, opera, brass instruments, drums, and guitar.” Several parents identified the influence of social factors such as peer pressure on their child's music preferences: “She likes KISS FM (pop/rock) mainly because it's the “in” thing ... is trying to fit in with peers.” Country, hip-hop, and pop music were some of the music genres in which their children were particularly interested. These reports fit with the findings of Greer, Dorrow, & Randall (1974) who found that children tend to demonstrate preferences for popular music around the 4th grade. Several children were involved in music ensembles in their schools and played the clarinet, saxophone, and piano.

Siblings with normal hearing—All respondents had at least one child with NH. Seventy-five percent of the NH siblings who were closest in age to the child with CI were between the ages of 7 and 13 years old. Approximately 80% of the NH siblings were involved in music when they were in elementary school and 69% were currently still involved in music.

Comparison between CI Children and NH Siblings

Parents who have both a child with a CI and at least one child with NH in the household ($n = 28$) reported their children's formal and informal involvement in music activities in the survey. Results from the McNemar's test indicated no significant differences ($p > .05$) in the frequency of engagement in music between the children with a CI and their siblings with NH. CI and NH children in both the preschool-aged and elementary-school-aged groups did not differ in their frequency of participation in formal music activities, such as taking music

lessons, singing in community and religious groups, and attending music programs sponsored by their schools, community, and religious organizations. They were also similarly engaged in informal music activities such as listening to music at home, social play with friends, singing/playing music together with family, watching music videos, and playing with musical toys, musical video games, and making up songs during play.

Comparison between Preschool-aged and Elementary-school-aged CI Children

The responses from the parents of preschool-aged children with CIs ($n=16$) were compared with those from the parents of elementary-school-aged children with CIs ($n=16$). Out of the 16 parents of elementary-school-aged children, 11 (68.75%) had discussed their child's music involvement with their teachers, therapists, and other professionals, whereas only 6 out of 16 (37.5%) parents of preschool-aged children had that discussion. This may be due to some parents staying home and the child not being placed into a childcare facility. Both groups of parents reported minimal utilization of online music resources or webpages created by CI companies. Three parents (18.8%) of preschool-aged children reported that they had visited the Advanced Bionics music website, and one (6.3%) parent had utilized the Cochlear Corporation music resources. None of the parents of elementary-school-aged children had utilized any online music resources.

The Fisher's exact test was used to test for differences in the involvement and interest in music between the CI children in both age groups. The results indicated significant differences between the groups in two areas: (1) frequency of involvement in music activities, and (2) reaction to music since implantation. The results showed significant differences in their involvement in both individual and group music lessons on an instrument ($p < .05$). A majority (87.5%) of the parents of preschool-aged children with CIs reported that their child had never taken individual or group music lessons, which fits with the limited options offered to children of this age. In contrast, there was more variability in the responses given by the parents of elementary-school-aged CI children, with 37.5% taking weekly music lessons on an instrument. For more informal forms of engagement in music, the majority (68.8%) of preschool-aged CI children engaged in daily social music activities such as pretend play with friends and singing action songs (e.g. "London Bridge," "Ring around the Rosie"). This frequency (daily involvement) was significantly different ($p < .05$) from those of the elementary-school-aged CI children. Only 17.7% of the elementary-school-aged children were engaged in social music activities daily. The majority of them were involved either weekly (35.3%) or occasionally (35.3%).

The results from the Fisher's exact tests also indicated significant differences ($p < .05$) between both groups of parents in their reports of their child's reaction to music after implantation. Twelve (75%) out of 16 parents of preschool-aged children commented that their child gradually became more interested in music after implantation. The remaining parents (25%) reported that their child was immediately more interested in music. The parents of elementary-school-aged CI children had a more varied response to this question with 37.5% of them reported their child gradually becoming more interested in music after implantation. The rest reported the child immediately becoming more interested (6.25%), less interested (6.25%), or had the same reaction to music before and after implantation

(18.75%). Two parents commented that their child was so young at the age of implantation that they could not differentiate any differences in their reactions to music, which is an important consideration.

Neither age group of CI children differed in their informal and formal involvements in music in many areas. No significant differences ($p > .05$) were found in their frequency of involvement in organized music groups such as school choirs, community music programs, or informal music engagements such as listening to music at home, social music activities, family musical activities, and creating or making up songs during play. There were also no differences ($p > .05$) found between the two groups in regards to types or modes of listening situations that might make music more enjoyable for the children with CIs. These listening conditions included live or recorded music, a quiet listening environment, having a music program setting on their CI, type of music or instruments, volume of the music, having a direct input into the implant, or having visual cues paired with the music.

Regarding the impact of parent ratings on the involvement of their children with and without CIs, two parents rated the importance of music as “low”, six parents rated “middle”, the remaining 24 rated music as highly important. Preschool CI users were found to be significantly more involved in daily musical activities than the elementary CI users ($p < .05$).

For preschool CI users, significant positive correlations were found between parent report and child involvement with independent music making ($p = .0477$), but no others. Correlation of demographic characteristics revealed there was a positive correlation with age and creating music ($p = .0001$), participating in community or religious groups ($p = .032$), independent music making ($p = .009$) and group involvement ($p = .0003$). Positive correlations were also found with months of CI use and involvement in a musical group ($p = .042$), moving to music ($p = .032$), and independent music making ($p = .046$). All families, with the exception of one (who ranked music highly), acknowledged occasional family music making, with many selecting a weekly involvement (including the family that rated music lowest).

For elementary school CI users, moderate correlations were found with parent rating and lesson participation ($p = .06$) and significant correlations were found with music listening ($p = .046$). Regarding demographic characteristics, a positive correlation was found between age and participation in music lessons ($p = .024$) and a moderate correlation was found for watching music videos ($p = .051$). All families, with the exception of one, acknowledged family music making occurring at least occasionally, but with less frequency than the preschool group.

Discussion

Similar to the study with adolescents (Gfeller et al., 2012), our results supported the hypothesis that preschool and elementary school-aged children whose families place value in musical involvement were more involved in music. Reflecting on the questions posed for the study: do children with CIs, whose families place more value in music-based activities, reflect the family's value in their own involvement? Yes. Those children with CIs who spend

a greater amount of time involved in music are typically from families who are more involved or who place a higher level of value in music. Involvement by the family can be instigated by the parents or a child, either the sibling with NH or the child with a CI who expresses interest. Often, a family unit will support certain activities and, as a result, children are exposed to the same opportunities and often align with the same choices. For example, parents who are heavily interested in sports will often attend games with their families and encourage their children to engage in the same athletic events. By virtue of the exposure, the child may learn and become more involved in that area of interest. Parents who do not place a significant value on music but who have children with CIs who express interest, can still encourage their children to pursue their musical interests. However, parents should be made aware that the quality of sound presented through an implant is not the same as what the parents hear when listening and that children are likely to vary in interests, including musical endeavors.

Second, will two children, from the same family (one NH and one with CI), show similar involvement in music based upon the value placed upon it by the parents? We found that children in the same family, regardless of hearing status, aligned their participation and enjoyment with the values demonstrated by their parents. We found no impact on music involvement as a result of implant use; rather, family involvement contributed to the preference of children with CIs. Again, the exposure by the family may be the contributing factor to the child actively seeking out musical opportunities.

Finally, does the implant play a role in music involvement and enjoyment? Despite a less than ideal musical signal through the CI, preschool and school-aged children do enjoy musical experiences and involvement. These findings greatly differ from those in many adults who have received CIs following a hearing loss later in life who have a memory for natural, acoustic sounds and some of whom report a significantly diminished capacity for enjoying music (Looi, Gfeller, Driscoll, 2012). However, the extent of music appreciation by adult CI recipients varies considerably, as well.

Further studies evaluating the impact of parent preference and family environment could continue to illuminate the effect on children with CIs in many performance areas. As Holt et al. (2012, 2013) showed the impact of family interactions and dynamics regarding speech and language measures, additional studies in music perception and enjoyment may reveal similar familial impact. Additional factors such as residual or contralateral hearing, language skills, socioeconomic status, and parental levels of value may provide further insight into performance of children with CIs. Three children in this study utilized contralateral hearing aids, but no effect on involvement was found. Further clarity regarding bimodal hearing (CI + contralateral HA) and whether it contributes to improved music perception and/or involvement may be determined by increasing sample size and recruiting more children who utilize contralateral hearing aids.

Studies comparing NH children to the siblings with CIs may also show further contribution of family environment in musical and non-musical sound perception. It is important to accept that not all children (NH or CI) will express interest in music involvement and that the implant is not the greatest contributing factor to those desires for the children with CIs.

Furthermore, many NH and CI children who have supportive families prefer other activities and social engagements that do not involve music. Such a choice by a child does not imply the child has poor CI use nor does it indicate lack of familial support. However, because music is an aural art form, the importance of auditory input in addition to social factors such as areas of familial involvement can be beneficial as well as enjoyable. Do children who value music show higher performance in perception? Is it possible they accept the degraded sound signal and adapt by utilizing contextual cues? Further studies comparing outcomes of those who place high value music with perceptual accuracy are warranted. This study presents the first step to approaching the follow-up questions presented.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

The authors would like to thank all those who took part in this study and Andrea Halvorson and Kristin Sjoberg for assistance in collecting data during this study.

This study was supported by grant 2 P50 DC00242 and RO1 DC012082-10 from the NIDCD, NIH and the Iowa Lions Foundation.

Abbreviation

CI	Cochlear implant
NH	Normal hearing
4AFC	Four Alternative Forced-Choice
IEP	Individualized Education Plan
MEQ-P/E	Music Experience Questionnaire-Pediatric/Elementary
SD	Standard Deviation

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