Research Article

Music Participation Among School-Aged Children Who Are Hard of Hearing

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Purpose: Music is an important part of life for many people. Furthermore, music training has been shown to improve a variety of cognitive functions among children and adults. However, little research exists on how children who are hard of hearing (HH) perceive or participate in music. In particular, it is unknown whether hearing loss limits participation in music activities among school-aged children with mild-to-severe hearing loss. The purpose of this study was to determine whether hearing loss limits participation among children who are HH compared to children with normal hearing (NH).

Method: Participants were parents of 2 cohorts of children finishing 5th grade (approximately 11 years old). Parents were asked to complete a survey (online or paper) regarding the role of music in their child's life. A total of 88 surveys were completed (67 from parents of children who are HH and 21 from parents of children with NH, with an overall response rate of 74%).

Results: Hearing loss did not limit music participation among children. Children who are HH listened to recorded music, attended live concerts, and practiced an instrument at the same rates as children with NH. Listening to recorded and live music, practicing an instrument, and playing in an ensemble were equally as important to children who are HH as children with NH. Children who are HH were significantly more likely to regularly play in an ensemble than children with NH. Parent participation in music significantly influenced music participation for children who are HH but not children with NH. Descriptive data about music genres, instruments, and ensembles are also presented.

Conclusions: Children who are HH participate in music at the same or greater rates as children with NH. Parent participation in music may be particularly important for children who are HH. In light of this, music listening should be a consideration when fitting children with hearing aids.

Music is a ubiquitous part of the human experience. Music has deep biological foundations, has been central to human existence for at least 250,000 years, and serves many psychological functions, including contributing to social, emotional, and physical well-being (e.g., Schäfer, Sedlmeier, Städtler, & Huron, 2013; Zatorre & Peretz, 2001; for a review, see Deutsch, 2012). Furthermore, music training, particularly in childhood, has many benefits that extend beyond the aesthetic. Children who receive music training score higher on standardized tests, have higher spatial intelligence, have an overall larger growth of neural activity, show improved speech and language development, have enhanced verbal ability, and are better at perceiving speech in noise than children who do not receive music training (Forgeard,

Winner, Norton, & Schlaug, 2008; Gaab et al., 2005; Gromko & Poorman, 1998; Hyde et al., 2009; Johnson & Memmott, 2006; Kraus & Anderson, 2015; Kraus et al., 2014; Miendlarzewska & Trost, 2014; Moreno et al., 2011; Slater et al., 2015; Tierney, Krizman, & Kraus, 2015; Zuk et al., 2013). The benefits of music training in childhood are robust and extend into older age; older adults who received music training as children show a slower and less drastic cognitive decline and have better neural processing of speech in old age than older adults who never had music training (Parbery-Clark, Anderson, Hittner, & Kraus, 2012; Parbery-Clark, Strait, Anderson, Hittner, & Kraus, 2011; White-Schwoch, Carr, Anderson, Strait, & Kraus, 2013; for reviews, see Alain, Zendel, Hutka, & Bidelman, 2014; Strait & Kraus, 2014). These findings are only a few examples of the enormous body of work that has demonstrated the benefits of music training in childhood for development and aging.

Despite this body of work, little consideration is typically given to music when treating or studying children who are hard of hearing (HH). Although this body of work has focused largely on the benefits of formal and

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often intensive music training, a key precursor to music training is simply participating in and appreciating music activities. Little is known on the effect of hearing loss on music participation among children. Given the potential beneficial impact of music training, particularly on speech and language outcomes, it is important to know if hearing loss negatively impacts music participation among children. To that end, the primary purpose of this study was to determine whether hearing loss limits music participation among school-aged children with mild-to-severe hearing loss.

Research on music participation among children with normal hearing (NH) has identified factors that affect music participation. For example, school-aged children with lower socioeconomic status, lower academic abilities, lower musical self-esteem, and lower parental music involvement have lower rates of music participation than children with higher socioeconomic status, higher academic abilities, higher musical self-esteem, and higher parental music involvement (Albert, 2006; Klinedinst, 1991; Sichivitsa, 2007). Although it is unknown whether these limiting factors extend to children who are HH, it seems plausible that many of these factors are generalizable to the HH population. Beyond these general factors, however, children who are HH might face unique factors that limit their participation in music (World Health Organization, 2001).

Little research exists on how children with mild-to-severe hearing loss perceive music, and it is therefore difficult to assess the degree to which auditory perceptual deficits might limit music participation in this population. Children with hearing aids have more accurate perception of musical elements than children with cochlear implants (CIs), although neither group is as accurate as children with NH (Innes-Brown, Marozeau, Storey, & Blamey, 2013). However, despite the relatively poor perception of music among children who use CIs, children with CIs generally participate in music at similar rates as children with NH, although rates of participation among children with CIs are highly variable (Gfeller, 2000; Gfeller, Witt, Spencer, Stordahl, & Tomblin, 1999; for a review of music and CI use in children, see Gfeller, Driscoll, Kenworthy, & Van Voorst, 2011). Adult hearing aid users report that music is important to them and that they listen to music regularly, but they also report mixed benefit of hearing aid use and many problems with hearing aids during music listening (Feldmann & Kumpf, 1988; Leek, Molis, Kubli, & Tufts, 2008; Madsen & Moore, 2014). Mixed benefit of hearing aid use among adults for music listening is likely the result of many factors, including degree of hearing loss, duration of hearing loss, deficits in suprathreshold processing, and the limits of hearing aids for reproducing music with high fidelity (Arehart, Kates, & Anderson, 2011; Chasin, 2006, 2012, 2014; Chasin & Hockley, 2014; Chasin & Russo, 2004; Croghan, Arehart, & Kates, 2012, 2014; Hockley, Bahlmann, & Fulton, 2012; Kirchberger & Russo, 2016; Madsen & Moore, 2014; Madsen, Stone, McKinney, Fitz, & Moore, 2015; Moore, 2016; Mussoi & Bentler, 2015; Tan & Moore,

2008). Whether these findings extend to children who are HH and use hearing aids is unknown. Hearing aids have evolved since many of these studies were conducted, and larger chip sizes and other innovations may ameliorate some of these challenges. However, to the extent that these findings extend to children who are HH, it seems possible that hearing loss and the use of hearing aids affect music perception among children who are HH. This may, in turn, affect participation in music activities. On the other hand, children who are born with hearing loss or acquire hearing loss at a young age develop their music perception abilities with a hearing loss and may therefore develop compensatory music perception strategies. If this is the case, music participation may not be negatively impacted.

Limitations that result from hearing loss but are not directly related to the effect of hearing loss or hearing aid use on music perception might also limit music participation among children who are HH. Children who are HH experience greater fatigue than children with NH as a result of increased listening effort throughout the day (Hornsby et al., 2017; Hornsby, Werfel, Camarata, & Bess, 2014). It might be then that children who are HH are simply too tired at the end of the day to practice an instrument or attend a music performance. Children who are HH have also been shown to have poorer overall psychosocial well-being than children with NH (Wake, Hughes, Collins, & Poulakis, 2004). That is, children who are HH have been shown to have lower self-esteem, poorer social and emotional behavior, and reduced family activity and parent impact time (Wake et al., 2004). Because motivation, self-esteem, and parent influence have all been shown to affect music participation (Albert, 2006; Klinedinst, 1991; Sichivitsa, 2007), it might be expected that children who are HH have lower rates of music participation than peers with NH as a result of lower psychosocial well-being.

In summary, there are a number of plausible factors that might limit music participation among children who are HH. The primary purpose of this study was to determine whether hearing loss limits music participation among children who are HH compared to children with NH. To answer this question, this study investigated the following primary research questions:

1. Do children who are HH participate less frequently in music activities than children with NH?
2. Do children who are HH have less music training than children with NH?
3. Is participation in music activities as important to children who are HH as children with NH?
4. Does degree of hearing loss among children who are HH affect frequency of music participation, years of music training, or importance of music participation?
5. Is parent influence on music participation different for children who are HH and children who are NH?

Our overall hypothesis was that, due to possible restrictions of hearing loss and hearing aid use on music activities, children who are HH would participate in music activities less frequently, have fewer years of music training, and perceive music participation as less important than children with NH and that the degree of each of these effects would depend on hearing loss severity.

This study also aimed to gather descriptive information about music habits and preferences among children who are HH. Such data might motivate future research, inform the development of music-related hearing aid technologies, or improve counseling or clinical interventions in the future. To this end, this study investigated the following secondary research questions:

1. What are the common genres of recorded music listening, live music listening, and music performance and practice among children who are HH and children who have NH?
2. What are the common instruments practiced and ensembles played among children who are HH and children with NH?
3. How do children who are HH and children with NH listen to music (e.g., transducer, hearing aid use, hearing aid protection use)?

Method

Participants

Participants in this study were recruited from the larger Outcomes of School-Age Children who are Hard of Hearing (OSACHH) study. OSACHH is a continuation of the Outcomes of Children with Hearing Loss (OCHL) study (Moeller & Tomblin, 2015). Participants in OSACHH were children with NH and children with hearing loss and were recruited between the ages of 6 months and 7 years. The participants with hearing loss had a better ear pure-tone average between 25 and 75 dB HL, were not CI recipients, spoke English as their primary language, and had no significant cognitive or motor delays. Participants were recruited across three clinical sites: The University of Iowa, The University of North Carolina at Chapel Hill, and Boys Town National Research Hospital. For a complete description of participants and methods used in the OCHL study, see Tomblin et al. (2015).

Participants in the current study were children completing or who had recently completed fifth grade. Fifth grade was chosen because, in the United States, most children have had the opportunity to participate in school-based music lessons and ensembles, particularly orchestra and band, by the completion of fifth grade. Two cohorts of fifth-grade children were surveyed over 2 consecutive years for this study. Responses from the two cohorts were pooled for the analysis. Participants who completed the survey consented to the survey prior to completing it. Participants were not compensated for completing the survey.

This study was approved by the institutional review board at The University of Iowa (IRB 200809708).

The survey was delivered to participants primarily through Qualtrics, an online survey implementation platform. Alternatively, parents could choose to complete the survey via mail. After the initial request to complete the survey, parents who did not complete the survey within 1 month were sent a reminder request. A second and final reminder request was sent 2 weeks following the first. A total of 119 requests to participate were sent. Ninety-two of the Qualtrics links were activated. A total of 88 surveys were completed: three by mail and 85 via Qualtrics. The overall response rate was 74%. Sixty-seven surveys were completed by parents of children who are HH, and 21 surveys were completed by parents of children with NH. This ratio reflects the population of the larger study. The average time to complete the survey was 12 min. The average age of children who are HH was 11.7 years ($SD = 0.79$), and the average age of children with NH was 11.5 years ($SD = 0.76$). Age did not differ between groups, $t(84) = 0.96$, $p = .34$. The average maternal education level, which is a reliable indicator of socioeconomic status (Tomblin et al., 2015), was the completion of undergraduate education for both groups. Maternal education level did not differ between groups ($W = -0.81$, $p = .42$). Hearing loss severity results of the children who are HH, based on better ear pure-tone average, were 15 under mild (20–39 dB HL), 22 under moderate (40–54 dB HL), 21 under moderately severe (55–70 dB HL), eight under severe (70–90 dB HL), and one with unknown. Most of the children who are HH in this study were identified as HH through the newborn hearing screening program; 85% did not pass their newborn hearing screening. Three of the children who are HH did not have hearing aids; the remaining 64 did have hearing aids.

Survey

The survey was designed to answer the overarching question: What is the role of music in the life of a child who is HH? In order to address this question, the survey asked parents to answer questions across five major areas of interest: how often their child participated in music activities, how important participation in music activities was to them, what kinds of music they participated in, how they used their hearing aids while participating in music, and how other members of the child's family participated in music activities (see Appendix).

Face and content validity of the survey was determined through preliminary reviews by parents of children who are HH. A statistician reviewed the survey, although a formal assessment of validity was not performed. Question responses were categorical or ordinal. In total, the survey comprised 39 questions across three music domains.

1. *Recorded music.* Questions in this section asked parents to report on the frequency and importance of

their child's recorded music listening, the genres and formats of the recorded music their child listened to, and their child's use of hearing aids when listening to recorded music.

2. *Live music.* Questions in this section asked parents to report on the frequency and importance of the child's attending live music concerts, the genres and venues of live music concerts their child attends, and their child's use of hearing aids when attending live music concerts.
3. *Music practice and performance.* Questions in this section asked parents to report on the frequency and importance of their child's practicing and/or performing music either alone or in an ensemble, the genres of music practice and performance, the types of instruments their child plays, the extent of their child's music training and proficiency, and the use of hearing aids in their child's music practice and performance.

Survey questions were presented to parents by domain (recorded music, live music, and music practice and performance). To clearly answer the research questions, results are organized here by area of interest: frequency of music participation; years of music training; importance of music participation; effect of degree of hearing loss on music participation; effect of parent influence on music participation, genres, instruments, and ensemble types; and transducer, hearing aid, and hearing protection use during music participation. Group differences in participation were tested using the Mann–Whitney–Wilcoxon test. Effects of hearing loss severity on music participation were tested using the Kruskal–Wallis chi-square test. Effects of parental influence on music participation were tested using the Mann–Whitney–Wilcoxon test. All statistical tests were performed using R 3.5.2 (R Core Team, 2019).

Results

Frequency of Music Participation

Parents were asked about the frequency of their child's recorded music listening, live music listening, and individual and ensemble music practice. Summary findings of the frequency with which children participated in music activities are shown in Figure 1. Only one significant difference was found between frequencies with which children who are HH and children with NH participated in music activities. Nearly all children from both groups listened to music daily (87% of children who are HH, 95% of children with NH; $W = 765.5, p = .27$). Roughly half of both groups rarely attended live music performances (46% of children who are HH, 43% of children with NH), although many children from both groups attended live music performances at least weekly (36% of children who are HH, 48% of children with NH; $W = 788.5, p = .38$). Children who are HH and children with NH practiced an instrument with the same frequency. Seventy percent of children

who are HH and 58% of children with NH practiced an instrument at least weekly; 9% of children who are HH and 19% of children with NH never practiced an instrument ($W = 569, p = .24$). Children who are HH were significantly more likely to regularly play in an ensemble ($W = 339.5, p = .006$). Sixty-five percent of children who are HH played in an ensemble at least weekly, whereas only 43% of children with NH played in an ensemble at least weekly. Only 16% of children who are HH never played in an ensemble, whereas 43% of children with NH never played in an ensemble.

Years of Music Training

Parents were asked to report on the number of years their child had received music training. Participants' history of music training is shown in Figure 2. There were no significant differences between groups for years of music training ($W = 672, p = .83$). Sixty-six percent of children who are HH and 72% of children with NH had some amount of music training. Thirty-three percent of children who are HH had more than 3 years of music training, whereas 24% of children with NH had more than 3 years of music training.

Importance of Music Participation

Parents were asked about the importance of their child's recorded music listening, live music listening, and individual and ensemble music practice. Summary findings about the importance of music participation are shown in Figure 3. Listening to recorded music was important to children in both groups and was not different between groups. Listening to recorded music was very or extremely important to 72% of children who are HH and to 82% of children with NH ($W = 686.5, p = .86$). Listening to live music was less important to both groups and was not different between groups. Listening to live music was very or extremely important to 32% of children who are HH and to 34% of children with NH ($W = 670, p = .74$). Listening to live music or attending concerts was at least moderately important to more than half of the children in both groups. Fifty-one percent of children who are HH and 29% of children with NH considered practicing an instrument to be very or extremely important ($W = 596, p = .28$). Playing in an ensemble was very or extremely important to 40% of children who are HH but only to 19% of children with NH, a difference that trended toward but did not reach significance ($W = 359.5, p = .07$).

Effect of Degree of Hearing Loss on Music Participation

Frequency of music participation, years of music training, and importance of music participation were examined as a function of better ear pure-tone average among children who are HH. There was a significant effect of hearing loss severity on the frequency of recorded music listening, $\chi^2(3) = 10.41, p = .02$. The nature of this effect

Figure 1. Frequency of music participation. HH = hard of hearing; NH = normal hearing.

Figure 2. Years of musical training. HH = hard of hearing; NH = normal hearing.

was such that the few children who did not listen to music daily were significantly more likely to have greater severity of hearing loss. With so few children who did not listen to recorded music daily, however, this finding may not be practically meaningful. There was no effect of hearing loss severity on frequency of live music listening, $\chi^2(3) = 4.06$, $p = .26$; frequency of practicing an instrument, $\chi^2(3) = 1.68$, $p = .64$; or frequency of ensemble practice, $\chi^2(3) = 3.87$, $p = .28$. There was no effect of severity of hearing loss on importance of recorded music listening, $\chi^2(3) = 1.56$, $p = .67$; importance of live music listening, $\chi^2(3) = 0.51$, $p = .92$; importance of practicing an instrument, $\chi^2(3) = 0.59$, $p = .89$; or importance of ensemble practice, $\chi^2(3) = 2.44$, $p = .49$. There was not a significant effect of hearing loss severity on years of music training, $\chi^2(3) = 2.55$, $p = .47$.

Parent Influence

The final primary objective of this study was to determine whether the parents' music participation affected music participation among children and whether this was different for children who are HH and children with NH. Parents were asked whether they or another adult in the household currently practiced an instrument or had done so in the past and how important practicing an instrument was to them or another adult in the household. Children who are HH listened to recorded music more frequently if a parent also listened to music frequently, $\chi^2(3) = 17.17$,

Figure 3. Importance of music participation. HH = hard of hearing; NH = normal hearing.

$p < .001$. This was not true for children with NH, $\chi^2(1) = 0.11$, $p = .75$. Children who are HH were more likely to consider listening to recorded music important if a parent also considered it to be important, $\chi^2(3) = 40.95$, $p < .001$. This was not true for children with NH, $\chi^2(3) = 6.09$, $p = .11$. Children who are HH were more likely to have more music training if a parent played an instrument, $\chi^2(2) = 10.06$, $p = .006$, or if the parent considered playing an instrument to be important, $\chi^2(5) = 12.36$, $p = .03$. This was not true for children with NH, either for whether a parent played an instrument, $\chi^2(2) = 1.40$, $p = .49$, or for whether playing an instrument was important to a parent, $\chi^2(5) = 3.33$, $p = .65$.

Genres, Instruments, and Ensemble Types

To address the secondary objective of this study of describing the genres of music children who are HH and children with NH listen to and practice, parents were asked to report on the live and recorded genres of music their child listened to and the genres they practiced alone or in an ensemble. Summary findings of music genres are shown in Figure 4. Children in both groups listened to, practiced, and performed a variety of genres of music. The mean number of genres of recorded music listening was 4.14 for children who are HH and 3.76 for children with NH. For recorded music, children especially listened to pop; 90% of children who are HH and 86% of children with NH

listened to pop music. Other common genres of recorded music listening in both groups were rock (55% of children who are HH and 38% of children with NH), hip hop (36% of children who are HH and 33% of children with NH), country (33% of children who are HH and 52% of children with NH), musicals and soundtracks (36% of children who are HH and 38% of children with NH), and religious music (42% of children who are HH and 52% of children with NH). Children listened to fewer genres of live music. The mean number of live music genres was 2.15 for children who are HH and 2.5 for children with NH. The most popular live music genre for both groups was religious (61% of children who are HH and 60% of children with NH). Other common genres of live music listening were classical (31% of children who are HH and 30% of children with NH) and pop (20% of children who are HH and 35% of children with NH). The mean number of practice and performance genres was 2.65 for children who are HH and 1.52 for children with NH. For both groups, classical was the most common practice and performance genre (70% of children who are HH and 38% of children with NH). Pop (51% of children who are HH and 14% of children with NH) and religious (16% of children who are HH and 24% of children with NH) were also common genres for practice and performance.

Parents were asked to report on what types of instruments their child practiced and what types of ensembles they participated in. The types of instruments children

Figure 4. Music participation genres. HH = hard of hearing; NH = normal hearing.

played and ensembles they participated in are shown in Figure 5. Piano and voice were the most common instruments practiced. Thirty-three percent of children in both groups practiced singing (note that parents were asked to report voice only if the child was singing in preparation for a lesson or performance, not simply singing for fun). Only 16% of children who are HH and 19% of children with NH did not play any instrument. This result is perhaps somewhat incongruous with the rate of reported music training, which was relatively lower, although it is possible that some children practiced instruments but did not have any formal training. Choir and band were the most common ensembles children participated in. Forty-nine percent of children who are HH and 19% of children with NH participated in a choir, and 43% of children who are HH and 29% of children with NH participated in a band. Forty-three percent of children with NH did not play in an ensemble, whereas only 17% of children who are HH did not play in an ensemble.

Transducer, Hearing Aid, and Hearing Protection Use

The final secondary objective of this study was to describe how children listen to music. Parents were asked about what transducer their child typically used for recorded music listening, whether their child used hearing aids for music participation, whether their child had a music

program, whether their child used an assistive listening device for live music listening, and whether their child used hearing protection for live music listening. Children listened to music primarily through speakers: 66% of children who are HH and 81% of children with NH listened to music primarily through speakers. Most children who are HH listened to recorded music using their hearing aids: 57% of children who are HH primarily listened to recorded music through speakers while wearing hearing aids, 7% listened to recorded music through headphones placed over their hearing aids, and 4% streamed music directly to their hearing aids. Twenty-nine percent listened to recorded music with no hearing aids, either through speakers (9%) or with headphones or earphones (20%). Eighty-one percent of children who are HH wore hearing aids while practicing music. Seventy percent of children who are HH had hearing aids and wore them while playing in an ensemble. Sixty-seven percent of children who are HH had hearing aids but did not have a music program on them. Nine percent had a music program, although only 4% and 3% used it to listen to recorded music and live music, respectively. Twenty percent reported they did not know if their child had a music program on their hearing aids. Almost no children who are HH used any type of assistive listening device for live music listening: 1% reported use of a frequency modulation system. Fifty-seven percent of children who are HH wore hearing aids for live music listening. Ten percent of children who are HH wore hearing protection

Figure 5. Types of instruments and ensembles. HH = hard of hearing; NH = normal hearing; perc = percussion.

instead of hearing aids for live music listening. Ten percent of children with NH used hearing protection for live music listening.

Discussion

The primary objective of this study was to determine whether mild-to-severe hearing loss limits music participation among school-aged children. Contrary to our hypothesis, this study found that hearing loss generally did not limit music participation among school-aged children. Children who are HH listened to live and recorded music at the same rate as children with NH. Children who are HH had the same amount of music training and practiced an instrument at the same rate as children with NH. Children who are HH played in an ensemble more frequently than children with NH. Music participation was equally important to children who are HH and children with NH. Not only did music participation not differ between groups, degree of hearing loss had almost no effects on music participation for children who are HH, with the exception that children with more severe hearing loss were less likely to listen to recorded music daily. Finally, parent participation in music significantly affected music participation for children who are HH, but not for children with NH. Overall, for children in both groups, music participation was frequent and important.

Why hearing loss was not shown to be a limiting factor on music participation among children is not a question that can be answered with the data presented here. Clearly, music participation among children who are HH is not being limited by the proposed primary or secondary factors (auditory-perceptual or cross-domain) that motivated our hypothesis. One possible explanation for this is that most of the children who are HH in this study were identified through newborn hearing screening and were thus born with their hearing loss. These children developed their music capacities and interests with a hearing loss. They therefore lack a reference to what music sounds like with NH and may develop compensatory music perceptual strategies. This has been argued to be the case with children who use CIs, who show higher rates of music enjoyment than adults who use CIs (Driscoll et al., 2015). Another possibility is that parents of children who are HH may be conscious of the importance of auditory input and are therefore vigilant about encouraging their child to participate in music. That children who are HH were, in fact, significantly more likely to play in an ensemble may support this interpretation. Finally, in this study, parent participation in music significantly affected participation in music for children who are HH. This is consistent with research that shows children with CIs are more likely to consider music participation important if their family also places high value on music (Driscoll et al., 2015). Research on a different cohort of children who are

HH who have less musically involved parents might therefore yield different outcomes. Whatever the reasons for the high rate of music participation among children who are HH, the results of this study are likely to come as an encouraging finding for clinicians and parents of newly identified children who are concerned with the possible activity restrictions imposed by hearing loss and the use of hearing aids.

This study also aimed to describe what genres of music children listen to, practice, and perform; what types of instruments children play; and what types of ensembles they play in. Pop and rock were the most common genres of music listening among children in this study. This is consistent with research on children with CIs (Gfeller, Christ, Knutson, Witt, & Mehr, 2003; Gfeller et al., 2011). A suggested reason for this preference is that the rhythmic and lyrical elements of this type of music are more accessible to children with hearing loss (Gfeller et al., 2011). However, that both groups of children in this study listened mostly to these genres suggests that this preference may simply reflect the trend of all children to begin to prefer popular music genres by fourth grade (Greer, Dorow, & Randall, 1974; Radocy & Boyle, 1988). Religious music was the most common type of live music for both groups, suggesting that much of children's live music listening happens at religious services. The most common practice and performance genres were classical and pop, which is consistent with the typical repertoire practiced by young musicians. Common instruments and ensembles also seem consistent with general musical cultural norms in the United States, although little empirical data on current instrument and ensemble participation exist.

Children Who Are HH and Children With CIs

Direct comparisons between this study and studies of children with CIs should be made with caution due to differences in perception with CIs and hearing aids, survey questions asked, ages of participants, the overall number of users of each device, and potential cohort effects. However, examining how children who use hearing aids engaged with music in comparison to children with CIs may provide a more complete picture of how hearing loss affects music participation among children. School-aged children with CIs do listen to music; Gfeller et al. (1999) found that 63% of children with CIs listen to music. In the current study, 97% of children who are HH listened to music, and 86% of them listened to music daily. Thirty-two percent of children with CIs attend concerts (Gfeller et al., 1999). This study found that 46% of children who are HH attended concerts. A recent study showed that, among school-aged children with CIs, 37.5% took weekly music lessons (Driscoll et al., 2015). Gfeller et al. (1999) found that 20% of school-aged children who use CIs participate in music lessons. In the current study, 57% of children who are HH reported some amount of formal music training, and 74% of children who are HH reported practicing an instrument at least weekly. Taken together, these comparisons

may indicate that children who are HH and use hearing aids participate in music activities at greater rates than children with CIs. This may be expected, as children who are HH and use hearing aids demonstrate better perception of at least some musical elements (Innes-Brown et al., 2013; Looi, Gfeller, & Driscoll, 2012). However, this interpretation assumes that music engagement is highly controlled by music perception. The fact that both children who are HH and children who use CIs show more music enjoyment and report greater importance of music than children who identify as Deaf and do not have CIs or use hearing aids supports this (Darrow, 2006). However, the relationship between music perception and participation among children who are HH is unknown.

Limitations

Interpretation of these results should be tempered by a number of considerations. The parents of the children, not by the children themselves, completed the survey. Although it seems reasonable that parents would be accurate reporters of their child's interests and activities, parents' impression of their child's music activities and the importance of such music activities to the child may be biased. In particular, parents' perceptions of their child's music participation may be influenced by the role of music in their own lives, by the desire to show their children in the best light, or simply by poor recall. Therefore, caution is warranted when interpreting the more subjective responses in the survey, such as importance. The high rates of music participation noted in this study may have been influenced by the fact that both groups had higher-than-average maternal education levels and, therefore, likely higher socioeconomic status (U.S. Census Bureau, 2016). This was also true of the OCHL population generally (Tomblin et al., 2015). Higher socioeconomic status predicts higher music participation (Albert, 2006). The distribution of hearing loss severities in the sample in this study may also be problematic. No effect of hearing loss severity on listening to or playing live music was found in this study; however, this may be due to the relatively small number of children with severe hearing losses in this study. Because live music is often performed at relatively high levels (e.g., Chasin, 2012), children with less severe hearing loss may not need much, if any, amplification for the music to be audible. Therefore, hearing aid processing may have less of an impact on their music perception for live music. Children with severe hearing loss, however, still require gain to perceive live music and, therefore, may be expected to have different music outcomes for live music than children with less severe hearing loss. Children with severe hearing loss may also experience increased effects of compression when listening to recorded music, as the music is compressed both in the recording and by their hearing aids. This may be one reason why children with severe hearing loss in this study were less likely to listen to recorded music daily. More research on music participation and perception, particularly for this group of children, is needed. Finally,

all participants were between the fifth and sixth grade, which is early in a person's musical life. Many children who begin music lessons do not continue them. It is likely that rates of music participation observed in this study would differ from those among older children or young adults, when more advanced music skills are emphasized (Gfeller, Driscoll, Smith, & Scheperle, 2012).

Clinical Implications

This study found that children who are HH generally used their hearing aids for music listening and practice. However, few had a music program, and almost none used assistive listening devices for live music listening. School-aged children may be able to responsibly use a music program on their hearing aids, and fitting a music program may be considered for some children. Music programs typically aim to improve music fidelity by turning off or reducing features that may distort music signals, such as frequency compression or feedback management. Music programs have not been shown to be very effective for adults, but whether they might be effective for children is unknown (Madsen & Moore, 2014; Moore, 2016). Therefore, fitting children with a music program should be considered. Fitting a music program for a child should be done with consideration of the genres of music the child listens to or the type of instrument the child plays. Music, unlike speech, is very heterogeneous in terms of frequency spectrum and dynamics (e.g., Kirchberger & Russo, 2016). Hearing aid settings appropriate for one genre of music or one type of instrument may not be appropriate for another. Real ear measures can be performed using recorded music or while the child is practicing their instrument to ensure appropriate audibility of the music signal. Many problems with hearing aids for music listening, particularly distortion caused by the limited input dynamic range, cannot be fixed with programming changes. Because of this, counseling on how to improve music listening with hearing aids, such as turning music down and letting the hearing aids amplify the sound, covering the microphone ports with tape during a live concert, using an assistive listening device, or via other strategies, may be indicated (see Chasin, 2006). Finally, pediatric audiologists should counsel parents of children who are HH that music can and should be an important part of the auditory life of their child.

Conclusion

Children who are HH participate in music at the same rate as children with NH. Listening to and playing music were frequent and important to both groups. Degree of hearing loss generally did not affect music participation among children who are HH. Parent participation in music significantly affected music participation for children who are HH, but not for children who have NH, indicating that parent encouragement for music participation may be particularly important for children who are HH. Because

of the frequency and importance with which children who are HH participate in music, music should be a consideration during hearing aid fittings for children.

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Part 1: Music Appreciation: Recorded Music

Part 1 asks questions about recorded music, as you would listen to on your computer/phone/CD player/record player/etc., through speakers, headphones, earbuds, etc.

1. How often does your child listen to recorded music (e.g., listen to music on a stereo or radio, from a computer, phone, or music player, in the car, etc.)?
- ☐ Never
 - ☐ Rarely
 - ☐ Monthly
 - ☐ Weekly
 - ☐ Daily

If you answered *Never*, please describe briefly why your child does not listen to recorded music.

2. In what format(s) does your child usually listen to recorded music in? Check all that apply.
- ☐ CD
 - ☐ Streaming/Internet (Spotify, Pandora, YouTube, etc.)
 - ☐ Vinyl Records
 - ☐ mp3 (iTunes, Windows Media Player)
 - ☐ Radio
 - ☐ Other (specify: _____)
3. Which of the following best describes how your child listens to music?
- ☐ Child does not listen to music
 - ☐ Through speakers while wearing hearing aids
 - ☐ Through speakers (no hearing aids)
 - ☐ Headphones over hearing aids
 - ☐ Headphones or earbuds only (no hearing aids)
 - ☐ Streams directly to hearing aids using direct audio input or connective device
 - ☐ Unsure
4. Do you employ a volume restriction on your child's music device—either by output-limiting earbuds or headphones (such as KidzSafe) or setting a volume limit within the software or on the device?
- ☐ Child does not listen to music on a device
 - ☐ Yes
 - ☐ No
 - ☐ Unsure
5. What type(s) of recorded music does your child listen to? Check all that apply.
- ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical/Soundtrack
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ Unsure

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Survey of Music Appreciation and Participation Among School-Aged Children

6. What type(s) of recorded music does your child think sound best through hearing aids? Check all that apply.
- ☐ Child does not wear hearing aids
 - ☐ Child has hearing aids but does not listen to recorded music while wearing their hearing aids
 - ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical/Soundtrack
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ Unsure
7. Which of the following best describes your child's experience with using a music program on their hearing aids for listening to recorded music?
- ☐ Does not have hearing aids
 - ☐ Has hearing aids but does not have a music program on them
 - ☐ Has hearing aids with a music program but does not use it to listen to recorded music
 - ☐ Has hearing aids with a music program and uses it to listen to recorded music
 - ☐ Unsure if my child has a music program on their hearing aids
8. How would you rate the importance of listening to recorded music in your child's life?
- ☐ Not at all important
 - ☐ Slightly important
 - ☐ Moderately important
 - ☐ Very important
 - ☐ Extremely important
 - ☐ Unsure
9. How often do **you or another adult in the household** listen to recorded music (e.g., listen to music on a stereo or radio, from a computer, phone, or music player, in the car, etc.)?
- ☐ Never
 - ☐ Rarely
 - ☐ Monthly
 - ☐ Weekly
 - ☐ Daily
10. What type(s) of recorded music do **you, or another adult in the household**, listen to? Check all that apply.
- ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical/Soundtrack
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ Unsure

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Survey of Music Appreciation and Participation Among School-Aged Children

11. How would you rate the importance of listening to recorded music in **your, or another adult in the household's**, life?
- ☐ Not at all important
 - ☐ Slightly important
 - ☐ Moderately important
 - ☐ Very important
 - ☐ Extremely important
 - ☐ Unsure
12. How often do **your child's siblings** listen to recorded music (e.g., listen to music on a stereo or radio, from a computer, phone, or music player, in the car, etc.)?
- ☐ No siblings
 - ☐ Never
 - ☐ Rarely
 - ☐ Monthly
 - ☐ Weekly
 - ☐ Daily
13. What type(s) of recorded music do **your child's siblings** listen to? Check all that apply.
- ☐ No Siblings
 - ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical/Soundtrack
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ Unsure

Part 2: Music Appreciation: Live Music

Part 2 asks questions about listening to live music, such as at concerts, worship services, or other events.

14. How often does your child listen to live music or attend concerts?
- ☐ Never
 - ☐ Rarely
 - ☐ Monthly
 - ☐ Weekly
 - ☐ Daily

If you answered *Never*, please describe briefly why your child does not listen to live music or attend music concerts.

15. Where does your child listen to live music or attend concerts? Check all that apply.
- ☐ Concert Hall/Theater
 - ☐ Church
 - ☐ School/Colleges
 - ☐ Community Space
 - ☐ Other (specify: _____)

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Survey of Music Appreciation and Participation Among School-Aged Children

16. What type(s) of live music concerts or performances does your child attend? Check all that apply.
- ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical/Soundtrack
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ Unsure
 - ☐ None
17. What type(s) of live music does your child think sound best through their hearing aids? Check all that apply.
- ☐ Child does not wear hearing aids
 - ☐ Child has hearing aids but does not listen to live music while wearing their hearing aids
 - ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical/Soundtrack
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ Unsure
18. Which of the following best describes your child's experience with using a music program on their hearing aids for listening to live music?
- ☐ Does not have hearing aids
 - ☐ Has hearing aids but does not have a music program on them
 - ☐ Has hearing aids with a music program but does not use it to listen to live music
 - ☐ Has hearing aids with a music program and uses it to listen to live music
 - ☐ Unsure
19. Which best describes your child's use of hearing aids and hearing protection at concerts?
- ☐ Does not have hearing aids and does not wear earplugs
 - ☐ Does not have hearing aids but does wear earplugs
 - ☐ Has hearing aids but does not wear them at concerts
 - ☐ Has hearing aids but wears earplugs at concerts
 - ☐ Has hearing aids and wears them at concerts
 - ☐ Unsure

20. Does your child ever use any of the following devices when attending a concert? Check all that apply.

- ☐ FM System
- ☐ Telecoil Loop
- ☐ Infrared System
- ☐ Remote microphone
- ☐ Other assistive listening device (specify: _____)
- ☐ None
- ☐ Unsure

21. How would you rate the importance of listening to live music or attending concerts in your child's life?

- ☐ Not at all important
- ☐ Slightly important
- ☐ Moderately important
- ☐ Very important
- ☐ Extremely important
- ☐ Unsure

Part 3: Instrument and Ensemble Participation

Part 3 asks questions about participation in musical activities, like music lessons, school music programs, and ensembles.

22. Does your child's school offer any of the following programs? Check all that apply.

- ☐ Band
- ☐ Orchestra
- ☐ Choir
- ☐ General music class
- ☐ Other (specify: _____)
- ☐ Unsure

23. How often does your child practice/play a musical instrument or sing (singing in preparation for a lesson or performance, not just singing for fun) at home?

- ☐ Never
- ☐ Rarely
- ☐ Monthly
- ☐ Weekly
- ☐ Daily

24. What kind of instrument does your child play? Check all that apply.

- ☐ Sing
- ☐ Piano
- ☐ Guitar
- ☐ Bass Guitar
- ☐ Strings (violin/viola/cello/string bass)
- ☐ Drums/Percussion
- ☐ Woodwind (flute/clarinet/saxophone/bassoon/oboe)
- ☐ Brass (trumpet/trombone/euphonium/tuba)
- ☐ Other (specify: _____)

25. How long has your child taken music lessons?

- ☐ Never
- ☐ Less than one year
- ☐ Between one year and three years
- ☐ More than three years

26. How would you rate your child's musical ability?

- ☐ Not at all musical
- ☐ Slightly musical
- ☐ Moderately musical
- ☐ Very musical
- ☐ Extremely musical
- ☐ Unsure

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27. What kind(s) of music does your child play? Check all that apply.
- ☐ Classical
 - ☐ Pop
 - ☐ Rock
 - ☐ Hip Hop/Rap
 - ☐ Jazz
 - ☐ Heavy Metal
 - ☐ Indie
 - ☐ Singer-Songwriter
 - ☐ Country
 - ☐ Dance/Electronic
 - ☐ Blues
 - ☐ Folk
 - ☐ Musical
 - ☐ Religious
 - ☐ Other (specify: _____)
 - ☐ None
 - ☐ Unsure
28. How would you rate the importance of playing an instrument or singing in your child's life?
- ☐ Not at all important
 - ☐ Slightly important
 - ☐ Moderately important
 - ☐ Very important
 - ☐ Extremely important
 - ☐ Unsure
29. Does your child ever make up or compose their own music to sing or play on their instrument?
- ☐ Yes
 - ☐ No
 - ☐ Unsure
30. Which of the following best describes your child's experience with playing their instrument or singing while wearing hearing aids?
- ☐ Has hearing aids but does not wear them while singing or playing instrument
 - ☐ Has hearing aids and wears them while singing or playing instrument
 - ☐ Does not have hearing aids but does sing or play an instrument
 - ☐ Does not have hearing aids and does not sing or play an instrument
 - ☐ Unsure
31. What type(s) of ensemble does your child play in? Check all that apply.
- ☐ Choir
 - ☐ Band
 - ☐ Orchestra
 - ☐ Jazz Band
 - ☐ Rock Band
 - ☐ Chamber Ensemble or Small Group
 - ☐ Religious worship group
 - ☐ Other (specify: _____)
 - ☐ Unsure
32. Where does your child usually play with their ensemble? Check all that apply.
- ☐ School
 - ☐ Church
 - ☐ Community Group
 - ☐ Other (specify: _____)
 - ☐ Unsure

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33. How often does your child rehearse or practice with an ensemble?
☐ Never
☐ Rarely
☐ Monthly
☐ Weekly
☐ Daily
34. Which of the following best describes your child's experience with practicing with their ensemble while wearing hearing aids?
☐ Has hearing aids but does not wear them while practicing with ensemble
☐ Has hearing aids and wears them while practicing with ensemble
☐ Does not have hearing aids but plays in an ensemble
☐ Does not have hearing aids and does not play in an ensemble
☐ Unsure
35. How would you rate the importance of participating in their musical ensemble in your child's life?
☐ Not at all important
☐ Slightly important
☐ Moderately important
☐ Very important
☐ Extremely important
☐ Unsure
36. Does your child plan on continuing to play their instrument and/or participate in an ensemble for the foreseeable future?
☐ Yes
☐ No
☐ Unsure
37. Do **you, or another adult in the household**, play an instrument?
☐ Never played an instrument
☐ Currently plays an instrument
☐ Played an instrument in the past, but not currently
☐ Unsure
38. How would you rate the importance of playing an instrument in **your, or another adult in the household's**, life?
☐ Not at all important
☐ Slightly important
☐ Moderately important
☐ Very important
☐ Extremely important
☐ Unsure
39. Do any of **your child's siblings** play an instrument?
☐ Child has no siblings
☐ Yes
☐ No
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