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Research Note

Factors Influencing Hearing Aid Use in the Classroom: A Pilot Study

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Purpose: This pilot study examined factors influencing classroom hearing aid use in school-age children with hearing loss.
Method: The research team visited classrooms of 38 children with mild-to-moderate hearing loss (Grades 1–7) on 2 typical school days, twice per day, to document hearing aid use. In addition, parents reported the number of hours their children used hearing aids at school.
Results: Nearly 24% of children were observed not wearing their hearing aids in the classroom on either observation day. Both grade level and degree of hearing loss appeared to affect hearing aid use. Children in Grades 5–7 and those with milder hearing losses were less likely to wear hearing aids. Overall, parents accurately reported classroom hearing aid use; however, those with children in Grades 5–7 were less accurate than those with children in earlier grades.
Conclusions: These preliminary results suggest that children with milder hearing loss and those in Grades 5–7 are at increased risk for reduced hearing aid use in the classroom. Also, parents of school-age children in these later grades are less accurate reporters of classroom hearing aid use compared to parents of children in earlier grades.

Audiologists generally recommend that children with hearing loss utilize prescribed hearing technology during all waking hours. A recent report from a multisite study reported hearing aid use time in 272 children with hearing loss, ages 6 months to 7 years, using parent estimates and data logging records (Walker et al., 2013). Data logging reports from 133 of the original 272 children revealed that average daily hearing aid use time was 8.3 hr per day, with some children showing no use of hearing aids and others showing as much as 16 hr of use per day. Such results suggest that some children are not following the recommendation of full-time hearing aid use during the first 7 years of life.

Walker et al. (2013) also used parent-estimated daily use time to investigate factors that influence hearing aid use in these same 272 children. Children who were older, children who had moderate-to-severe hearing loss, and children whose mothers completed college had parents who reported more hours of daily hearing aid use than younger children with mild-to-moderate hearing loss and those with mothers who did not complete college. Such findings provide valuable information regarding factors that may place children at risk for not using hearing aids consistently from birth through 7 years of age. Research that examines trends of daily hearing aid use, as well as factors influencing this use in children with hearing loss who are older than 7 years of age, is extremely limited.

As children grow older, factors other than those addressed by Walker et al. (2013) may influence whether the child wears hearing aids. One potential factor that might contribute to school-age children wearing hearing aids less than full time could be a lack of perceived benefit due to hearing aid malfunction. Several early studies documented that hearing aid malfunction rates can occur in 27%–60% of devices used by school-age children with hearing loss (Bess, 1977; Gaeth & Lounsbury, 1966; Riedner, 1978). These studies provide information regarding a potential reason for limited use of early generations of hearing aid technology. However, these studies do not provide sufficient information regarding the ages of children represented in their samples, making it difficult to generalize their results to today's population of school-age children with hearing loss.

Another factor that might influence hearing aid use beyond 6 years of age is the changing educational environment as children continue through primary and into secondary school. For instance, full-day academic instruction often requires children to spend 6–8 hr in classrooms with 15–30 other children and only one or two teachers. As children advance through primary school, they often receive

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instruction from multiple teachers in multiple classrooms. Because this educational structure yields an environment in which the teacher may have increased difficulty monitoring the use of hearing assistive technology for one of his or her many students, the responsibility to maintain consistent hearing aid use is generally transferred to the child. This may occur before the child is responsible enough to take on the role of hearing aid management. During this time, social pressure to "fit in" with peers with normal hearing may also negatively influence how the child shoulders this new responsibility. For instance, Keilmann, Limberger, and Mann (2007) found children with hearing loss between the ages of 6 and 11 years to show less self-confidence than their peers with normal hearing as they reach higher grades. This reduction in self-confidence is likely a result of increased social pressure as children advance through primary school (Elkayam & English, 2003). Low levels of self-confidence have been shown to result in reduced use of prescribed eyeglasses in school-age children (Castonon Holguin et al., 2006; Dias, Hyman, Manny, Fern, & COMET Group, 2005). It is reasonable to posit that children in this age range who have hearing loss might show a similar decline in consistency of hearing aid use that is reflective of this reduction in self-confidence.

Understanding hearing aid use patterns in school-age children is a first step in beginning to examine factors that might place children at risk for inconsistent hearing aid use in the classroom. The primary purpose of this pilot study was to document the use of hearing aids during regular classroom instruction in a small sample of children with mild-to-moderate hearing loss between the ages of 6 and 12 years. In addition, we explored the impact of factors known to affect hearing aid use in a younger population of children (degree of hearing loss and grade level of the child) on hearing aid use in this sample of school-age children. Last, we examined the agreement of parent report and direct observations of hearing aid use in the classroom. The results of this study will help inform future research examining other factors influencing hearing aid use in school-age children.

Method

Participants

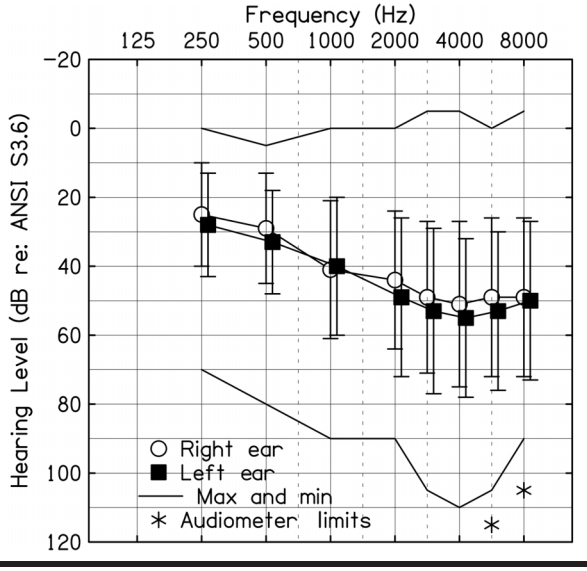
Children with mild-to-moderate hearing loss and their parents were recruited from Vanderbilt's pediatric audiology clinics and school systems throughout the middle Tennessee area to participate in a larger, ongoing study examining listening effort and fatigue in school-age children with hearing loss. Mild hearing loss was defined as a pure tone average (PTA; thresholds at 0.5, 1.0, and 2.0 kHz) between 20 and 40 dB HL or thresholds greater than 25 dB HL at two or more frequencies above 2.0 kHz. Moderate hearing loss was defined as a PTA of 45–70 dB HL in the better ear. Children exhibiting a conductive component were included in the data set as long as the sensorineural hearing loss fit the above criterion and the hearing loss was stable (not fluctuating). Hearing thresholds were confirmed within the mild-to-moderate hearing loss range upon study entry. Children qualified for the larger study if they had no diagnosis of autism spectrum disorder or cognitive impairment as reported by the parents. All children spent at least 2 hr per day in a general education classroom. Participants volunteered their time and were compensated for other aspects of the more extensive, ongoing study; however, no compensation was provided for parent responses or the classroom observations reported here. Informed consent and assent were obtained for all participants in accordance with Vanderbilt University Institutional Review Board policies.

Children in this data set included 20 girls and 18 boys who were between 6.5 and 12.92 years (M = 10.11 years, SD = 1.95 years). All children included in this data set had personal hearing aids recommended by an audiologist. Children with cochlear implants and children with unilateral hearing loss were not included. Figure 1 shows a composite audiogram for the 38 children discussed here.

Procedure

Hearing aid use was documented in two ways: (a) parent report and (b) classroom observation. Upon study entry, parents were asked to estimate the number of hours per day their child uses hearing aids at school. Although parents were aware that research assistants would be visiting their child's classroom for another aspect of the study, they were not informed that their child's hearing aid use/nonuse would

Figure 1. Average thresholds for left (filled squares) and right (open circles) ears of children included in this data set. Solid lines represent minimum (min) and maximum (Max) thresholds recorded from individual children. Asterisks indicate "no response" obtained at the limits of the audiometer at those frequencies for at least one participant. Error bars represent standard deviations. ANSI = American National Standards Institute.

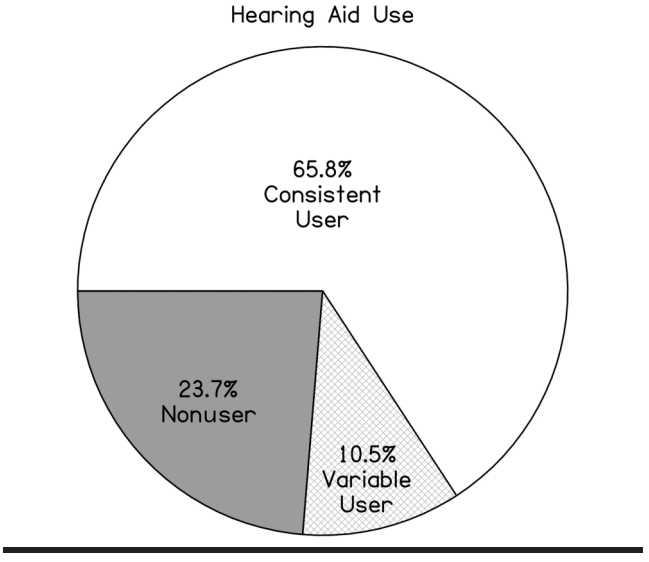


be documented. Classroom observations of hearing aid use were obtained as part of a larger, ongoing project examining listening effort and fatigue in school-age children with hearing loss (see Bess, Gustafson, & Hornsby, 2014, for an overview of this larger project). Research assistants visited each participant's classroom on two typical school days (e.g., no fire alarm, no standardized testing) at approximately 10:00 a.m. and 2:00 p.m., for a total of four 10-min observations. During these observations, the research assistant documented whether the child was wearing his or her hearing aids. Observation days occurred within the same week for 28 of the 38 children or within 2 weeks for 37 of the 38 children. One child's second observation occurred 8 weeks after the first observation because of complications with scheduling (i.e., school closings due to inclement weather, illness, and a family emergency). Children were classified into one of three groups on the basis of these four observations. Children who were not observed wearing hearing aids during any of the four observation periods were categorized into the *nonuser* group. Those children observed one, two, or three times wearing hearing aids were considered *variable users*. If children were observed wearing hearing aids during all four observation periods, they were considered *consistent users*.

Results

Figure 2 shows the proportion of children in each of the three hearing aid use groups. The majority of children were observed wearing hearing aids during all four classroom observation periods; however, nine children (23.7%) were not observed wearing hearing aids during any of the classroom observations. A one-way analysis of variance (ANOVA) showed no significant effect of gender on hearing aid use in the classroom, $F(2, 35) = 0.021$, $p = .979$, $\eta_p^2 = .001$).

Figure 2. Proportion of children in each hearing aid use group based on classroom observations.



Degree of Hearing Loss

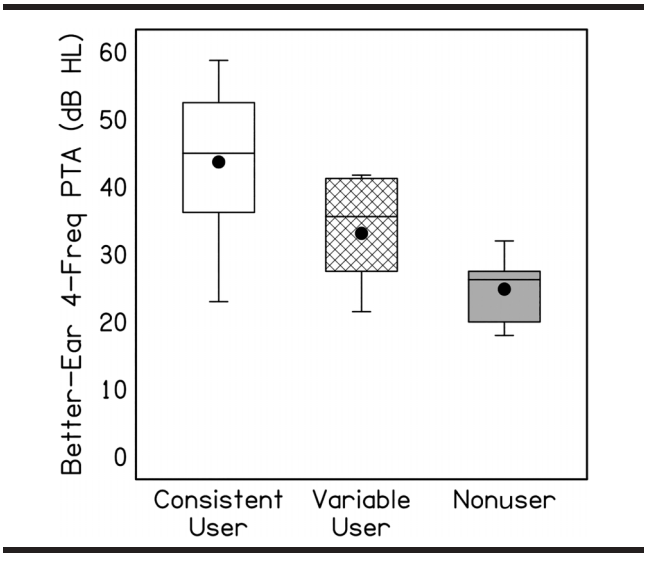
To examine the effect of degree of hearing loss on observed classroom hearing aid use, we conducted an ANOVA on the four-frequency, better ear PTA (500, 1000, 2000, and 4000 Hz; 4-PTA) among the three hearing aid use groups (nonuser, variable user, and consistent user). The ANOVA revealed significant differences in better ear 4-PTAs as a function of hearing aid group, $F(2, 35) = 10.897$, $p < .001$, $\eta_p^2 = .384$. Tukey's honestly significant difference post hoc test revealed hearing thresholds of the nonuser group to be significantly better than thresholds of the consistent user group ($p < .001$; see Figure 3).

Grade Level

Grade levels of participants ranged from first through seventh; six children repeated at least one grade on the basis of parent report. Because of anecdotal reports from children and parents, we felt that social pressure was a likely contributor to whether school-age children decided to wear their hearing aids during a typical school day. Therefore, we examined grade level, rather than chronological age, to determine whether classroom hearing aid use differed across the wide developmental range included in this data set.

To examine the effects of grade level on hearing aid use, we first confirmed there was no relationship between grade level and better ear 4-PTA ($r = -.043$, $p = .796$). Next, because degree of hearing loss varied among hearing aid

Figure 3. Better-ear four-frequency (Freq) pure-tone average (PTA) (dB HL) in each hearing aid use group based on classroom observations. Box plots represent median (solid middle line) and interquartile range (25th and 75th percentile). Error bars represent the 5th and 95th percentile for each group. Filled circles represent mean data for each group.



use groups, we used the better ear 4-PTA as a covariate in an ANOVA examining grade level as a function of hearing aid group. A significant effect of hearing aid use group was present, $F(2, 34) = 6.753$, $p < .05$, $\eta_p^2 = .265$. Post hoc pairwise comparisons revealed the consistent use group to have a lower mean grade level (3.323) than the variable (5.999, $p < .05$) and nonuser (5.882, $p < .05$) groups. The variable and nonuser groups showed no difference in mean grade level ($p = .910$).

Figure 4 shows the number of children categorized into each hearing aid use group for all seven grade levels. Gross patterns of directly observed hearing aid use presented in this figure show mostly consistent observations of hearing aid use for children in Grades 1–4. A mixed pattern of hearing aid use was observed directly for those in Grades 5–7. On the basis of this observation, we divided children into two grade groups (1–4 and 5–7) for subsequent analyses. Of the 19 children in Grades 1–4, 17 (89.5%) were observed wearing hearing aids during all four classroom visits (consistent users). On the other hand, only eight children (42%) in Grades 5–7 were observed to be consistent users. A Mann–Whitney rank-sum test performed with grade group (1–4 vs. 5–7) as the between-groups factor confirmed that this difference was significant ($U = 99.00$, $p < .05$, two tailed).

Agreement of Parent Report and Observation

Table 1 shows the number of children in each hearing aid use group according to parent report and classroom observation. Overall, parent report of their child's hearing aid use/nonuse in the classroom agreed with our observations ($r = .744$, $p < .001$). A Mann–Whitney rank-sum test comparing children in Grades 1–4 and 5–7 revealed significant differences in agreement of parent report and observation of hearing aid use ($U = 123.50$, $p < .05$, two tailed). For children in Grades 1–4, parents accurately reported hearing aid use/nonuse 95% of the time. Parents of children in Grades 5–7 were less accurate, with only 63% accurately reporting use/nonuse. All five parents who reported their child to be a nonuser were correct—their child was not observed wearing hearing aids during classroom visits. Three of the nine children (33%) in the nonuser group had parents who reported them as using hearing aids during the entire school day.

Figure 4. Number of children in each hearing aid use group based on classroom observations for each grade level.

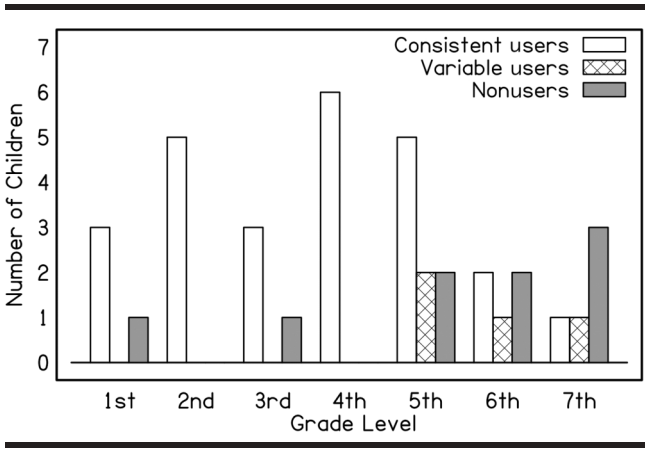


Table 1. Total number of children within each hearing aid use group according to parent report and researcher observation.

Hearing aid use	Consistent user	Variable user	Nonuser
Reported	32	1	5
Observed	25	4	9

Discussion

The primary purpose of this pilot study was to document hearing aid use for school-age children with mild-to-moderate hearing loss during classroom instruction. Our observations indicate that the majority of children were wearing hearing aids during each of our observations; however, almost one quarter of the children in this sample were not observed wearing hearing aids during regular classroom instruction. A secondary purpose of this pilot study was to examine whether factors known to influence hearing aid use in young children might also influence hearing aid use by school-age children in the classroom. Preliminary findings showed that degree of hearing loss and grade level are likely factors that influence classroom hearing aid use/nonuse for children with mild-to-moderate hearing loss. To be specific, children in Grades 5–7 and those with less severe degrees of hearing loss might be at risk for reduced hearing aid use in the classroom. Our results are consistent with previous studies in younger children who show more consistent hearing aid use in children with more severe hearing loss (Muñoz, Preston, & Hicken, 2014; Walker et al., 2013). Our results of reduced hearing aid use in higher grade levels expand upon findings from earlier studies that have reported an increase in hearing aid use time as children age from 6 months to 7 years (Moeller, Hoover, Peterson, & Stelmachowicz, 2009; Walker et al., 2013). Because the children in our study were somewhat older and overlap with the age range of children reported in previous studies by only 2 years, these divergent patterns in hearing aid use are not surprising. It is likely that hearing aid use time increases as children age from early childhood into primary school, but that use time might decrease as children transition from elementary to middle school classrooms. Combined with previous results, our findings suggest that increased monitoring of daily hearing aid use is especially important for children with milder hearing loss and those who are in Grades 5 and above.

Another purpose of this study was to determine whether parent reports of their child's classroom hearing aid use agreed with our observations. Our results showed that parents were generally accurate in reporting the hearing

aid use/nonuse of their children; however, parents of children in Grades 5–7 were more likely to overestimate their child's classroom hearing aid use than those with children in earlier grades. This information is useful to audiologists working with children in these grades. For instance, relying on the parent report to determine whether the child is using the hearing aids at school may not yield an accurate portrayal of the child's typical classroom listening strategies. For children in these higher grade levels, it may be especially beneficial for audiologists to consider using data logging technology as a tool to obtain an accurate report of hearing aid use and for counseling purposes among the children, parents, and teachers. Of course, data logging technology provides limited information regarding the details of hearing aid use. Data logging has also been found to have a varied effect on increasing a child's hearing aid use time when used as a counseling tool for families of younger children (Muñoz et al., 2014). Future studies are needed to determine whether data logging can be used successfully to increase hearing aid use in this population.

To our knowledge, this is the first study to systematically examine factors influencing hearing aid use of school-age children in the classroom. Although these results provide valuable information for clinicians, teachers, and families of children with hearing loss regarding two risk factors for reduced hearing aid use at school, there are several limitations that should be considered when interpreting these results and that should be addressed in future studies. For instance, observations were brief (10 min) and anticipated by all parties—teachers and children knew that researchers were visiting classrooms on the day of observations. This may have influenced the consistency with which some children used hearing aids and the awareness of teachers regarding hearing aid use. Future studies would benefit from longer and randomly assigned observation periods to provide a more naturalistic view of typical classroom hearing aid use. In addition, the factors influencing hearing aid use examined in this pilot study were selected on the basis of their significant effect on hearing aid use in young children reported in previous studies. In addition to degree of hearing loss and age, Walker et al. (2013) found that maternal education influenced the hearing aid use time reported by the parent. The small sample size of this pilot study did not yield sufficient statistical power to examine the influence of maternal education on observed hearing aid use in school-age children. Our small sample of children also came from families who might be considered highly motivated because all received audiologic services at a large university medical center and were enrolled in an extensive research study requiring multiple research visits. Future studies should consider a larger catchment of children from diverse areas and backgrounds to yield more generalizable results.

It is important to note that this study did not address reasons underlying use and nonuse of hearing aids in the classroom; neither did it explore factors contributing to hearing aid use and nonuse outside of those previously explored in a younger population. Future studies should conduct listening checks to ensure devices are functioning adequately, and ask children to discuss the reason(s) they are or are not using hearing aids. Care was taken in this pilot study not to schedule observation dates when hearing aids were out for repair (this was confirmed prior to each scheduled observation via a phone call with the parent); however, it is possible that the hearing aid(s) required repair but the child or parent was unaware of the malfunctioning device(s). It is also possible that children in the variable or nonuser groups may have stopped using their hearing aids during an observation day because of an unforeseen device malfunction. This was the case for at least one child in the variable user group who was not wearing a hearing aid on an observation day due to a dead battery and no available replacement.

It is also unclear whether children in the variable and nonuser groups would have been considered consistent users at an earlier age. Children in these two groups might have exhibited consistent hearing aid use early in life, but reduced the amount of hearing aid use as they advanced in grade level. Longitudinal data are needed to document hearing aid use patterns as children advance from early childhood through primary school and into adolescence. These data might allow us to identify more specific factors that influence whether children consistently use their hearing aids during all levels of their education. There is a paucity of data addressing potential negative consequences of reduced hearing aid use during later stages of childhood. This type of research has the potential for motivating families, teachers, and physicians to encourage children to wear their hearing aids on a regular basis in school.

It is important that future studies examine factors in addition to the functionality of the devices that might influence hearing aid use in the classroom. For instance, assessments of psychosocial barriers to device use (e.g., peer pressure, self-esteem) might contribute to our knowledge of why school-age children decide not to wear their hearing aids. Educational factors may also influence device use in school-age children. It is not known at present whether factors such as consistent access to a Teacher of the Deaf, time spent in a general education classroom, or a classification of deaf/hard of hearing on an individualized education program would have an effect on the likelihood of full-time use of hearing aids. In addition, school-age children with hearing loss are often fit with other hearing-assistive technology (e.g., FM systems) in addition to personal hearing aids to help ameliorate the negative effects of poor classroom signal-to-noise ratios. It may be that children who have access to these additional technologies are more likely to wear their hearing aids consistently because the combination of hearing aid and FM technology is known to provide significant benefit over the use of hearing aids alone (Hawkins, 1984).

Last, it is interesting to note that children with mild hearing loss continue to show academic difficulties compared to their peers with normal hearing and are more often reported at increased educational risk by teachers compared to their peers with more moderate-to-severe hearing loss (Most, 2004, 2006). The limited use of hearing aids during classroom instruction observed in children with mild hearing

loss may play a role in their educational challenges. For example, the limited hearing aid use observed for children with mild degrees of hearing loss would have had a direct impact on their ability to use a personal FM system routed through the hearing aid. Future research should explore the potentially cascading impact of reduced hearing aid use observed in this population.

The overall goal of this research was to characterize classroom hearing aid use patterns in children with mild-to-moderate hearing loss and to explore whether risk factors known to influence hearing aid use in younger children also influence hearing aid use in school-age children. The results of our pilot study suggest that hearing aid use in the classroom is influenced by degree of hearing loss and grade level, with children in later grades and those having milder hearing loss being at risk for inconsistent hearing aid use. Audiologists and other service providers in the schools should be particularly cognizant of these hearing aid use trends when serving children beyond Grade 4 because our findings also suggest that parents may overestimate classroom hearing aid use in this group. Care should be taken to provide counseling to families and support for teachers of children entering these grade levels, in particular those with milder degrees of hearing loss.

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