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Consistency of Hearing Aid Use in Infants with Early-Identified Hearing Loss

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Abstract

Purpose—This study was designed to examine the consistency of hearing aid use by infants. A goal was to identify maternal, child and situational factors that affected consistency of device use.

Method—Maternal interviews were conducted using a non-validated structured interview (*Amplification in Daily Life Questionnaire*), which included five-point Likert scale items and open-ended questions. Participants were mothers of seven infants with mild to moderately-severe hearing loss, who were enrolled in a longitudinal study. Data were collected at four intervals (10.5–12, 16.5, 22.5 and 28.5 months of age).

Results—Consistency of amplification use was variable at early ages, but improved with age. By 28.5 months of age, toddlers used amplification regularly in most settings. Selected daily situations (e.g., car, outdoors) were more challenging for maintaining device use than contexts where the child was closely monitored. Only two families established early, consistent full time use across all contexts examined. Qualitative results were used to identify familial, developmental and situational variables that influenced the consistency of infant/toddler device use.

Conclusion—Families may benefit from audiological counseling that acknowledges the multi-faceted challenges that arise. Audiologists can work in partnership with families to promote consistent device use across a variety of daily situations.

Introduction

As a result of newborn hearing screening initiatives, infants with hearing loss (HL) are identified at earlier ages (Harrison, Roush & Wallace, 2003; Vohr, Carty, Moore & Letourneau, 1998) and receive amplification devices at earlier developmental stages (Uus & Bamford, 2006) than in the past. Pediatric audiologists are eager to fit amplification as early in life as possible to optimize infants' auditory experiences and foster auditory foundations for language learning (Sininger, Doyle & Moore, 1999). Optimal benefit from amplification may only be achieved with consistent and appropriate hearing aid use. Although the issue of parental monitoring of children's hearing aid use was studied in the past (Blair, Wright & Pollard; 1981, Elfenbein, 1994), less is known about hearing aid adjustment processes in this new generation of families who have benefited from newborn hearing screening and early intervention. The goal of this study was to examine the consistency of hearing aid use longitudinally over the second year of life in a group of infants with mild to moderately-severe hearing loss. Parental interviews were used to examine factors that influenced the consistency of device use.

Previous studies suggested that parental affective responses to diagnosis and hearing aid fitting play a role in early device adjustment (Sjoblad, Harrison, Roush & McWilliam, 2001). Sjoblad et al. (2001) administered a survey to 213 parents and found that in the early stages of hearing aid use, parents expressed three primary areas of concern about amplification: how to maintain devices; device appearance; and potential benefit for the infant/child. In addition to common reactions to diagnosis (e.g., guilt, denial, Luterman, 1996), affective responses included: initial worry that the child may not be accepted socially after hearing aids were fitted; and concerns about impact of hearing loss/aids on development. A key finding was that only 25% of parents responding to the survey perceived that the benefit the child received matched their expectations. This suggested that audiologists need to be “supportive, but realistic in describing the potential benefits of hearing aids” to parents. Unrealistic expectations could influence parental perceptions of benefit and compliance with device use in the face of challenges. It also may be the case that parents encounter difficulty recognizing subtle changes infants make in response to amplification, especially early in development. There is a need to understand how parents of young infants with hearing loss judge hearing aid benefit. Studies that focus on parental attitudes and their influence on adjustment to devices are helpful in guiding audiological counseling practices. However, there also is a need to understand child and situational factors that may complicate the parents’ role in maintaining consistent hearing aid use. A clear understanding of these factors could alter the type of instructions and support given to parents.

Results of previous studies suggested that many parents of children with hearing loss (HL) lack sufficient understanding of hearing aids (Blair, Wright & Pollard, 1981), and that parents of preschoolers with HL did not perform daily hearing aid checks (Elfenbein, 1994). Parents who did use appropriate equipment to check amplification often missed primary signs of hearing aid malfunction (Elfenbein, 1994), which could have a negative impact on the audibility of speech (Smedley & Plapinger, 1988). Collectively, these studies suggested a need for more comprehensive educational materials and strategies for families. Contemporary guidelines (AAA, 2003; JCIH, 2007) stress the importance of the establishing parent-professional partnerships and comprehensive orientation and training related to amplification. There also is a need to understand if the situation is improving for families as a result of these efforts.

In a more recent study, 28 experienced parents were surveyed (Martin, Stroud & Nicholson, 2005) as a part of a quality improvement initiative related to hearing aid adjustment processes for families. Parents reported that their greatest concerns involved acceptance of the hearing aids by their young children and their fear of losing or breaking hearing aids. Parents indicated that they would have valued additional information or support from the audiologist in the following areas: (a) emotional support (contacts with other families, patience with the process); (b) accessories (for safety, retention, checking devices); and (c) awareness of potential complications (changes in hearing thresholds due to middle ear effusion or progressive hearing loss). The most frequent advice these parents had to share with other parents was the importance of “perseverance” with devices. One mother stated, “...You really have to be somewhat determined to make your child wear the hearing aids frequently so they get used to them and want to wear them (p. 11).” It was concluded that there is a need to: (a) increase support and information for families (especially parent to parent contact); (b) increase message redundancy; and (c) use multiple formats for educating family members. Although demands of busy clinics may limit the time available for family support, take-home educational resources could be developed to facilitate these audiological goals. Increased understanding of the barriers families encounter related to consistency of use may guide the development of parent support strategies and resources.

Measurement of device use consistency has its own challenges. Previous studies with adults demonstrated low correlations between self-reports of hearing aid use time and objective measures of actual use (Humes, Halling & Coughlin, 1996; Taubman, Palmer, Durrant & Pratt, 1999). One study suggested that adult self-reports overestimated use time by as much as 4 hours (Humes et al., 1996), while another showed both over-and-under-estimation of use time (Taubman et al., 1999). This brings into question the validity of self-report for analyzing an outcome like hearing aid adjustment and consistency of use. It is unclear if these findings generalize to the situation of parents, who are caretakers for infant hearing aid users, and are often asked to report on their children's developmental behaviors. However, given the challenges to validity with adults, the current study avoided any estimate of overall "use time." Rather, parents were asked to judge use "consistency" on a Likert scale across a variety of situations encountered daily. It was hypothesized that consistency of use may vary by situation as well as with age and developmental stage. The current study focused on understanding the dimensions of the challenges parents face (e.g., personal adjustments, family-infant relationship, situational barriers, child temperament/state issues). This was accomplished through proxy report in the form of maternal interviews conducted longitudinally.

In spite of early identification and intervention efforts, studies found that many infants with hearing loss experienced delays in the early vocabulary development in comparison to peers with normal hearing (Mayne, Yoshinaga-Itano, Sedey & Carey, 2000; Moeller, Hoover, Putman et al., 2007 a, b). These studies also confirmed wide variability in performance outcomes, suggesting the need to examine closely factors that contribute to individual differences. Consistency of device use may be one of several factors that contributed to differences in outcomes for infants with hearing loss. It is likely that the challenges for parents are multidimensional, and a clearer understanding of the process could result in improvements in hearing aid use time and auditory experiences for infants. The information also may have practical implications for audiological counseling and for technological improvements in hearing instruments. The current study addressed the following specific questions: (a) How consistently did infants with mild to moderately-severe hearing loss use their devices in the second year of life?; (b) Did consistency vary across situations and with age and developmental changes?; and (c) What factors influenced the consistency of use within these families?

METHOD

Participants

Participants were mothers of seven infants (5 females, 2 males) with mild-to-moderately severe hearing loss. These mother-infant dyads were enrolled in a broader prospective, longitudinal study of word learning in infants with normal and impaired hearing (Moeller et al., 2007 a, b). Six infants had bilateral sensorineural hearing losses, and one had a permanent bilateral conductive hearing loss. All infants were referred from newborn hearing screening programs. The mean age of identification for this group was 1.64 months (SD = 1.97 months), and the mean age at fitting of amplification was 5.0 months (SD = 1.8). Age at entry to the longitudinal study ranged from 9 to 13 months (Mean = 10.4 months). The mean right ear pure tone average (PTA) for the group was 51.1 dB HL (range: 37.5–70); the mean left ear PTA was 50.4 dB HL (range: 36.3 – 70). Five children were fit binaurally with wide dynamic range compression (WDRC) hearing aids, one with frequency compression (FC), and the child with a conductive hearing loss wore a bone conduction aid. Six of the seven participants received regular pediatric audiological monitoring at Boys Town National Research Hospital. Parents received systematic instruction in the use and care of their amplification devices in this clinic. The final participant was followed at a local ear, nose and throat (ENT) clinic. All children were enrolled in early intervention programs through public or private schools. They were accompanied to all longitudinal study visits by their mothers, who spoke English in the home. One mother had

a moderate, bilateral sensorineural hearing loss, and all others had normal hearing. Six mother-infant dyads were Caucasian; one dyad was Hispanic. Early motor, cognitive and adaptive milestones were within normal limits for all infants. Demographic information for the children is shown in Table 1; specific audiometric details are included in Table 2.

Structured Interview Instrument

Amplification in Daily Life Questionnaire—As part of the current study protocol, mothers were asked to participate in a structured interview related to their infants' hearing aid use habits across a variety of common daily situations. The non-validated, experimenter-constructed interview tool was called the *Amplification in Daily Life Questionnaire*. The interview included 15 five-point Likert scale items, a daily schedule grid, and a set of open ended questions. Likert scale measures have clear limitations in that they yield ordinal data. However, objective measures of duration, (e.g., from data logging features of digital hearing aids) were not available in the children's devices at the time of this study. Further, adult estimates of their own use time have not correlated well with objective measures (Humes et al, 1996; Taubman et al., 1999). Because of these limitations with use time estimates, Likert scale items (which allowed parents to rate the relative consistency of use across a variety of daily situations) were used. Interviews were conducted by the first or third author when the infants were 10.5 to 12 months, 16.5, 22.5 and 28.5 months of age. The interviews were administered at four to six month intervals in an effort to sample a range of infant developmental/behavioral stages that could influence device use. The exact ages at each visit were a function of the schedule for the larger longitudinal study in which these children participated. To be included in the study, at least three of the four interviews had to be completed. Five mothers completed all four interviews and two mothers (S1, S5) completed the final three interviews. Interviews were conducted in the Infant Development Laboratory setting following a 30-minute videotaping of mother-child interaction.

During the interview, mothers were asked to rate the consistency of their children's use of the device across 8 daily situations. Mothers judged consistency on a five-point scale, as follows: never (0); rarely (1); occasionally (2); frequently (3); always (4). Situations included the infant/child: (a) riding in the car; (b) interacting with a daytime caregiver; (c) eating at mealtime; (d) playing with parents; (e) playing alone; (f) looking at books with parents; (g) playing outside; and (h) going on family "outings" (zoo, store, etc.). Several additional scaled questions explored device care, noise levels in the home, and the child's adjustment to the device. Open-ended questions were asked about the child's daily schedule, evidence of benefit, strategies parents used to encourage device use, and challenging situations for device use. The interview tool can be found in Appendix A. Three history-oriented, open-ended questions related to device adjustment were answered retrospectively in writing (see Appendix B) following the final interview.

There was reason to suspect that mothers may have a tendency to over-report their children's consistency of device use. They may have presumed that their infant's consistent use of devices was a reflection of their parenting skills. This potential concern made it necessary to devise an interview strategy that would be likely to reduce the pressure to over report. Prior to the structured interview, mothers were informed that the researchers were studying challenges that families faced in helping young infants adjust to full time use of hearing aids. They were told, "We know it can be difficult for some infants to wear their hearing aids as much as we want them to. We are trying to understand situations and factors that make hearing aid use challenging. We are not expecting perfect records of hearing aid use. We encourage you to tell us honestly about what you have experienced with your baby/toddler." Using qualitative methods, the interviewers explored mothers' interpretation of events through follow up questions (e.g., If a mother reported that outdoor play was especially challenging for hearing

aid use, follow up questions were, “Why is it challenging?” and “How do you typically handle these challenges?”).

RESULTS

Maternal reports suggested that, on average, consistency of hearing aid use improved with age during the second year of life. Several main points are apparent from Fig 1. By 28.5 months, mothers reported regular use (ratings between frequent and always) of hearing aids by their toddlers for a majority of the situations probed. However, consistency of device use fell short of the ideal (full time) for most situations at earlier ages¹. In addition, maternal reports indicated that certain situations (car, outdoor play, outings) were far more challenging than others in terms of maintaining consistent device use with infants/toddlers. Notably, riding in the car was described as the most challenging for mothers, primarily due to the lack of opportunity to monitor the child and concerns for safety (i.e., putting the hearing aid in the mouth). Parents reported that they achieved the greatest levels of consistency in situations where they were in close proximity to the child or could supervise the activity.

Individual patterns of use: Monitored vs. difficult to supervise situations

There was considerable individual variation in patterns of device use at different ages and in the level of challenge presented by specific situational contexts. Fig 2 shows the maternal ratings for each participant for three situations in which mothers were able to monitor their infants closely. In these contexts (i.e., playing together, book reading, mealtime), most of the families achieved frequent device use by 16.5 months of age.

As shown in Fig 3, only three families established consistent hearing aid use in outdoor play and family outings by 16.5 months of age. These same situations were reported to be challenging for four of the seven families, and most experienced fluctuations in consistency of use across the ages sampled. When asked why these situations were challenging, mothers reported: (a) concern for damage/loss of the hearing aids; (b) child’s activity level resulted in frequent hearing aid retention problems; and (c) weather (too windy, wet conditions) or high environmental signal/noise levels (e.g., parade, loud movie).

Only one family (S5) achieved early full time hearing aid use during rides in the car. All other families described challenges for device use in this setting. When asked to describe the specific challenges of use in the car, mothers reported: (a) Child was restrained in a car seat in the backseat and was unsupervised; exploration/throwing of devices by the infant was an issue; (b) Acoustic feedback was an issue in car seats; and (c) Car rides were not an optimal time for communication with a child who has hearing loss, so safety concerns outweighed device use. Two of three families who eventually achieved full time use in the car used frequency modulated (FM) systems to maintain communicative contact. The third family used a bonnet to retain the hearing aids.

In summary, three distinct patterns of hearing aid use over time were observed in these seven families: (a) full time use was accomplished by at least 16.5 months and consistently maintained (S1, S3, S5); (b) consistency of use fluctuated across the ages (S2, S6); and (c) frequent, but not full time use occurred across most ages and situations (S4, S7).

Device adjustment and management

Mothers were asked to indicate if their children ever requested their hearing aids, as this might suggest how well bonded the child was to the devices. Four of the seven mothers reported that

¹Day care was omitted because most of the children in this study spent limited time in day care settings at the ages assessed.

their children made requests to have their hearing aids put on, but typically not until the later ages sampled. However, some responses suggested that a lack of a request for hearing aids was not necessarily a concern. One family reported that hearing aid use in their family was routine and non-negotiable; the child had no opportunity to request her devices. On the other hand, two inconsistent users made no requests for their devices.

Device management: Daily maintenance—Mothers were asked to report about their typical patterns of device monitoring and their comfort with handling the devices. All mothers reported a high level of comfort with handling and manipulating the devices and seating the earmolds. Given that all of the infants began wearing devices early in the first year of life, this was not surprising. Mothers varied, however, in their habits of daily hearing aid checks. Most reported that they cupped the hand around the device to check for feedback rather than completing formal listening checks.

Device management: Transitions in Routines—Mothers were asked to describe their children's typical daily schedule, including periods of hearing aid use and nonuse. The most interesting finding was that some families had difficulty managing transition times (e.g., getting dressed, getting up from naps). Interviewers asked, "When your child wakes from a nap, does the hearing aid go on right away, or is there some wait time?" Some mothers described waiting 30 minutes to one hour after morning wake up or after naps before putting hearing aids in, while others put the hearing aids in immediately. Similarly, two families reported less use of the hearing aids on weekends, when the family routine was less structured. These results suggested that family schedules and routines influenced device use in some cases.

Open ended responses

Specific challenges related to device use—Mothers were asked in each interview to describe the situations or circumstances that were the most challenging for device use. Their input is summarized in Table 3. Qualitative analysis revealed that described challenges could be classified into three main categories or themes: (a) setting-specific issues; (b) child-state or temperament issues; and (c) activity-based issues. In terms of setting-specific issues, riding in car seats and restraint in high chairs were concerns at all ages. Outings and outdoor settings/conditions also were viewed as difficult settings regardless of age. On the other hand, child state/temperament and activity-based issues varied as a function of age. Importantly, mothers considered children's state when deciding when to reinsert a removed device. For example, if the infant was ill or having a tantrum, mothers waited before attempting reinsertion.

Perception of benefit—All seven mothers perceived that their children were receiving benefit from amplification. Several mothers reported that they observed clear differences between aided and unaided behaviors that supported their impressions. However, two mothers of children with mild hearing loss reported that their infants' responses were the same with or without the hearing aids. One of these mothers added, "But I just know they help." These mothers eventually found a way to "trust" that hearing aids were helping the child, even though they waited many months for observable evidence. Developmental trends were apparent in mothers' descriptions of evidence of child benefit. At the earlier ages, mothers observed that the infant could be soothed by hearing mom's voice at a distance, responded to voiceless sounds (/p/,/t/), understood some words, and expanded their vocal behaviors. At later ages, reports included behavioral, auditory, speech, language and changes. Mothers noted that their toddlers were more confident and alert, turned to many sounds, copied inflections during book reading, produced speech that was clearer with aids than without, and made steady gains in language development. Interestingly, some comments related to FM use suggested behavioral improvements that affected quality of life. For example, mothers reported that it was easier to get toddlers' attention at a distance and that the children complied better with parental requests

on outings. This reduced safety concerns (when children ran off in stores or parking lots) and less need to physically chase after the child.

Open Ended Historical Questions (see Appendix B)

Strategies parents used to overcome barriers—A final question prompted mothers to talk about the devices and strategies they used to address some of the challenges they faced with hearing aid use with their young children. One family managed their son's attention-seeking behaviors (i.e., throwing his hearing aids) by learning to react neutrally and reinsert the hearing aids within a few minutes. Other parents reported that they used hearing aid retention devices, and that the need for these varied across the ages sampled. Parents reported using bonnets, Critter Clips, toupee tape and Ear Gear to promote hearing aid retention. Some mothers found these devices useful for a specific developmental period (e.g., 12 to 16 months when device removal to seek attention was frequent), but phased them out naturally when the behavior stopped. Results suggested that commitment to and persistence in insisting on device use is effective in the long run. Various retention devices can help families overcome age or situation-specific barriers in the shorter run.

Parental attitudes and perceptions—Mothers were asked to comment on parenting and adjustment factors that influenced device use. A few mothers shared that their grief reactions influenced their consistency in promoting device use in the early months following diagnosis. One mother stated, "There was a definite adjustment to the hearing aid...For me as the mom, it was emotional. On the bad days I felt a deep desire to pull it off and just believe that he would hear anyways." Mothers of children with mild hearing loss reported difficulty accepting the need for amplification because their infants responded to many sounds with or without amplification. One stated, "With time, we just 'had to get on board' and believe what the audiologists were telling us, that hearing aids would help her speech and language development."

DISCUSSION

The results of this study suggest that the consistency of hearing aid use by infants improves over the second year of life, to optimal levels (full time use) for some children, but less than optimal for others. There were individual differences in how device use varied across the ages studied. For a few families, full time use was established early and maintained. In other cases, the consistency of the infant's hearing aid use increased over time, and for others, it varied at different developmental stages. It can be tempting for professionals to assume that inconsistent hearing aid use is primarily a parenting issue. It may be oversimplifying the issue to think that if parents are just persistent enough, full time use will be accomplished. Persistence is certainly an ingredient to success, however, maternal responses suggested that use consistency can "ebb and flow" depending on situational/activity variables, child temperament, and child developmental or state changes. It is clear that the process was affected by issues that are not one-dimensional; they included child-related issues, bidirectional (parent-child) issues, situational issues, and parental adjustment issues that complicated the process. It is important to consider these layers of complexity when guiding and counseling families of infants.

Child-related issues included developmental changes such as: a) increasing awareness that pulling hearing aids out gets parental attention (perhaps related to emergence of causality concepts around 10–12 months of age); b) increasing motor skill allowing exploration/activity; and c) affective/behavioral changes (i.e., starting to throw tantrums). Several infant-state changes also influenced device habits, including: a) illness; b) teething; c) hunger; d) fussiness; e) ear infections; and f) emotional distress. When put in the context of the parent-child relationship, these underlying child-related issues required different and flexible solutions.

Parents approached a hungry, fussy baby in a different way than they would an infant who needed to re-acclimate to earmolds following a bout with a painful ear infection. Professionals may guide parents to “just keep putting the hearing aid back in” whenever the infant pulls it out. However, a responsive parent may realize the child needs to calm down and regulate himself/herself before he/she will accept the hearing aid. This example illustrates bidirectional influences on the hearing aid adjustment process; both parental and infant behaviors play a role.

Results of the current study also suggested that some situations are decidedly more difficult than others for succeeding in enforcing hearing aid use with infants/toddlers (e.g., riding in car seats, playing outside). Even highly motivated, persistent parents experienced these challenges. It may be valuable for audiologists to structure hearing aid adjustment questions around some of these specific daily situations. It is possible that increased use of personal FM systems would address some of the situational challenges, like car rides and outings (AAA, 2003; Thibodeau & Schafer, 2002). FM systems not only accommodate the need for better signal-to-noise ratios, they also provide better communicative contact with an active toddler who is exerting independence.

This study showed a consistent theme around parental safety concerns, which also were reported by Martin et al. (2005). Preventing loss and ensuring child safety are issues that need to be addressed directly and comprehensively. Orientation about how to access insurance coverage and use devices such as Critter Clips or bonnets may increase parental willingness to have the toddler use amplification on outings or during outdoor play. This orientation typically may occur in the first year of life when an infant is less than 6 months of age and is less mobile. It needs to be revisited and repeated as the infant ages and new developmental stages and activities bring about new challenges.

Some parents acknowledged that their own adjustment issues played a role in selected situations. The obvious counseling goal for the audiologist is to be aware of and sensitive to the fact that both parental and child issues may be complicating the hearing aid adjustment process. The study results also suggested that many parents will benefit from ongoing support about their hearing aid daily checks and maintenance procedures.

All mothers in this study perceived that their children were benefiting from their devices, which likely supported parental efforts to be persistent. It may be that family education about the benefits of hearing aids should strive to help families make a strong connection between the infant's hearing and the development of speech, language and learning. Haggard and Primus (1999) showed that parents presented with traditional audiological labels like “mild” or “moderate” consistently underestimated the impact of the loss on development. In contrast, when they heard simulations of hearing loss, they associated these with terms that conveyed greater magnitude of risk. These results are an important reminder of the need to be sensitive to the message that labels convey, and that there may be creative ways to establish the link between hearing loss and communication abilities. The use of hearing loss simulations may be particularly effective because parents are able to “experience” the sensory deficit. Families of children with mild degrees of loss should be educated about recent studies pointing to the consequences of minimal hearing loss (Hicks & Tharpe, 2002; Teasdale & Sorensen, 2007; Wake & Poulakis, 2004).

When interpreting the results of this study, several points should be kept in mind. This was a highly motivated group of families; all were committed to participation in an ongoing longitudinal study. They had frequent contact with and education from their pediatric audiologists, and regular support from parent-infant teachers. It is unclear if their experiences are representative of the general population of families whose infants are wearing hearing aids.

However, even in this group of motivated families, hearing aid use consistency fell short of full time use for four out of seven families, particularly in the challenging settings described above. It is possible that the interview instructions led the mothers to be conservative in their judgments of use consistency. It is also difficult to generalize the conclusions from this study due to the small number of subjects. However, the results provided insights about the types of challenges parents encountered as they work toward full time hearing aid use with young infants.

Future studies should include objective measures of use time (i.e., using data logging devices in digital hearing aids), as well as further qualitative investigations of factors that influence the adjustment process with even younger infants. Novel approaches to explaining the connection between hearing, speaking and learning should be explored. Audiologists will need to be adaptive in their counseling approach, with differential responses to issues that arise singly or in interaction from parental adjustment, child temperament or state, situational complications, or parent-infant dynamics.

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Appendix A BTNRH Infant Development Project Amplification in Daily Life Questionnaire

	0 – Never	1 – Rarely	2 – Occasionally	3 – Frequently	4 – Always
1. My child uses the hearing device:					
a. In the car					
b. When with a daytime caregiver					
c. During mealtime					
d. When I am playing with him/her					
e. When he/she is playing alone					
f. When we are looking at books together					
g. Outside or during playground time					
h. During "outings" (store, zoo, Children's Museum, etc.)					
2. My child complains when device is removed					
3. My child requests device (or shows excitement, points or fusses)					
4. I have to adjust my child's hearing aid due to acoustic feedback (push earmold in, turn volume down, etc.)					

	0 – Never	1 – Rarely	2 – Occasionally	3 – Frequently	4 – Always
5. I perform a daily listening check (or my child lets me know when the device is malfunctioning)					
6. The device is removed (by accident or on purpose) and I have to reinsert/reattach.					
7. The noise levels are high in the home/daily environment of the child					
8. I am comfortable handling/manipulating the device					
TOTAL					

On a typical day, my child wears his/her hearing device: (Put X's in the time blocks)

7-8 am	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9

Wake up time: _____

Naptime(s): _____

Bedtime: _____

Child: _____ CA: _____ DOB: _____

Date of Interview: _____ Interviewed by: _____

Subject #: _____

Open-ended questions:

1. Is your child with a daytime caregiver other than a parent?

If so, how many hours per week?

2. Are there differences in wearing time on a weekend day?

3. Are there any situations when it is challenging to keep the device on? If yes, please describe:

4. Do you think that wearing the device helps your child? In what ways?

Appendix B Open Ended Questions about History of Strategy Use

1. What strategies did you use to increase your child's hearing aid use? Were they useful?

2. At what ages were these techniques necessary? Why do you think you needed these at these ages (e.g., Was the infant more active?)

3. Some parents have told us that both the parents and the infant had to make an adjustment during the process...maybe telling yourself that you needed to get his hearing aids on -Was this true for you? In what ways?

Fig 1.

Averaged maternal ratings for consistency of hearing aid use across 7 daily situations, plotted as a function of age (10.5–28.5 months).

Fig 2.
Maternal ratings for each child plotted as a function of age for three situations in which children can be closely monitored.

Fig 3. Maternal ratings for each child plotted as a function of age for three situations in which monitoring of the child is challenging. Asterisks denote a rating of *never*.

Table 1

Characteristics of the children with hearing loss.

Subject #	Gender	Age of ID (mos) (SD)	Age Aided (mos) (SD)	HA Circuit (L/R)	Age at Study Entry (mos) (SD)	Interview Sessions**	Intervention Program Type
1	female	1	4	WDRC/WDRC	12	2-4	private oral
2	female	1	3	WDRC/WDRC	9	1-4	public oral
3	female	6	6.5	WDRC/WDRC	9	1-4	public oral
4	male	0	4.5	Bone Cond.	9	1-4	private oral
5	female	1.5	3	FC/FC	13	2-4	private TC ⁺
6	female	1	7	WDRC/WDRC	9	1-4	private oral
7	male	1	7	WDRC/WDRC	12	1-4	public oral
		1.64 (1.97)	5.00 (1.80)		10.43 (1.81)		

** Session 1 was conducted when the child was 10.5 to 12 months, Session 2 at 16.5 months, Session 3 at 22.5 months and Session 4 at 28.5 months.

⁺TC refers to total communication program (simultaneous use of sign individual and spoken communication)

Table 2
Participants' threshold values for right and left ears (250 – 4KHz).

Subject #	Threshold (L/R)				Unaided PTA (L/R)
	250	500	1000	2000	
S1	45/45	40/40	40/40	40/45	38.8/40
S2	30/25	25/35	40/40	45/40	36.3/37.5
S3	DNT	70/70	70/70	60/60	62.5/62.5
S4	DNT	DNT	70/70	50/50	61.7/61.7
S5	DNT	45/45	75/75	90/90	70/70
S6	35/35	40/40	50/45	45/55	43.8/46.3
S7	25/25	45/50	40/40	40/40	40/40
Means (SD)					50.4/51.1 (13.8/13.3)

DNT = did not test.

Table 3

Maternal reports about setting-specific challenges, child state or temperament challenges and activity-related challenges in relation to age.

Age	Setting-Specific Challenges (weather conditions, ambient noise, group settings)	Child State or Temperament Challenges (e.g., child health, behavior or affective state)	Activity-Based Challenges (e.g., motor exploration, type of play, availability of parental attention)
10.5–12 months	Car/Car Seat (6/7)– acoustic feedback, lack of supervision, safety concerns, taking device apart Loud restaurants Outings Mealtime (High chair confinement)	Fussy Teething Tired Attention seeking	Curious sibling takes out Rolling on floor Nursing
16.5 months	Car/Car Seat Outings Outdoor conditions (windy, wet, hot) Child at daycare pulls out Outings (safety; scouring driveway for lost aid)	Itchy ears, teething Sick/ear infection Tired Attention seeking Curious (chews on earmolds)	Playing alone (safety issues when unsupervised) Wrestling Dancing Horse play
22–24 months	Car/Car Seat Mealtime Outdoor conditions (snow, loud) Outings	Sick Tired, hungry Mad/tantrum Silly mood	Mom busy with younger baby
28.5 months	Car/Car Seat Outdoor conditions (windy, rainy, loud)	Ear infection New earmold bothering ears	