Pediatric Fittings in 2010: The Sound Foundations Cuper Project

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Introduction

Pediatric audiologists make decisions every day based on evidence for or against certain procedures and interventions. As Gravel observed (2004), the explosion of information and technology mandates that clinicians cannot rely on information they learned in formal training, but they need to commit to continually updating these "truths." One aspect of practice where the "truth" may not yet be fully understood is the provision and usage of pediatric hearing instruments. Currently, there is a lack of substantial clinical evidence regarding pediatric hearing instrument selection, technology application and use. As such, there is a clear need for a more robust evidence basis regarding how certain fitting and use practices impact outcomes. Some topics for which there is currently little evidence in the literature include how closely clinical guidelines are adhered to, what types of pediatric hearing losses are managed with hearing instruments, what is typical hearing instrument usage by children of various ages and how technologies are applied to children. The goal of this project was to collect a large number of pediatric hearing instrument fitting files and usage data logs to develop a better understanding of issues around the provision of instruments for children.

Data Collection Procedures

Cuper is a tool developed by Phonak to better understand how hearing instruments (HIs) are being fitted and used in real life. With the consent of participating pediatric fitting centers, each mouse click in Phonak iPFG fitting software (iPFG) was recorded. This provides an understanding of the process used to program devices and what choices were made. The usage data were recorded from the data log each time the HI was connected to iPFG. As part of this project, all iPFG sessions were collected for nine months from 100 workstations located in more than 60 pediatric clinics and schools in the United States. Fitting and usage information was obtained from nearly 5000 subjects and 8500 ears. The data collected allow us to glean useful insights into numerous aspects of the provision and use of hearing instruments. This includes data on client profiles, HI and feature selection, workflow, utilization of fitting tools, and usage of modern hearing instruments in real-life listening environments. The evidence should help hearing instrument fitters and manufacturers gauge the effectiveness of hearing instrument usage in daily life, improve efficiency of the fitting process, and optimize hearing instrument performance in the future.

Participating clinics enabled a logging function in their Phonak iPFG programming software. This function created a data store of all subsequent fittings that was transferred twice to a central server during the nine month project. To maintain patient confidentiality, all identifying information was removed from the client file prior to data transfer to the central server. The only client information collected was age and gender. The Sound Foundations Cuper data were then analyzed, and in some cases were compared to the body of adult data previously collected (Launer and Jones 2011) using the same mechanism. Clients were divided into three age groups: infants and toddlers (0–4 years), young school-aged children (5–8 years) and older children and teens (9–18 years). These age groupings match those used in the Phonak iPFG Junior Mode. For the purposes of this

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study, and for the provision of default HI settings in iPFG, the lifestyles and sophistication of children within these age ranges were presumed similar. Obviously, there are some limitations to such generalizations. However, the advantage of the Cuper tool is that the data on any particular subject can be retrospectively analyzed in very significant detail. For example, future studies could examine the 0–4 data to see how hearing instrument use changes between birth and 4 years of age.

Pediatric Hearing Instrument Users

Cuper provides detailed insight into the audiological profiles of children receiving hearing instruments. The mean pure tone average (PTA) in the 0–4 age group was 63 dB. This was statistically significantly different from the mean degree of loss in the 5–8 and 9–18 age groups (56 dB and 57 dB respectively); there were no significant differences between genders. There could be various explanations for the observed differences in average PTAs. Those clients with the most severe hearing loss in the youngest age group may be awaiting cochlear implantation and therefore are still included in the youngest cohort. Also, initial assessments might yield supra-threshold responses, or later onset losses could be of a lesser degree than congenital and early onset losses.

Forty-eight percent of ears in this study were fitted with hearing instruments to treat a moderate degree of hearing loss. Twenty-two percent of ears exhibited a severe degree of loss. Twenty-one percent presented with a mild degree and just 9% of ears had a profound loss.

In 6% of fittings, bone conduction thresholds were entered into iPFG. This indicates the presence of a mixed or conductive hearing loss. It is expected that Cuper data under-estimate the total number of conductive hearing losses because clients with aural atresia and more significant conductive pathologies would likely be fitted with bone conduction devices, which are not accounted for here. At this time, only air conduction instruments programmed with iPFG are included in this data set.

The distribution of fittings by age shows an interesting trend (see Figure 1). The number of fitting sessions stays approximately constant for children up to age 12. Between 13–18 years of age, however, there is a sharp decline in fitting visits to roughly half of that seen in younger clients. Although this decline seems to indicate that teens do not require as much follow up as younger clients, some teens may choose to receive care outside of pediatric centers and would, therefore, be excluded from this data collection. It is also possible that they are seeking less audiological care altogether. Perhaps this decline presents an opportunity for audiologists to better meet the needs of this population with different technology selections or through support programs promoting self-advocacy, support and transitioning skills.

Pediatric Hearing Instrument Usage

The information from the hearing instrument data log was collected for each instrument hooked up to iPFG throughout the duration of the project. This allowed better understanding of what happens after the hearing instruments are worn outside of the clinic. Figure 2 depicts hours of HI use by age group. Data logging tells us that, on average, the amount of HI usage per day increases with age, although there are large variances for all ages. All users under 19 years old wore HIs for an average of 5.5 hours per day. Infants and young children wore their devices 5 hours per day on average, compared to adults (Launer and Jones 2011) who averaged more than 8

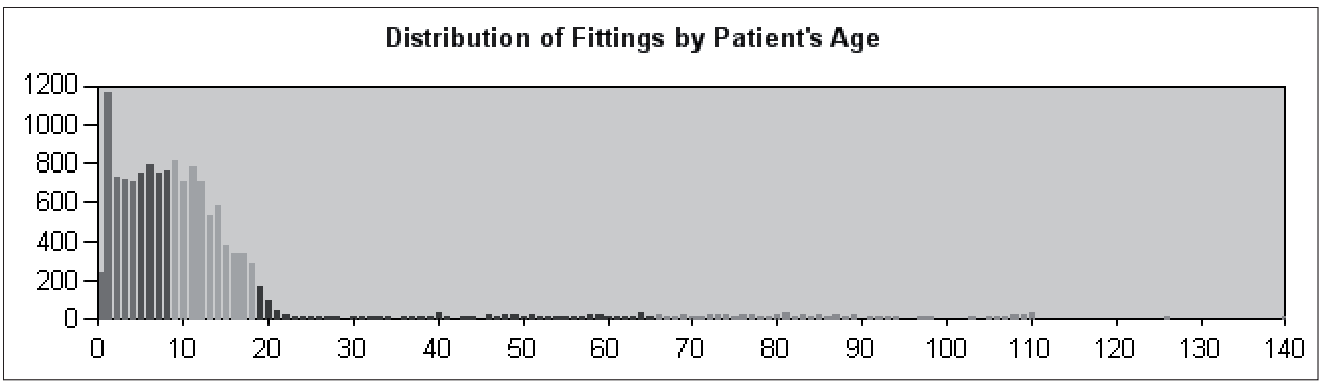

Figure 1. Distribution of hearing instrument fitting sessions by client age.

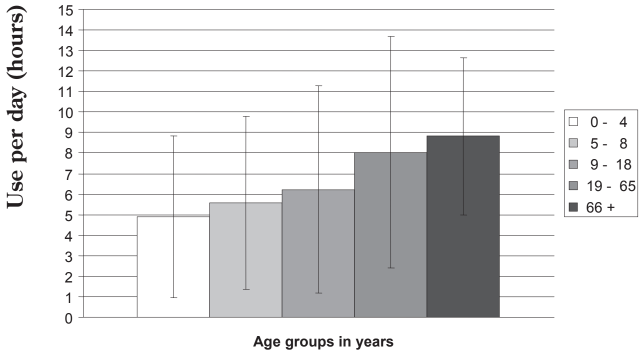

Figure 2. Average hearing instrument usage per day by age group as collected according to the hearing instrument datalogs. This graph represents data collected from all Cuper projects, not exclusively the Sound Foundations Cuper pediatric data.

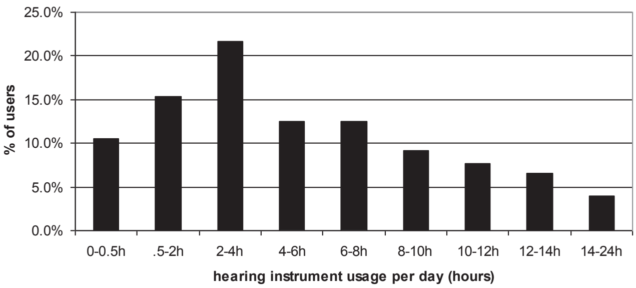

Figure 3. Percentiles of children by hours of hearing instrument use per day.

hours of use per day. This may be attributed to the limited amount of time infants spend awake and alert each day. Cuper data also indicate that 40% of children in this sample used their hearing instruments for 4 or fewer hours per day (Figure 3). Another area of concern is that relatively few children are "full time" HI users, with only 10% wearing HIs more than 12 hours per day. It is commonly assumed that a high amount of daily use correlates to better auditory performance. Although the number of full time users is low, it should be remembered that a few of the participating sites were schools where full time hearing instrument use would not be expected.

In Marketrak VIII, Kochkin (2010) reported that nearly 40% of adult hearing instrument users were either neutral or dissatisfied with their hearing instruments' performance in noise. This finding supports the notion that listening in noise continues to present a major challenge to adult HI users. In automatic mode, the HI classifier determines whether the environment meets the criteria for noise and selects a listening program accordingly. The data logging function in the hearing instrument tracks the amount of listening time spent in each program. Unpublished Cuper data from over 25,000 adult hearing instrument users show that, on average, about 20% of an adult's listening day is classified as "noise." This means that the criteria for noise, as defined by the intrinsic parameters built into each HI, are met or exceeded for a fifth of an average adult's listening day. The pediatric data in our study show that the noise criteria were met or exceeded in 33% of the listening hours for school-aged children. Data logging revealed that even infants and young children under 4 years of age spent almost a quarter of the day in environments classified as noisy. This finding could have important implications for the application of sound cleaning features and technologies, such as automatic switching, directional microphones and FM systems.

Pediatric Hearing Instrument Feature Application

The availability of sound cleaning features to aid understanding and comfort in complex listening environments is dependent on the technology class of the hearing instruments. In the Phonak portfolio of instruments that were available for Cuper analysis, products fell into four technology classes: basic, economy, advanced and premium. Basic hearing instruments in the Phonak product portfolio presently have a fixed single-channel directional system, manual program switching, and noise reduction. A premium device typically includes a multi-channel adaptive directional system, automatic program switching between four base programs, high fidelity noise reduction and other more advanced signal processing features. In the present study, 63% of the pediatric instruments were economy class models, while 22% of children were fitted with advanced level products. These selection trends illustrate that children, despite spending relatively high proportions of time in noise, do not have access to the most sophisticated sound cleaning technologies.

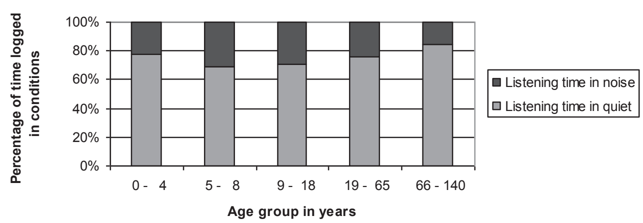

Figure 4. Percentage of time logged in quiet and noise conditions according to the hearing instrument classifier. Data logging shows that school-aged children spend approximately 30% of their listening hours in noise compared to about 20% for adults under 66 years of age.

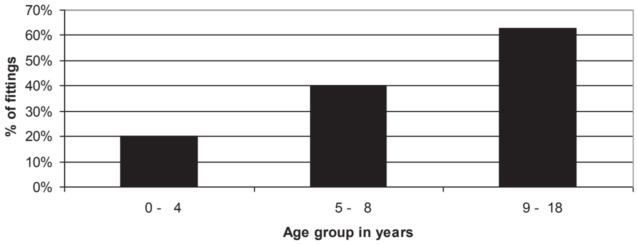

Figure 5. Percentage of time a manual program toggle was activated in pediatric fittings by age bracket (in years).

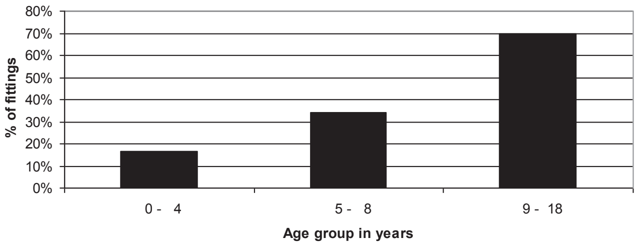

Figure 6. Percentage of time a manual volume control was activated in pediatric fittings by age bracket (in years).

Although children are rarely afforded premium sound cleaning features, there is evidence that children can benefit from directional microphones (Gravel 1999; Ricketts, Galster and Tharpe 2007), although not all of the benefits and limitations are understood (AAA 2003). Ricketts and Galster (2008) reported that children in school exhibited a high degree of accuracy in orientation, a requisite for directional microphone benefit. Despite the potential benefits, a speech in noise program, the typical mechanism for activating a directional microphone, was made accessible in only 11% of pediatric fittings. The reservation in applying this technology may be related to concerns about reducing access to information originating from behind the listener or practical concerns about appropriate manual program switching by the child. Recent work presented in this volume by Ricketts and colleagues further analyzes the listening environments of school-age children. This might be a first step towards better understanding the listening needs of children in school environments and towards designing special algorithms for speech intelligibility improvement and automatic environment classification specifically designed for the needs of children.

Automatic program switching presents another method of accessing directional technology. When this feature is activated, the hearing instrument performs an ongoing acoustic scene analysis to determine which program would be most appropriate for the listener. The automatic switching mode was made accessible in more than 45% of pediatric fittings and was situated as the start-up program in more than 35% of pediatric HIs. The default settings of Phonak Junior mode likely influence some of these trends. Junior mode applies a set of defaults defined by available published evidence and the consensus of the Phonak Pediatric Advisory Board (Woodward 2009). These are applied to pediatric fittings according to the age of the child. By default, children ages 5–8 have manual access to a speech in noise (directional) program and the HIs in children ages 9–18 have manual access to the automatic switching mode.

For the approximately 65% of pediatric HIs that did not start up in an automatic program, the user would need a remote control or active program toggle to access multiple listening programs. Most children under 9 years old did not receive access to the manual program toggle (Figure 5). However, 20% of instruments in the 0–4 age group had an active program switch. This grew to 40% for the young school-aged children and 60% for older children and teens. When considering age, the activation of the manual program toggle correlated closely with the activation of a manual volume control (Figure 6).

Cuper also allows us to compare the utilization of various HI features to the recommendations published in professional guidelines. The American Academy of Audiology's (AAA) Pediatric Amplification Guidelines (2003) recommend the use of behind-the-ear style (BTE) devices with children because of the potential for growth of the outer ear and greater durability compared to custom products. Ninety-seven percent of the products used for children in the Cuper dataset were BTEs. Another 2% were receiver in canal (RIC) aids. Only 1% of the devices fitted to children were custom styles. The Hearing Industries Association (2010) reported that 30% of fittings in the United States in 2010 were RIC aids. This recent market shift has had little impact on teen fittings, according to the data obtained in this project. Ninety-four percent of children 9–18 years of age were fitted with BTEs, while RIC technology was utilized only 4% of the time.

In addition, The AAA Pediatric Amplification Protocol (2003) confirms the viability of a number of signal processing features for children. These include multiple channels, expansion, and amplitude and frequency compression. In our sample, biased by the availability of features in Phonak hearing instruments, multiple channels (between 4 and 20), expansion, and amplitude compression were utilized in 100% of fittings. Frequency compression, specifically Sound Recover®, was applied in 60% of pediatric fittings overall. When Sound Recover®

was an available feature on the HI, this signal processing feature was utilized in 90% of fittings.

Pediatric Hearing Instrument Fitting Process

In 1996 Hedley-Williams, Tharpe and Bess conducted a survey of the practices utilized by audiologists fitting hearing instruments on children. One of the survey questions was whether audiologists would use a "personal fitting strategy" or an evidence based approach such as DSL (Seewald, Moodie, Scollie and Bagatto 2005). Almost half of the respondents reported using a "personal fitting strategy" 75–100% of the time. Similarly, 90% of the audiologists reported using the DSL method 0–24% of the time. These reports show that 14 years ago an evidence-based approach to fitting hearing instruments on children was seldom used. In contrast, 85% of the pediatric fittings logged in this project were fitted to the DSL prescription, available in iPFG. While data logging cannot confirm that real ear or simulated test box measures were performed to verify that targets were met and maximum power output (MPO) levels were not exceeded, we know at least the DSL prescriptive method for applying gain was utilized with age-appropriate, average calculations. Of the remaining 15% of fittings in this sample, for whom NAL or Phonak's proprietary fitting formula was selected, half of the subjects were in the 9–18 age bracket. This indicates that more than 90% of hearing instrument fittings on young children in this project prescribed gain and output according to the DSL prescription, making it likely that audibility and safe output levels were achieved. The data collected in this study were based on Phonak's fitting software; that is, they strictly apply to fitting of Phonak products only. However, we think it is fair to assume that pediatric fitting centers would follow the same fitting approach and especially prescriptive fitting approaches independent of brand. Thus we think this estimate is representative of clinical practice.

Other aspects of the fitting process that were studied in this project included binaural fitting rates and the workflow through the Phonak iPFG software. The binaural fittings rates for children were similar to the adult Cuper data (Launer and Jones 2011). Across all ages, binaural fitting rates in the United States hover around 65%. We also saw that pediatric audiologists have no uniform pathway through the iPFG fitting software. This may indicate that there is a large degree of variability in the processes that audiologists use to program instruments for children and in the tools they employ, such as data logging, feedback management and program fine tuning. Regardless of the audiologist's path through the software, fitting programming sessions take a relatively short amount of time. Average programming time lasted 10–15 minutes with follow up taking approximately 2 minutes longer than the initial fitting (Figure 7).

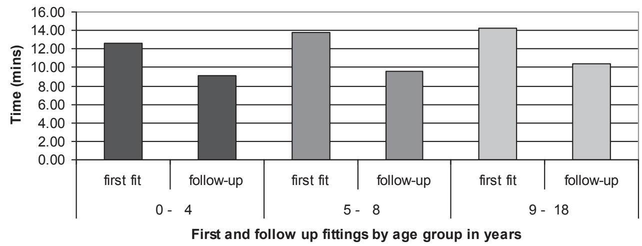

Figure 7. Average duration of first and follow up fittings (in minutes) by age bracket.

Conclusions

The Sound Foundations Cuper project provides some objective insight regarding HI fitting and usage in the pediatric population. As we strive toward more evidence-based practice, it is important to first identify what variables lead to the range of outcomes seen in children with hearing loss. Cuper is a window into professional practices and real life usage. It gives us perspective into the pediatric audiologists' application of technology and the client practices to assist in the identification of predictors of the best outcomes for children. Although there is more work to be done, it is encouraging that, compared to 15 years ago, there has been a large increase in the utilization of an evidence-based prescriptive method. Additionally, the data collected in this study suggest that professional best-practice guidelines were generally followed.

Another benefit of Cuper is that it allows device manufacturers to examine the ways in which technology is applied to various client groups. This study of how tools and technologies are fitted and utilized gives the manufacturer an authentic understanding of real-use cases. This knowledge fuels the development of more efficient tools, more intelligent technologies, and more targeted innovations. It is our hope that the enhanced visibility and richer understanding of pediatric hearing instrument fittings will lead to better products, more efficient processes and improved outcomes for children with hearing loss.

Acknowledgments

We would like to express our sincere gratitude to the Pediatric Centers that made this study possible by collecting and providing the data as well as our colleagues (including Daniel Meier, Ulrike Lemke, Solange Anderson, Deborah Edwards, Shannon Motsett, Megan Quilter, Stacey Rich, Dawn Ruley, Dave Wessell and Miranda Weidle) who helped tremendously in collecting and analyzing this wealth of data.

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References

American Academy of Audiology 2003. *Pediatric amplification protocol.* Reston, VA: American Academy of Audiology. Available at www.audiology.org

Gravel, J. 1999. Children's speech recognition in noise using omni-directional and dual-microphone hearing aid technology. *Ear and Hearing* 20: 1–11.

Gravel, J. 2004. Evidence based practice in pediatric audiology. In R. Seewald (ed.), *A sound foundation through early amplification: Proceedings of an international conference* (pp. 17–26). Stäfa, Switzerland: Phonak AG.

Hearing Industries Association. 2010. *Hearing industries association statistical reporting program 3rd quarter 2010.* Nashville, TN: Prepared by Bostrom Inc.

Hedley-Williams, A., Tharpe, A.M., and Bess, F. (1996). Fitting hearing aids in children: A survey of practice procedures. In F.H. Bess, J.S. Gravel, and A.M. Tharpe (eds.), *Amplification for children with auditory deficits.* Nashville, TN: Bill Wilkerson Center Press.

Kochkin, S. 2010. MartkeTrak VIII: Consumer satisfaction with hearing aids is slowly increasing. *The Hearing Journal* 63(1):19–27.

Launer, S., Jones, C. 2011. CUPeR: An Objective look into hearing instrument fitting and usage. Presentation at AudiologyNow! Chicago

Ricketts, T., Galster, J. and Tharpe, A.M. 2007. Directional benefit in simulated classroom environments. *American Journal of Audiology* 16: 130–144.

Ricketts, T., and Galster, J. 2008. Head angle and elevation in classroom environments: Implications for amplification. *Journal of Speech, Language, and Hearing Research* 61: 516–525.

Seewald, R., Moodie, S., Scollie, S., and Bagatto, M. (2005) The DSL Method for pediatric hearing instrument fitting: Historical perspective and current issues. *Trends in Amplification* 9(4): 145–157.

Woodward, J. 2009. Focus 39: Latest developments in fitting software for children: The junior mode. http://www.phonakpro.com/content/dam/phonak/b2b/C_M_tools/Library/focus/en/focus_39.pdf