Pediatric Focus 2

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Finding the right fit: Pediatric hearing aid coupling options for children

Introduction

As universal newborn hearing screening (UNHS) has become more prevalent around the world, pediatric audiologists are tasked with fitting hearing aids on infants diagnosed with hearing loss at a very young age. In 2007, the Joint Committee on Infant Hearing (JCIH) set forth the following goals: children should have a hearing screening by one month, hearing loss should be diagnosed no later than three months, and intervention should commence no later than six months (JCIH 2007). Meeting this ambitious timeline means that children are routinely being fitted for hearing aids in the first few months of life. In fact, the report from one early intervention program (Halpin, Smith, Widen & Chertoff, 2010) showed that within five years of enacting UNHS, the percentage of children fitted with hearing aids by six months of age grew from just 14% before the legislation to 68% after legislation.

Fitting amplification to a child in the first months of life presents some unique clinical considerations and challenges for the pediatric audiologist. According to an internal database of Phonak fittings, 83% of hearing aids fitted on children are the behind-the-ear (BTE) style (Phonak CUPeR fitting database, 2017). This is consistent with recommendations made by both the Ontario Infant Hearing Program (Scollie et al., 2010) and the American Academy of Audiology (2013). Selecting, coupling, and maintaining hearing aids on infants and children requires solutions that are different than those needed when working with older children or adults. First, earmold impressions can be tricky on a tiny ear, especially if the infant is uncooperative or has an unusually small ear canal. Second, a device has to be selected that can provide appropriate levels of amplification, even when venting is not possible. Feedback is another issue that will need to be managed because infants have poor head control and may often have one ear that is held against the body of the caregiver. Hearing aids for young children must also be tamperproof to avoid manipulation and ingestion of batteries. Finally, infants will need to have their earmolds replaced frequently as their ears grow rapidly. With infants, it is not uncommon that a new earmold impression will need to be taken every few weeks to prevent feedback and loss of necessary amplification. To support successful fittings, numerous pediatric-

specific accessories and general recommendations are available. This paper is intended as a resource to offer some solutions to these challenges and to provide information about some of the specialized fitting and coupling options available.

Earmolds

An ear impression must be taken in order to fabricate a properly fitted earmold. Prior to taking the impression, an otoblock should be inserted into the ear canal to facilitate a safe impression. While foam otoblocks are frequently used with adults, small cotton-type otoblocks are more comfortable for use with children and come in a variety of sizes. With some tiny ears, even the smallest otoblocks may need to be trimmed down to a smaller size in order to fit into an infant ear canal. Knowing the average canal length by age is useful when placing an otoblock in the ear of small children. See the data in Figure 1 from Keefe et al. (1994) as a reference. Caution is still necessary; however, since these estimates may not be useful when working with children who present with external ear and other cranio-facial anomalies.

There are three general categories of earmold materials available: acrylic/lucite, vinyl, and silicone. Acrylic/lucite earmolds are made of hard plastic. They are very durable and easy to clean and modify, but they are more likely to cause feedback in little ears. They also present safety issues for older children who are at risk for injury to the ear if they receive a blow to the head (e.g. while playing sports). For comfort, safety and retention, a soft earmold material should be used when ordering custom earmolds for infants and young children. Of the two types of soft materials (vinyl and silicone), a vinyl earmold may be preferable over silicone for younger children for ease of insertion as some of the silicone materials have a rubbery texture that can be more difficult for parents and caregivers to insert in an infant or toddler ear. In addition, vinyl earmolds can be easily modified in the office if needed while most silicone earmolds can only be modified at an earmold lab.

Age	Canal length
1 month	14 mm
3 months	16.5 mm
6 months	17.5 mm
12 months	20 mm

Figure 1. Average ear canal length by age for infants from Keefe DH, Bulen JC, Campbell SL, & Burns EM (JASA, 1994)

Earmolds also come in a variety of styles including shell, skeleton and canal (Figure 2). For infants and toddlers, a full shell earmold with a helix lock is often best, as the helix lock allows for better retention of the earmold in small ears. Figure 2a shows examples of shell earmolds with and without a helix lock. As children get older and are learning to insert the earmold by themselves, eliminating the helix lock allows for easier insertion and greater comfort. Older children may also find a skeleton type of earmold more cosmetically appealing, however; skeleton earmolds with soft material are often too flimsy for infant ears making insertion more difficult. In addition to an array of styles, earmolds are also available in a wide variety of colors, including even swirled together colors and glitter (Figure 3). The best combination is one that the child will happily wear!

In the first year of life, a child may need more than six sets of earmold impressions and earmolds, so parents' expectations should be set accordingly. It is also important to note, that as the child outgrows earmolds, the acoustic properties of the ear are changing as well, necessitating new real ear to coupler difference (RECD) measurements, recalculation of targets, and adjustments of the hearing aids to maintain the same degree of audibility (Bagatto et al 2010). Earmold venting options will often be restricted by the small size of the child's ear. Regardless of the hearing loss configuration, a vented earmold will likely not be an option early in life; however, the optimal acoustic selections for the earmold should be reconsidered as the child grows. If feedback persists in the presence of a new earmold, the audiologist may need to obtain a deeper fitting earmold down to the bony portion of the ear canal, activate the feedback management system in the hearing aid, or reassess any venting.

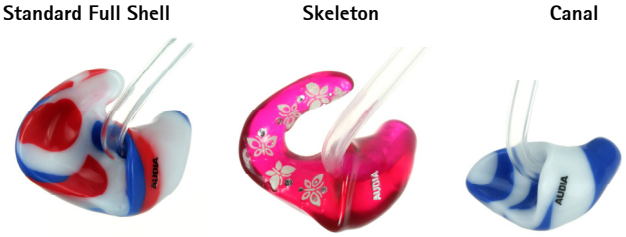


Figure 2. Earmold styles including full shell, skeleton mold and canal mold.

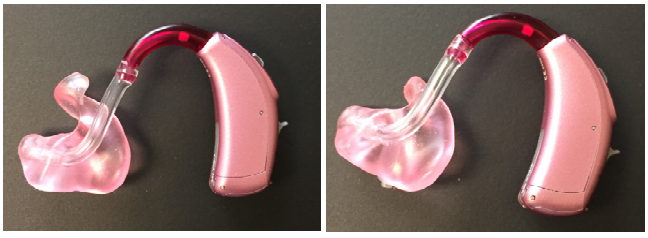


Figure 2a. Shell earmold with (left) and without (right) helix.

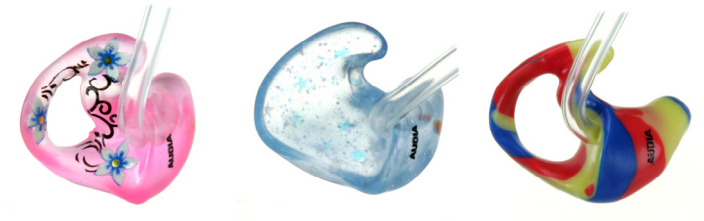
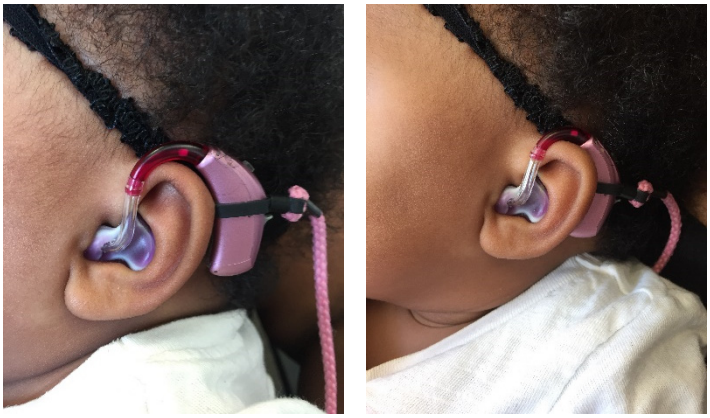


Figure 3. A sample of the variety of colors, swirls, and glitter available in pediatric earmolds

If caregivers struggle to insert a tight new earmold for a young infant, an earmold lubricant, such as glycerin or OtoEase, can be provided to simplify the process. Conversely, a sealant, such as OtoFerm, may help bridge the days before a new earmold can be obtained and when a loose earmold is resulting in feedback. When using these products, families should be advised to use sparingly and only when necessary to prevent the creation of a moist ear canal and subsequent bacterial growth. Families may need appropriate counseling support and practice with the audiologist when first learning to insert earmolds to gain confidence and competence in inserting earmolds.

Earhooks

A BTE style hearing aid requires that sound be channeled from the loudspeaker into the ear canal. Earhooks and tubing coupled to a traditional earmold are the most common coupling choices with BTE devices. Standard size earhooks often result in a floppy, loose fitting on little ears. Figure 4 shows examples of a young child with a loose fitting hearing aid with a standard size earhook and an improved fit using a pediatric size earhook. Pediatric "mini hooks" are suggested for use with infants and young children because they are shortened with a tighter curve over the ear to support hearing aid retention and optimal positioning. A comparison of the two types of earhooks is illustrated in figure 5.



Figures 4. A loose fitting hearing aid with a standard earhook (left). An improved hearing aid fitting in which a mini earhook is used to improve positioning, retention and comfort over the ear (right).

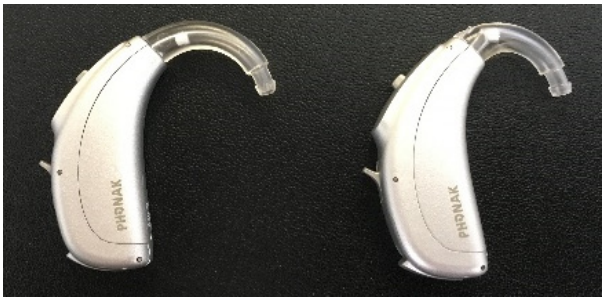


Figure 5. A BTE with a standard HE 10 680 hook (left) and a HE 10 680 mini hook (right).

Both standard and mini earhooks are available with a 680 filter to provide a smoothed frequency response in this frequency region. This filter is recommended because it smooths peaks that lead to feedback and makes it easier to optimize the maximum power output (MPO) of the device (Scollie and Seewald, 2002). It is important to note that these acoustic damping elements are made of absorptive fibers that can get damp or clogged. A water-logged filter can produce a muted response or even block the sound channel all together, leading one to believe that the hearing aid is nonfunctional. When troubleshooting, it is important to remove the hooks to ensure that the filter is not impeding performance. All Phonak BTEs are compatible with a mini earhook and tamperproof mini earhook. For additional piece of mind, all Phonak tamperproof accessories are designed to prevent small hearing aid parts from being removed and ingested by children and to comply with IEC standards. A small tool is needed to unlock the pediatric tamperproof earhook from the BTE (Figure 6). The earhooks are available in 6 colors (Figure 7) to make the selection of hearing aids more fun and appealing to children. They can also be changed at home and are an inexpensive way to personalize the hearing aids.

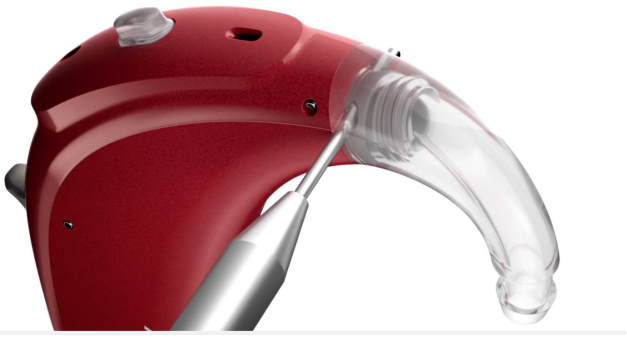


Figure 6. The Phonak tamperproof earhook being unlocked with the tool

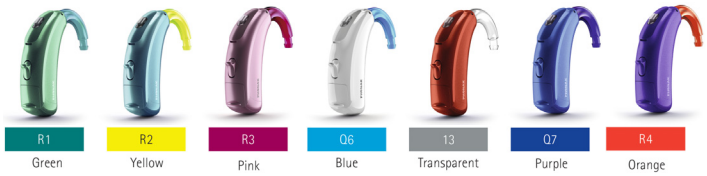


Figure 7. Phonak standard and tamperproof mini earhooks are available in 6 colors and a transparent option to personalize pediatric hearing aids.

SlimTubes

SlimTubes are an alternative coupling option for BTEs. In this case, a one-piece thin sound tube replaces the earhook and tubing. Figure 8 compares the Power SlimTube on the Phonak Naída hearing aid to a traditional coupling. SlimTubes are available in standard and power versions and multiple lengths. A dome or custom tip can be snapped onto the end of the SlimTube. It should be noted that while a SlimTube offers a cosmetically discreet solution, there are some acoustic compromises. Maximum gain and output is reduced 5-10 dB with the SlimTubes compared to the HE 10 680 standard earhook. The standard SlimTube is offered in sizes 0-3 and the Power SlimTube (compatible with Naída and Sky SP and UP) is offered in sizes 00-3. Size 0 generally works for children down to about 7 years of age. Since a SlimTube can reduce the gain and output of the device, the effects of which cannot be simulated in the coupler, it is advised to always do real ear verification of these fittings rather than simulated test box fittings using real ear to coupler differences (RECDs).

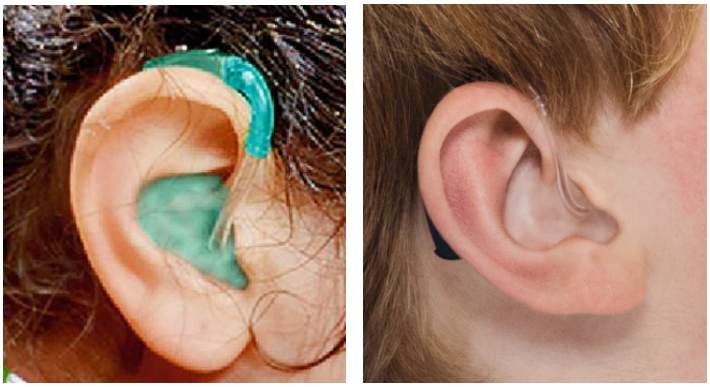


Figure 8. Traditional earhook and tubing on the left. SlimTube pictured on the right.

A variety of standard and custom tips are available for use with slim tubes. Non-custom couplings include snap-on open, closed, and power domes. The open and closed domes come in multiple diameters including small (5 mm), medium (7 mm), and large (9 mm). The power domes are a dual flange model intended for maximum occlusion and range in size from small (9 mm), to medium (10 mm), and large (11 mm). None of these are ideal for children with severe hearing losses because of the potential for sound leakage and compromised audibility due to feedback. Custom tips (Figure 9) can also be used with SlimTubes. These are fabricated from an ear impression and are available in a hard or soft material. Generally, they improve retention compared to the standard domes.

a) b)

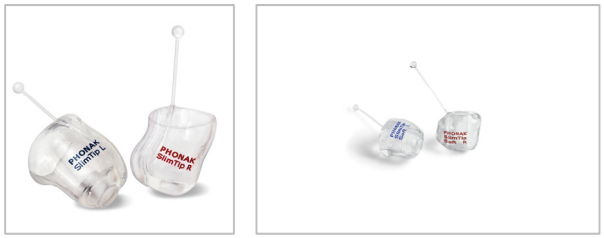


Figure 9. Custom hard (a) and soft tips (b) can be coupled to SlimTubes for improved retention

RIC Hearing Aids

Receiver-In-Canal (RIC) devices are very popular with adult hearing aid users due to their cosmetic appeal and the open fitting that is often applied with this style. Despite the generally small size of the housing of the RIC, there are several drawbacks for young children. The wire leading from the portion that goes behind the ear into the ear canal is relatively delicate and can result in more breakage than the more robust conventional BTE style hearing aid, where all of the electronic components are protected in the BTE housing. Additionally, the receiver itself is worn in the ear and young children's ear canals may not be of sufficient size to accommodate the receiver. Also, the most powerful external receivers still do not offer the power equivalent of a power BTE.

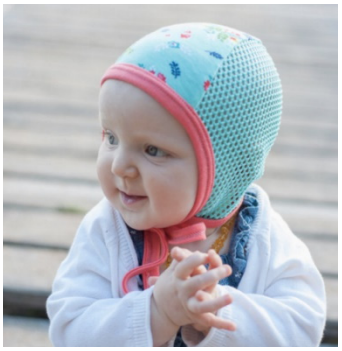
When a RIC is selected for an older child or teenager, the fitter again has the choice of standard open, closed and power domes or custom tips. For maximizing gain and output, a custom cShell option (Figure 10) is also available. The cShell includes a custom earpiece with a closed faceplate, similar to a completely-in-canal (CIC), but with a wire running to the behind-the-ear portion. This coupling is recommended when a RIC is used for hearing losses exceeding 50 dBHL. Venting can be specified. Due to the delicacy of the wired component and the fact that the receiver cannot be changed in the field (due to the sealed faceplate), the RIC and cShell solution should only be considered when the hearing aid will be managed by someone who can accept the additional care and handling required. With these considerations in mind, RICs are not the best option for an infant or young child.

Figure 10. The custom cShell encloses a canal receiver in a custom housing with a sealed faceplate.

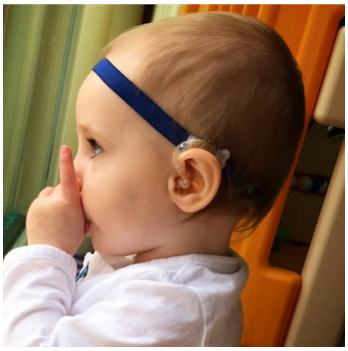
Retention options

A variety of hearing aid retention strategies are available to assist families in increasing hearing aid wear time. Options available include: double-sided tape, caps or bonnets, headbands and retention straps (Figures 11 a-c). For very young infants a small amount of double sided tape (often called 'toupee tape') applied to the inside of the BTE portion of the hearing aid may be all that is needed. As infants begin to explore with their hands and mouths and begin to remove their hearing aids, often around 4-6 months of age, use of a 'pilot type' cap may be useful. When using a cap, it is important to ensure that the portion of the cap that covers the ears is made of a material that is not too thick creating feedback or reducing the amount of sound entering the microphone of the hearing aid. Figure 11a shows an example of a pilot cap made partially with a mesh material used for this purpose. A newer solution that many families have found useful is a stretchy headband that has a rubber holder attached to the headband to hold the hearing aid in place above the ear (fig. 11b). Once children are walking, many families find that a simple retention strap as shown in figure 11c is helpful. Whatever strategy is used, as with selection of earmold colors, the one that is used most and ensures that children are wearing their hearing aids during all of their waking hours is the best choice.

a)



b)



c)

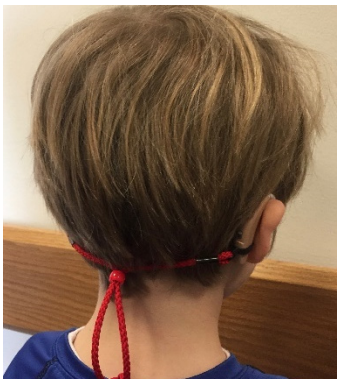


Figure 11. Retention solutions for babies include: a) pilot cap with mesh sides b) headband with sleeves, c) retention straps.

Conclusions

A variety of hearing aid styles and coupling options are available to meet the size, handling, and cosmetic needs of even the smallest users. Special considerations such as tamper proofing, durability, and size constraints should be considered when selecting the best solution for young children. The Outcomes of Children with Hearing Loss study (Tomblin et al., 2015) revealed that the three strongest predictors of auditory outcomes are early age at hearing aid fitting, well-fit hearing aids and consistent hearing aid use. Based on this evidence, pediatric audiologists can provide many critical links to support families striving to maximize auditory access and learning for their children. Well-fitted, comfortable, feedback-free devices are a necessary first step. These specialized pediatric solutions support our ability to provide successful intervention for children with hearing loss from the earliest weeks of life leading to positive outcomes for children with hearing loss.

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Christine Jones joined Phonak in 2001. She currently serves as the Director of the Phonak Audiology Research Center (PARC) where she manages a program of internal and external clinical research. Prior to this role, Christine was responsible for Phonak US Pediatrics and ran pediatric clinical research in PARC. Christine received her Master's degree in Audiology from Vanderbilt University and her Doctorate of Audiology from Central Michigan University.