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- Hospital for Sick Children, Toronto, ON
- Hamilton Health Sciences, Audiology, Hamilton, ON
- Vancouver Coastal Health, Vancouver Community Audiology Centres, Vancouver, BC
- Montreal Children's Hospital, Montreal, QC
- Fraser Health (South Region), Surrey, BC
- Nova Scotia Hearing & Speech Clinics, Halifax, NS
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Introduction to the UWO PedAMP v1.0

Pediatric audiologists have a common goal of providing infants and children who have permanent hearing loss appropriate access to sound through the use of hearing aids. Suitable technology and evidence-based hearing aid fitting protocols (i.e., American Academy of Audiology [AAA], 2003; Bagatto, Scollie, Hyde & Seewald, 2010; British Columbia Early Hearing Program [BCEP], 2006; College of Audiologists and Speech Language Pathologists of Ontario [CASLPO], 2002; Modernising Children's Hearing Aid Services [MCHAS], 2005) support accurate and safe hearing aid fittings so that infants and children identified with permanent childhood hearing impairment (PCHI) have an opportunity to develop language and literacy skills. The aim of providing hearing aids is to improve functional auditory capacity and participation in hearing- and communication-specific situations. The provision of amplification is a process that includes the calculation of prescriptive targets based on accurate hearing assessment information, the selection of the physical and electroacoustic elements of a hearing aid, verification that the specified acoustical prescriptive targets have been achieved, and outcome evaluation of device effectiveness in daily life. Of these stages, outcome evaluation does not currently have a systematic approach described in many pediatric hearing aid fitting protocols. Additionally, monitoring of infants at high risk of developing late-onset or progressive hearing impairment or those with PCHI who do not wear hearing aids (i.e., due to family choice) is an important aspect of pediatric audiology services. A lack of clinical tools with known normative properties, feasibility, validity, and utility has been a barrier to the development of an evidence-based evaluation protocol. The University of Western Ontario Pediatric Audiological Monitoring Protocol Version 1.0 (UWO PedAMP v1.0) consists of a battery of outcome evaluation tools and aims to systematically evaluate several auditory-related outcomes of infants and children with PCHI who may or may not wear hearing aids.

Monitoring the hearing-related outcomes of infants and children with hearing loss can be accomplished both objectively and subjectively. Visual reinforcement audiometry (VRA) can be conducted in the sound field with the child wearing his/her hearing aids. This measures the child's aided ability to detect low-level sounds in a clinical, and is considered an *objective* measure. Questionnaires, diaries, and structured interviews are examples of *subjective* ways to assess a child's auditory behaviours in the real world. A combination of objective and subjective outcome evaluation tools will provide a multi-dimensional approach to tracking a child's auditory-related performance

over time. A test battery of outcome evaluation tools provides parents and clinicians with a way to measure the audiological performance of an infant or child during the early months as well as later years of hearing aid use or non-use (i.e., if the child has a known hearing loss but does not wear a device).

Characteristics of a Good Outcome Evaluation Tool

The quality of an outcome evaluation tool should be assessed before including it in an outcome evaluation guideline. Several researchers have described criteria for assessing the quality of outcome evaluation tools in rehabilitation (Andresen, 2000; Cox, Hyde, Gatehouse, Noble, Dillon, Bentler, et al., 2000; Hyde, 2000). A good outcome evaluation tool should have *conceptual clarity* to ensure that it covers the relevant domains intended to be measured. *Normative data* for comparison purposes are a valuable aspect of any outcome evaluation tool. Published norms allow the clinician to compare the results obtained from the tool to standards for normal hearing and hearing impaired children. The *measurement model* of a good quality tool should be able to capture the true breadth and detail of the differences in the group being measured. Tools that consistently result in responses at the bottom (i.e., floor) or top end (i.e., ceiling) of the scale are not assessing the true range of the population being assessed. The outcome evaluation tool should *not have bias* either within the items or the instrument as a whole; the responses should not be affected by differences in culture, social circumstances, etc. Excessive *respondent and administrative burden* should be avoided with outcome evaluation tools. The length and the content should be acceptable to the respondent and the tool should be easy to administer, score and interpret by the clinician. Statistically, the tool should have good test-retest *reliability*, internal consistency, *validity,* and *responsivity*. These qualities were considered when selecting outcome evaluation tools for the UWO PedAMP v1.0.

Questionnaire- and interview-based outcome measures for infants and children with PCHI were examined for this version of the guideline. While there are many subjective tools available for this population, few meet the criteria mentioned above (Bagatto, Moodie, Seewald, Bartlett & Scollie, 2011). For those that do, many are more appropriate for older children and do not assess areas of early auditory development in infants from birth to two years of age who wear hearing aids. In addition to structured parental reports using questionnaires and interviews, behavioural assessment of auditory function serves as an objective outcome measure. The operant conditioning paradigm

employed with VRA can be modified to assess aided auditory function and confirm behavioural responses to sound. In the aided condition, VRA can be used in conjunction with subjective questionnaires as part of a more complete outcome evaluation guideline for infants and children with hearing loss. For this version of the UWO PedAMP, protocols for objective measures of aided auditory function have not yet been included, but are currently being developed.

The questionnaires included in this version of the UWO PedAMP were chosen based on a critical review of their statistical and practical qualities (Bagatto et al., 2011). Prior to clinical implementation, a purposefully selected sample of pediatric audiologists from provinces across Canada (Nova Scotia, Quebec, Ontario, Alberta, and British Columbia) were invited to examine each of the outcome evaluation tools and offer their subjective opinion. They work in private practice, public health and hospital-based settings. Soliciting opinions and experiences from respondents, clinicians, and researchers has been recommended when developing outcome evaluation tools and clinical practice guidelines (Graham, Logan, Harrison, Straus, Tetroe, Caswell, et al., 2006; Andresen, 2000). Including this community of practice (CoP) early in the process of guideline development provided an opportunity to use an engaged community with a shared understanding of the knowledge needed and who had the ability to assist in tailoring or customizing the knowledge for better use among intended end-users (Stahl, 2000; Gajda & Koliba, 2007, 2008; Salisbury, 2008a, 2008b; Koliba & Gajda, 2009). Opinions were gathered from the pediatric audiology CoP regarding the clinical relevance, quality, feasibility, utility, executability, acceptability, and comparative value of each of the chosen UWO PedAMP v1.0 outcome evaluation tools (Moodie, Bagatto, Miller, Kothari, Seewald & Scollie, 2011). When possible, modifications to the outcome evaluation tool, scoring, and/or instruction set was made and training materials were developed based on audiologist responses and feedback (Moodie, et al., 2011). In addition to information regarding each of the UWO PedAMP measures, this CoP provided valuable information about the barriers to implementing outcome evaluation tools in clinical practice and possible facilitators to implementation. The pediatric audiologist CoP was provided with an opportunity to appraise the entire UWO PedAMP v1.0 guideline when it was completed and provided the authors with implementation information over an initial time period in which they put the UWO PedAMP into clinical practice. The information that was obtained from this group of pediatric audiologists, and which we hope to continue to collect, has had a positive impact on the development of the UWO PedAMP and the authors gratefully acknowledge and value the input of the pediatric audiologists.

Contents of the UWO PedAMP v1.0

The UWO PedAMP v1.0 is an extension of current pediatric hearing aid fitting protocols (e.g., Bagatto, et al., 2010) and includes two types of outcome evaluation tools: (a) clinical process outcome measures to characterize the implementation of the previous stages of the hearing aid fitting process (e.g., verification) to aid in the interpretation of functional outcomes; and (b) individual patient functional outcome measures in a two-stage process by developmental level. The functional outcome measures aim to measure auditory-related outcomes in children. The following dimensions are included: (a) subjective assessment of early auditory development; (b) subjective ratings of auditory performance in daily life; (c) subjective judgement of the presence or absence of speech production; and (d) objective detection of aided sound. Some dimensions are assessed at certain ages (a, b, c) while others are assessed continuously (d). The tools included in version 1.0 of the UWO PedAMP are the:

1) Infant Hearing Program (IHP) Amplification Benefit Questionnaire
2) Hearing Aid Fitting Summary
3) Aided Speech Intelligibility Index (SII) Normative Values
4) LittlEARS Auditory Questionnaire (Tsiakpini, Weichbold, Kuehn-Inacker, Coninx, D'Haese & Almadin, 2004; Copyright MED-EL 2004)
5) Parent's Evaluation of Aural/Oral Perfomance of Children (PEACH) (Ching & Hill, 2005; Copyright Australian Hearing 2005)
6) Canonical Babbling Interview[1]
7) Aided Audiogram[1]

The UWO PedAMP is intended to be used with children with permanent hearing loss from birth to age 6 years who may or may not wear hearing aids. The following sections provide an overview of each tool as well as suggested administration guidelines, instructions for scoring, frequently asked questions, case examples and references. In addition, a section describing important details of the

[1] At the time of this writing, the Canonical Babbling Interview and the Aided Audiogram were still in the pilot phase and under development. They may be included upon completion of the pilot phase.

hearing aid verification process (i.e., clinical process outcomes) has been included. The quality of the hearing aid fitting plays a significant role in the child's outcome, therefore the verification process warrants attention as part of this guideline. As previously mentioned, given the lack of normed and validated outcome evaluation tools for infants and children with hearing loss, the contents of the UWO PedAMP will be re-evaluated and revised as more information is gathered through its implementation in clinical practice. Work has been done to support the characterization and validation of existing tools with normal hearing and hearing impaired children with hearing aids up to six years of age. Children of various audiometric and medical profiles were included in the longitudinal intervention study and details can be found in an article at the end of this manual (Bagatto, Moodie, Malandrino, Richert, Clench & Scollie, 2011).

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Administration of the UWO PedAMP in the Ontario Infant Hearing Program

The Ontario Infant Hearing Program (IHP) is a comprehensive program which identifies children born deaf or hard of hearing and provides the supports and services they need to develop the language and literacy skills necessary to achieve success in school. The program provides services for children from birth to age six who are identified with permanent childhood hearing impairment (PCHI) and their families/caregivers. As well, it monitors those children born with, or who acquire risk indicators for permanent hearing loss throughout early childhood. Program protocols are in place to provide universal newborn hearing screening, audiological assessment for those babies who do not pass the screening, and amplification and communication development services for children found to be deaf or hard of hearing.

The majority of children with PCHI enrolled in the IHP use hearing aids to facilitate development of communication skills and readiness for school. Measuring the impact of the hearing aid fitting is important for tracking an individual child's progress as well as evaluating the program as a whole. The outcome evaluation tools within this version of the UWO PedAMP provide a systematic method for monitoring children enrolled in the IHP. This section will describe the administration of the UWO PedAMP within the IHP and includes the following:

1) Administration Guideline for children with *aided* hearing loss (Figure 1)
2) Administration Guideline for children with *unaided* hearing loss (Figure 2)
3) A description of the IHP Amplification Benefit Questionnaire
4) Data entry details for each tool within the UWO PedAMP
5) The IHP Amplification Benefit Questionnaire
6) A Clinical Summary Form for optional use by clinicians wishing to track scores and dates of repeated administration of the UWO PedAMP for an individual child

Information regarding Hearing Aid Fitting Details, the LittlEARS, and the PEACH are provided in separate sections of this manual.

UWO PedAMP Administration Summary

The following grids summarize the administration of each outcome evaluation tool within the UWO PedAMP v1.0 during a child's routine follow-up. Figure 1 describes the administration guidelines for a child who wears hearing aids and Figure 2 for a child who *does not* wear hearing aids.

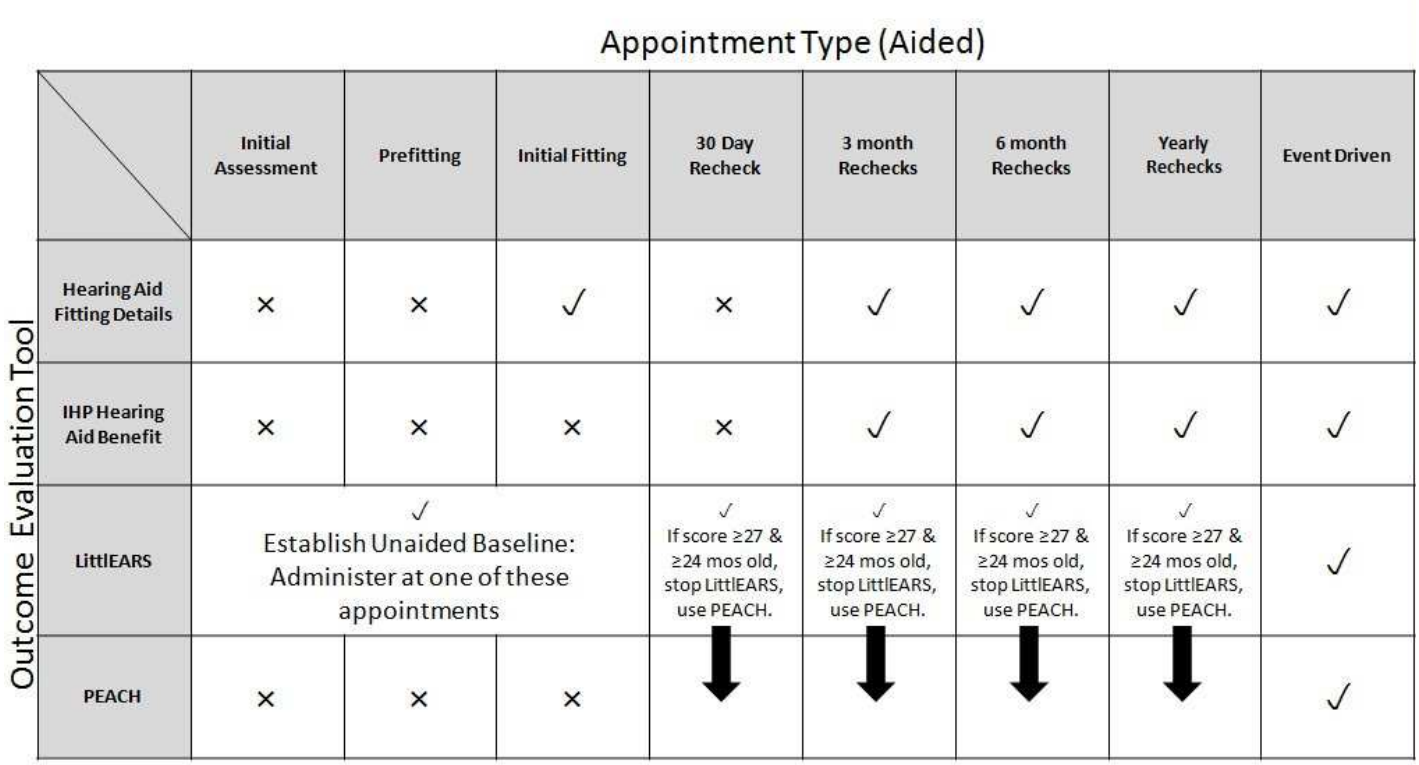

Figure 1: Guidelines for the administration of the UWO PedAMP for infants and children who wear hearing aids. The top row specifies the routine appointment type and the far left column indicates the outcome evaluation tool within the UWO PedAMP that should be administered. Within the grid, "✓" and "X" designates when an outcome evaluation tool should or should not be administered at a particular appointment. An example of an Event Driven situation is when the child's hearing changes resulting in a change in hearing aid settings that did not occur at a routine appointment.

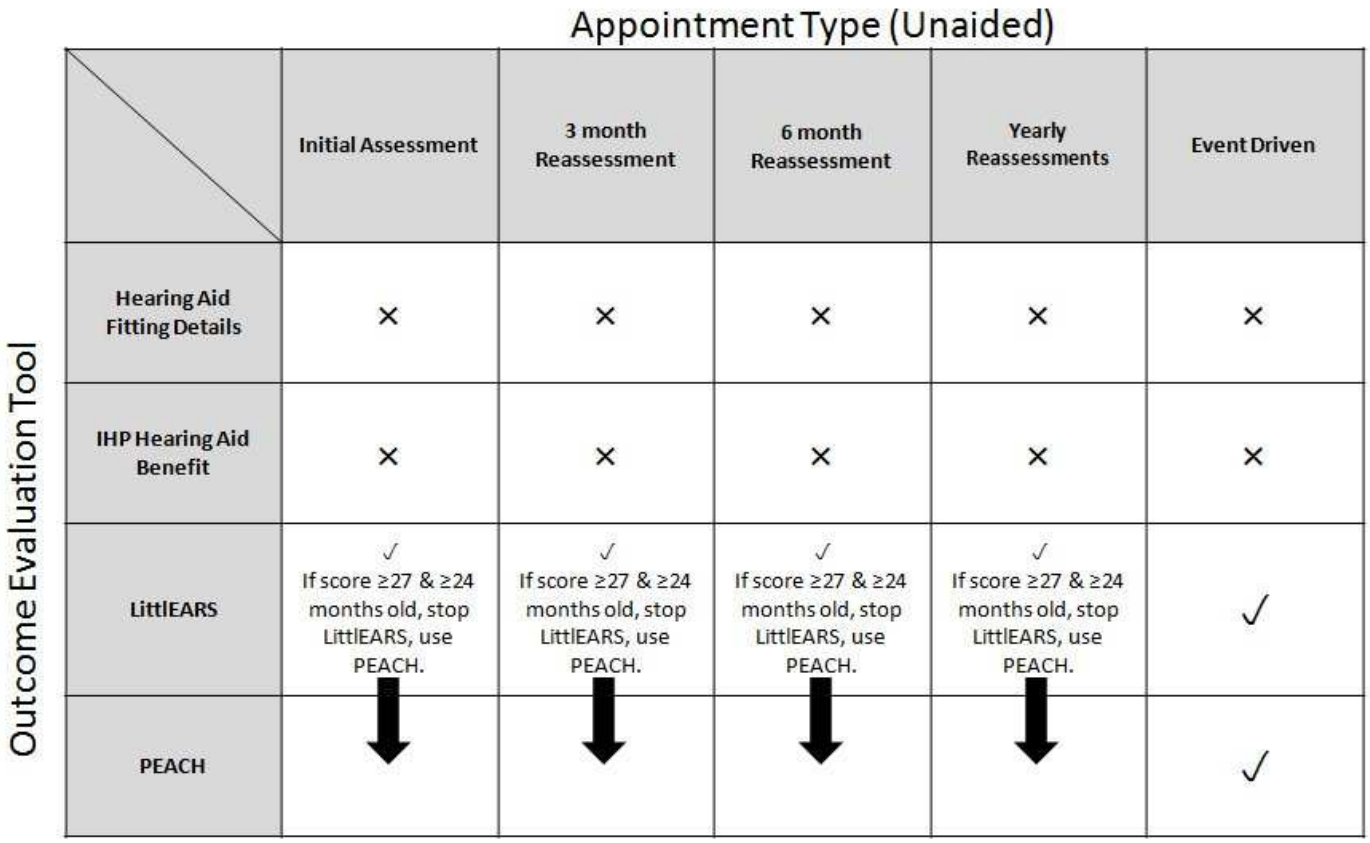

Figure 2: Guidelines for the administration of the UWO PedAMP for infants and children who do not wear hearing aids. Some children identified with PCHI may not wear hearing aids due to parental choice (i.e., ANSD, unilateral or mild hearing losses).

The IHP Amplification Benefit Questionnaire

This 11-item questionnaire was jointly developed by the IHP and the members of the Child Amplification Laboratory at the University of Western Ontario. Using a 5-point rating scale, this tool addresses acceptance and use of hearing aids, auditory performance for different levels of sound, effectiveness of service delivery and overall satisfaction. The final question is open-ended and asks the parent about how hearing aid services could be improved within the IHP. The questionnaire should be answered by the parent after their child has worn hearing aids for *three months or more* so as to give the parent a chance to become comfortable with their child's hearing aids and the services offered by the IHP. It should be readministered at follow-up visits thereafter (see Figure 1). It was piloted at the University of Western Ontario H.A. Leeper Speech and Hearing Clinic to determine if there were any administrative or respondent issues with the items. The questionnaire takes a few minutes to complete and a summary of some responses to date are provided in the Table 1 below as well as some comments from parents regarding hearing aid services.

Table 1: Preliminary Results from IHP Amplification Benefit Questionnaire

Item	Question	Responses				
		3 mos	**12 mos**	**24 mos**	**36 mos**	**60 mos**
1	About how many MONTHS ago was your chid first fitted with the PRESENT hearing aids?	2	29	18	17	3
		Never	**<1 hr**	**1 to 4 hrs**	**4 to 8 hrs**	**>8 hrs**
2	How much does your child use hearing aids in a typical day?	0	2	11	22	47
		Never	**Rarely**	**Sometimes**	**Most of the Time**	**Always**
3	Does your child willingly accept wearing the hearing aids?	1	4	9	28	40
4	Overall, how well do you feel your child responds to sounds, when wearing the hearing aids?	0	0	6	42	34
5	Wearing the hearing aids, does your child respond to soft sounds?	1	0	16	44	21
6	Wearing the hearing aids, does your child show discomfort to loud sounds?	21	19	34	4	4
7	When putting the hearing aids on your child, do you check that they are working properly?	2	1	4	19	56
8	Do you know how to fix problems with the hearing aids when they occur?	10	8	19	33	12
9	Considering everything, do you think the hearing aids are worth the effort?	1	2	7	26	46
10	Considering everything, how satisfied are you with the hearing aid services you have received for your child?	0	1	4	20	57

Question 11: If you can think of ONE most important way the hearing aid services for your child could have been better, please describe very briefly:

- None. Very happy with all the services except AV prescription.
- Nothing.
- More appointments with AVT and Audiology.
- Have to wear hearing aids too long; on waiting list.
- Charge less for dispensing fee.
- Want in-the-ear hearing aids.
- I am very happy with all the support we have received from everyone involved!!!!
- Why do we have to attend so many appointments?
- Pretty good as they are.
- To test 2 to 3 times before finally adjusting the volume. Explain to families why adjustments were made and bring families in on changes especially when results were worse than before.

Frequently Asked Questions

Should the parent complete the information section at the top part of the questionnaire?
The parent or the audiologist can complete the general information in the top section of the questionnaire if desired.

Does Question #10: "Considering everything, how satisfied are you with the hearing aid services you have received for your child, in the Infant Hearing Program?" refer to audiology or dispensing services?
This question is a general question about satisfaction with all components of hearing aid services the parent receives. It has been decided to keep one general overall question regarding satisfaction with hearing aid services at this time, rather than try to ask the parent multiple questions to separate audiology services from dispensing services from other types of services.

How should I administer the questionnaire?

This questionnaire can be administered interview-style, independently in the waiting room or clinic office or by mail. It is important to ensure that the clinician review the responses with the caregiver following completion to determine if there are points of discussion.

In what languages are the IHP Amplification Benefit Questionnaire offered and where can I find them?

The IHP Amplification Benefit Questionnaire is offered in English, French, Bengali, Dutch, Farsi, Gujarati, Mandarin, Portuguese, Somali, Spanish, Tamil, Urdu and Vietnamese. They can be found on the DSL website at www.dslio.com.

IHP Data Reporting

Data gathered from each outcome evaluation tool within the UWO PedAMP will be tracked by the IHP for program evaluation purposes; the data will not be used to evaluate individual clinicians. This will be discussed further in the following sections. Table 2 summarizes the data items to be provided to the IHP database for each tool.

Table 2: IHP Data Reporting Summary

Outcome Evaluation Tool	Data	Entry Format
IHP Amplification Benefit Questionnaire	Date completed	dd/MMM/yyyy
	Background information	Provider name, respondent, months of hearing aid use
	Rating for 9 questions	Frequency ratings
	One open-ended answer	Text from open-ended answer
Hearing Aid Details	RECD	Measured Predicted Measured on Other Ear Entered previous measurement
	Speech Intelligibility Index (SII)	Value for Soft Speech (55 dB) Value for Average Speech (65 dB)
	Maximum Power Output (MPO)	Measured (Yes) Not Measured (No)
LittlEARS	Date completed	dd/MMM/yyyy
	Total 'yes' score	Value from 0 to 35
PEACH	Date completed	dd/MMM/yyyy
	Rating for each question	Rating of Never, Seldom, Sometimes, Often, Always for 13 items.
	Final score	Overall Score from 0 to 100

References

Cox, R.M., Hyde, M., Gatehouse, S., Noble, W., Dillon, H., Bentler, R., et al. (2000). Optimal outcome measures, research priorities and international cooperation, *Ear Hear, 21*, 106S–15S.

Hearing Aid Fitting

Background Information

Hearing aids are used or worn for a trial period by the majority of children who have been identified with permanent childhood hearing impairment (PCHI). Evidence-based pediatric hearing aid fitting protocols are used in order to ensure that an infant's hearing aid will positively impact on his or her ability to develop auditory skills in daily life (e.g., AAA, 2003; Bagatto, et al., 2010). Outcome evaluation is designed to be completed following the hearing aid verification stage of the fitting process as it allows one to measure the impact of the fitting. Since positive outcomes infer good hearing aid fittings, it is important to monitor factors associated with 'good' hearing aid fittings as part of the UWO PedAMP. There are two primary reasons to monitor hearing aid fitting details. First, each clinician can determine whether an **individual child's fitting** is providing a typical degree of audibility. For example, if the output of the hearing aid is significantly less than the DSL v5.0a prescription, the child's ability to use sound for development may be impacted more so than for a child with a typical fitting. Clinicians and parents will have a better understanding of how the child is progressing with respect to audiological outcomes when details of the hearing aid fitting are tracked as part of an overall outcome evaluation guideline.

The second reason for monitoring hearing aid fitting details is **at the level of the program** as a whole. The brief fitting details gathered in this protocol will help to determine, for example, the typical rate at which real-ear-to-coupler difference (RECD) measures are made, or the typical amount of audibility provided by hearing aids. Health care programs that receive government funding are increasingly being pressured to document that the programs being implemented have measurable outcomes for reporting purposes.

As part of the UWO PedAMP, audiologists have been provided with two tools to monitor their hearing aid fitting details, which include:

1) Hearing Aid Fitting Summary

2) Aided SII Normative Values: Birth to 6 Years v1.0, r1

Used together, they provide helpful information for the audiologist, parents/caregivers, and health policy makers about the hearing aid fitting as part of an outcome evaluation guideline. Each tool will be discussed in detail later in this section of the manual.

Summary of Hearing Aid Verification

The UWO PedAMP assumes that the audiologist has followed preferred practice guidelines for pediatric hearing assessment and the fitting of hearing aids to infants and young children (Joint Committee on Infant Hearing, 2007). Several steps are followed in the verification stage of the pediatric hearing aid fitting process. Once hearing aids have been obtained, simulated (or predicted) real-ear measurements of hearing aid performance are the preferred method of verification for infants and young children and are recommended by several pediatric hearing aid fitting protocols (i.e., AAA 2003; Bagatto, et al., 2010). The real-ear performance of the hearing aid is predicted, from coupler measures, using the infant's RECD (Seewald, Moodie, Sinclair & Scollie, 1999). The hearing aid is attached to the HA-2 coupler and placed in a test box, and verification of hearing aid performance is conducted at various input levels representing soft, average, and loud speech (i.e., 55 to 75 dB SPL) in order to evaluate fit to prescriptive targets and determine audibility of speech (Figure 3). The hearing aid's maximum power output (MPO) is verified using narrowband stimuli. Figure 3 displays one example of this procedure. The solid lines represent the output of the hearing aid at various input levels. These are compared to the prescriptive targets represented by the plus (+) signs or asterisks (*). The clinician then evaluates how closely the output of the hearing aid matches the prescribed targets. A close match is encouraged to ensure that speech is audible and loud sounds are not uncomfortable, across a broad frequency range. This coupler-based approach to electroacoustic verification allows shaping of the hearing aid response in the highly controlled test box environment, while also avoiding the need to ask the infant or young child to sit still, quiet, and cooperate while real-ear verification measures are performed. This facilitates routine verification of hearing aids for young patients, which are conducted at regularly scheduled follow-up visits.

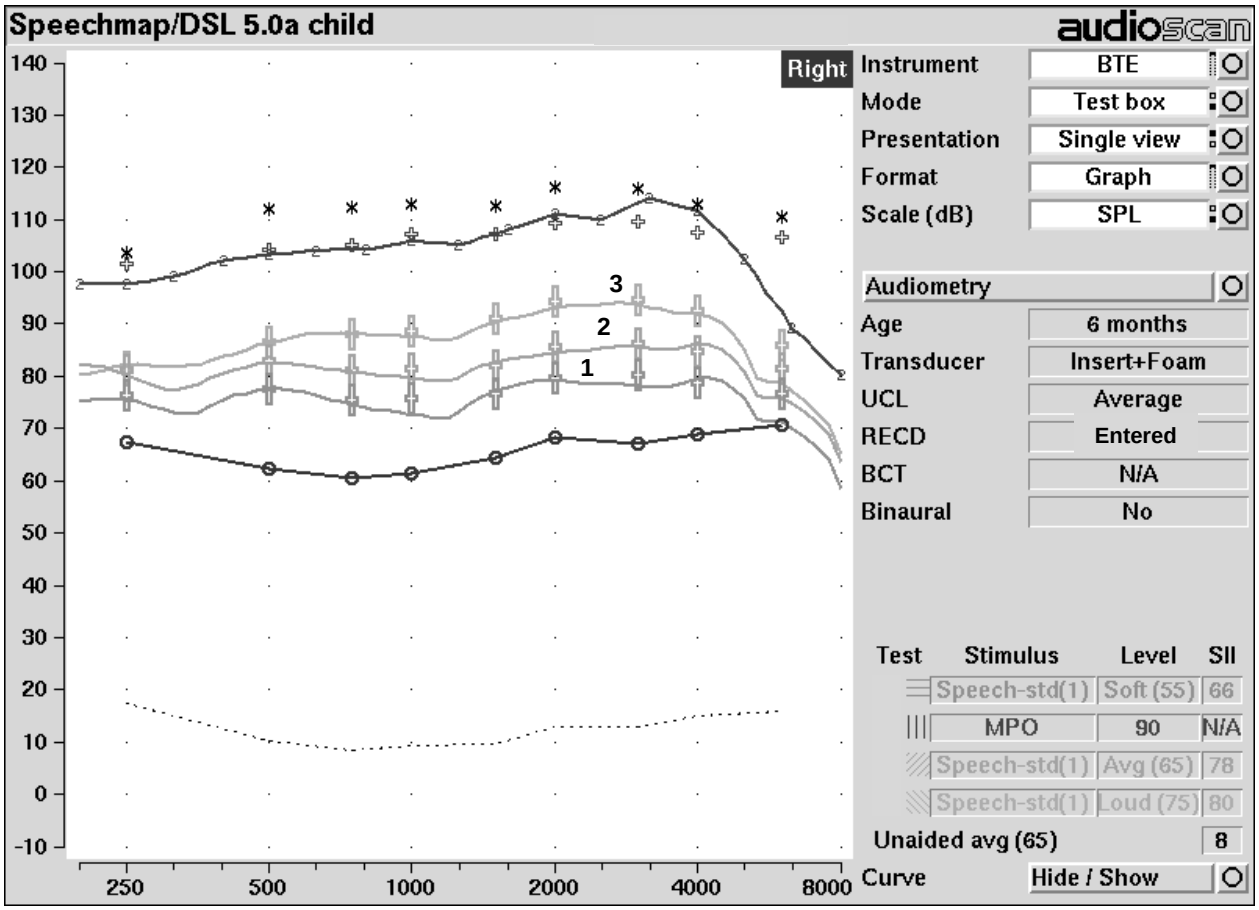

Figure 3: SPLogram display of hearing instrument performance in relation to pediatric DSL *m*[i/o] v5.0a targets for a child with a PTA of 52 dB HL. The solid lines represent the output of the hearing instrument for soft (1), average (2), loud (3) speech inputs and MPO (4) in relation to the various speech targets (large +) and MPO targets (small +). Thresholds (o) and upper limits of comfort (*) are also displayed.

Outcome evaluation of the hearing aid fitting will be measured through the use of the UWO PedAMP. In this guideline, the aim is to minimize the time needed to capture the hearing aid fitting details. For this reason, the exact fit-to-targets at each frequency and test level do not need to be documented. Instead, the overall amount of audibility provided for low and moderate level speech (via the Speech Intelligibility Index [SII]) and whether or not key protocol elements were measured for each fitting (RECD, MPO) can be tracked. These tracked items are discussed in the following sections, with the Hearing Aid Fitting Summary and Aided SII Normative Values clinical forms provided at the end of this section.

Real-Ear-to-Coupler Difference (RECD)

The UWO PedAMP assumes that the pediatric audiologist will measure the child's RECD values whenever it is possible. The RECD is a measurement of the acoustic properties of an individual's occluded ear canal. The acoustics of infant ear canals vary greatly from the average adult and change over time as the infant's ear grows. Many pediatric amplification protocols require the audiologist to attempt measurement of the infant's RECD to obtain an individualized acoustic transform for use within the DSL (Desired Sensation Level) prescriptive method (Moodie, Seewald & Sinclair, 1994; Scollie, Seewald, Cornelisse, Moodie, Bagatto, Laurnagaray, et al., 2005). The individual's RECD is used in the hearing aid fitting process to obtain predicted ear canal sound pressure level (SPL) thresholds, generate the appropriate gain and output response for a hearing aid, and has been shown to be highly repeatable and valid for the purposes of infant hearing aid fitting (Munro & Hatton, 2000; Sinclair, Beauchaine, Moodie, Feigin, Seewald & Stelmachowicz, 1996; Seewald, et al., 1999).

As the infant's external ear canal grows, the acoustic properties of the ear will change substantially (Kruger, 1987; Feigin, Kopun, Stelmachowicz & Gorga, 1989). This change in ear size will necessitate new earmolds on a frequent basis, especially during the first year of life. Whenever a new earmold is made, an RECD measurement should be obtained and applied in the calculation of prescriptive targets for the hearing aids. Hearing aids are re-verified and re-tuned with revised thresholds and RECD measurements over time, by entering new information, recalculating new targets, and readjusting to maintain the fitting and audibility.

In the event that the individual RECD measurement cannot be obtained, age-related predicted values can be applied (Bagatto, Scollie, Seewald, Moodie & Hoover, 2002; Bagatto, Moodie, Scollie, Seewald, Moodie, et al., 2005). Current age-related predicted values are derived from data collected from infants and children of varying ages and are provided for foam tip and earmold coupling (Bagatto, et al., 2002; 2005). It is important to note that these values were collected on infants and children with normal middle ear status and will not reflect any acoustic changes that a fluid filled middle ear or perforated eardrum will display, in the individual ear. For these reasons it is important to attempt an RECD measurement on an infant whenever possible.

Speech Intelligibility Index (SII)

The SII is a value representing the proportion of speech that is heard by the listener through his/her hearing aids (ANSI S3.5, 1997). The SII is an acoustic measure, not a behavioural prediction. This means that the SII represents the audibility of speech, and is not a prediction of speech recognition scores. The SII provides a value that clinicians, parents, and teachers can use to conceptualize the proportion of speech that is available to the child. It is important to note that for speech input levels higher than approximately 62 dB SPL, a level distortion factor is applied. Particularly for listeners with severe to profound hearing loss, this correction makes the SII value appear lower than one would expect. SII values are provided from hearing aid verification systems (e.g., Audioscan®, Interacoustics) for various speech inputs and are based on the real-ear sound pressure level thresholds (converted from dB HL using the RECD) and the measured real-ear aided response (REAR) of the hearing aid. If a clinician has performed multi-level speech-based real-ear verification of the young child's hearing aids, they would also be provided with the associated SII values for these measurements. For instance, in Figure 3, the measured real-ear performance of the child's hearing aids for an average speech input provides an associated SII value of 78% which indicates that 78% of moderate-level speech is audible to the wearer. The clinician will also be provided with SII values for verification measures made with other speech input levels. In this example, 66% of soft speech is audible when heard in a quiet environment.

At this point, published normative data relating the specific SII values for acceptable hearing aid fittings are not available. However, work from a study conducted with pediatric audiologists across Canada have provided some normative data for SII values associated with pediatric hearing aid fittings (Moodie, 2009). Data from 161 infants with hearing loss are provided in Figure 4. The majority of these fittings were within 5 to 7 dB of the prescribed DSL v5.0 target. It can be seen that a general pattern emerges in which the SII values decrease as hearing level increases. This trend is due to the application of the level distortion factor associated with the SII calculation and narrower bandwidth typical of higher gain fittings.

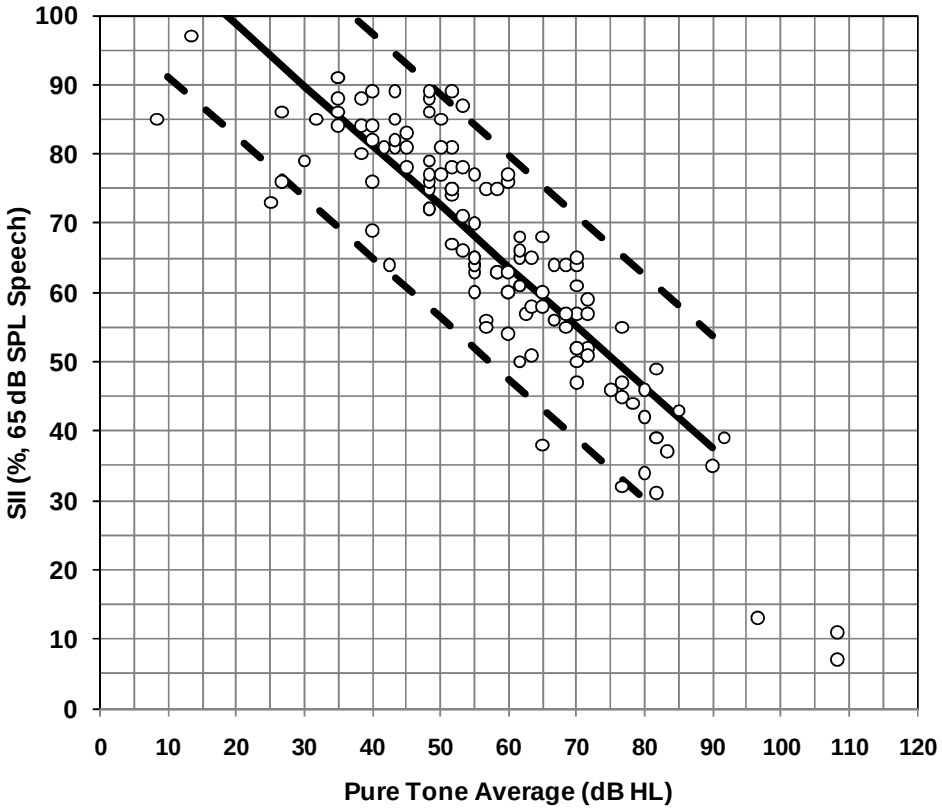

Figure 4: Aided SII Normative Data displaying SII values for a 65 dB speech input for a wide range of hearing losses. The SII values were obtained from hearing aid fittings on 161 ears of infants and children. The open circles represent individual SII values for a given pure tone average. The solid line represents the linear fit to the data and the dashed lines represent the upper and lower 95% confidence interval ranges. An SII value that falls between the dashed lines is considered to be a good value for that pure tone average.

What is also notable is the relatively little data in the severe to profound PTA range. Recall that an SII value that falls within the dashed line is considered acceptable for that PTA hearing loss. Due to the lack of data in the region with higher PTA, a guideline for SII values is not provided at this time. Users of the SII Normative Values v1.0, r1 should extrapolate these values with caution.

Maximum Power Output (MPO)

Every hearing aid has a maximum power output (MPO) which is the level beyond which the aid will no longer amplify sound. The purpose of setting the MPO to an appropriate level is to ensure the safety of the residual hearing and listening comfort for the wearer when loud sounds are

encountered. The DSL *m*[i/o] v5.0a prescriptive formula calculates MPO targets based on the listener's hearing thresholds. The UWO PedAMP assumes measurement of the MPO of each hearing aid as a required component of verification.

Guidelines for Reporting Hearing Aid Fitting Details

To facilitate the collection of relevant hearing aid fitting details, the UWO PedAMP provides a Hearing Aid Fitting Summary form. This form provides a way of recording, at regular intervals, important information about the hearing aid fitting. The UWO PedAMP recommends that the details of the RECD measurement, the SII values associated with low and moderate level speech inputs, and acknowledgement that an MPO measurement was made be recorded on this form at the initial hearing aid fitting and at 3-month, 6-month and yearly follow-up visits. Hearing aid fitting details may also be provided in event-driven situations. A summary of the clinical administration guidelines can be found in Figure 1 in the IHP section of this manual.

For both individual-level and program-level outcome evaluation, it is of interest to know whether the RECD was *individually measured* or *predicted*. A complete outcome measure for the RECD will indicate how the RECD was obtained (measured, predicted) for each ear. The clinician may indicate whether the RECD was measured or predicted for each ear. If an RECD was measured on one ear and applied to the other ear, an option for *measured in other ear* is available (see Hearing Aid Fitting Summary Form at the end of this section).

For many pediatric hearing aid fitting protocols, measurement of the real-ear aided response (REAR) for low and moderate speech inputs are required. Since hearing aid verification systems provide an associated SII value for all REARs, the next step is to document the SII values. The clinician's judgment is the most important way to determine an acceptable hearing aid fitting. The SII norms provide a gross index to supplement the clinician's judgment of fit-to-targets and are an overall indicator of the fitting's audibility. The fit-to-targets data show that many of the fittings were within the 5-7 dB range. Investigation of hearing aid fittings that fell 10 dB or more below target was generally associated with technology that was several years old. The fit-to-target work has revealed that the SII is not highly sensitive to minor or medium deviations from target. But it is sensitive to

large, for example 20 dB, deviations from target. Given that the SII is already calculated in some real-ear systems, these norms allow the clinician to make use of the SII by PTA and it can be useful for counseling purposes. It is therefore recommended that the following fit-to-target criteria be considered before using the v1.0, r1 norms:

1) **For hearing losses up to and including 70 dB PTA**: Determine whether your patient's hearing aid fitting is within 5 dB of the target from 250 through 2000 Hz for average and soft speech inputs and within 5 to 7 dB of the target at 4000 Hz;

2) **For hearing losses in the severe to profound range**, attempt to fit as closely as possible to the prescribed target, understanding the inherent limitations in this type of fitting.

3) When the criteria in 1 or 2 are met, the aided SII norms seen in the attached worksheet can be used as they were previously.

When the above criteria are met, an SII for a given PTA is considered acceptable if it falls within the dashed lines for soft (55 dB SPL) and average (65 dB SPL) speech level inputs. Including the *SII for low and moderate speech* in the outcome evaluation process will provide information about the quality of the hearing aid fitting for each ear for a particular patient. A complete outcome measure for the SII will include a value from 0 to 100 for low- (55 dB SPL) and moderate-level (65 dB SPL) speech. In summary, two SII values per hearing aid fitting will be entered on the Hearing Aid Fitting Summary form.

The data recorded on the form related to the individual fitting SII values can be transferred to the Aided SII Normative Values form to visually see that the child has a high-quality hearing aid fitting. For example, the SII value that is associated with the child's hearing aid fitting in Figure 3 can now be plotted on the Aided SII Normative Values form and a judgement about the appropriateness of the fitting relative to the normative data can be made. Figure 5 plots the results of the SII value associated with average speech results from Figure 3 on the Aided SII Normative Values v1.0, r1 form. Results indicate that the fitting for a child with a 52 dB HL PTA falls within the 95% confidence interval and therefore would be considered electroacoustically acceptable and the clinician could proceed with using the outcome evaluation tools (i.e., LittlEARS, PEACH) with the knowledge that they have started with a good quality hearing aid fitting.

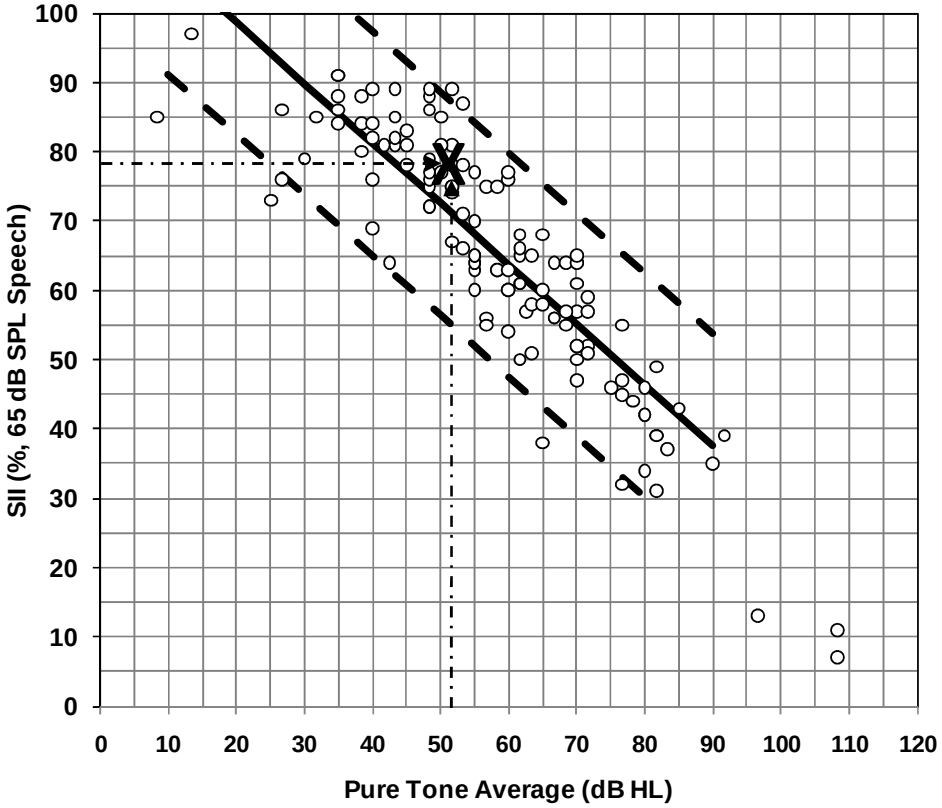

Figure 5: Aided SII Normative Values graph with the SII value for a moderate level speech input from the fitting in Figure 3 above. The child has a pure tone average (PTA) of 52 dB HL and the SII value for a 65 dB SPL speech input was measured to be 78%. Therefore, the X represents the intersection of PTA and SII for this fitting. Note that the X falls within the dashed lines indicating it is an acceptable fitting for this child's PTA.

Since the MPO is measured using a narrowband signal and not speech, there is no SII value associated with it. Therefore, the clinician should indicate whether or not the MPO was measured during the child's hearing aid fitting and any follow-up visits. For outcome evaluation of the individual child, this simply documents that this important step was fulfilled. At the program level, this information can be used to evaluate program-wide adherence to the recommended protocol.

Recording of this information can facilitate interpretation of auditory-related outcomes obtained using the UWO PedAMP outcome evaluation tools (i.e., LittlEARS, PEACH). For example, if the behavioural outcome measures gathered via the UWO PedAMP indicate that an individual child is not demonstrating progress with amplification, a sensible next step may be to review the child's assessment and fitting details that appear on the Hearing Aid Fitting Summary form. This information may encourage the pediatric audiologist to obtain additional hearing aid

fitting measurements, (an individualized RECD for example) which might alter the fitting in order to try to obtain a different result on the UWO PedAMP evaluation outcome tools.

Many hospitals, government-funded programs, and private practices participate in program-level evaluations. Therefore, a second use of The Hearing Aid Fitting Summary form could be to evaluate the overall fidelity of a program that has been implemented to fit hearing aids to children aged birth to six years. For example, the Ontario Infant Hearing Program (Ontario IHP) in Canada will use anonymized results of the Hearing Aid Fitting Summary form at the program and regional levels (not individual clinician level) to determine, for example, the typical rate at which RECDs are measured, or the typical amount of audibility provided by hearing aids. This type of program evaluation will allow evaluation of the Ontario IHP protocol development and training supports. It also will provide information that may encourage continued or additional government funding because it documents measurable program outcomes for healthcare policy-makers.

The results of the Hearing Aid Fitting Summary form can also be used for continued development of normative values for the Aided SII Normative Values form. As more data is collected, normative SII values for low and moderate level speech inputs as a function of pure-tone average hearing loss will be obtained and provide additional outcome measurement tools for use in future versions of the UWO PedAMP.

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LittlEARS Auditory Questionnaire

Background Information

The LittlEARS Auditory Questionnaire is one of the subjective outcome evaluation tools included in the UWO PedAMP v1.0. According to the authors of the questionnaire, the purpose of the LittlEARS Auditory Questionnaire is to assess the auditory behaviour of infants with permanent childhood hearing impairment (PCHI) who wear hearing aids or cochlear implants (Coninx, et al., 2009; Tsaikpini, et al., 2004, Copyright MED-EL 2004). The 35 questions in the LittlEARS assess auditory development during the first two years of hearing in the real-world and tap into receptive and semantic auditory behaviour as well as expressive-vocal behaviour. The questions are listed in an age-dependent order and are in a yes/no format. The total of all 'yes' answers provide a score that can be compared to average and minimum age-dependent values. These values are provided in one-month age categories based on normative data (Coninx, et al., 2009). The LittlEARS is designed to be answered by parents and is not affected by how it is administered (i.e., under professional guidance or independently).

A validation study of the LittlEARS questionnaire was conducted on 218 normal hearing children from German-speaking families (Coninx, et al., 2009). Results indicate that the questionnaire is reliable (split half $r = 0.88$), has good internal consistency (Cronbach's alpha = 0.96), and predictive accuracy (Guttman's lambda =0.93). There is also high correlation between the overall score and the age of the children ($r = 0.91$). The data collected from the parents was used to obtain normative values for the development of early auditory behaviour in normal hearing infants and used to derive average and minimum values for scoring. A validation study was conducted with 63 children in Germany and Italy who wear cochlear implants. The results indicate that the LittlEARS questionnaire is appropriate for use with children provided with cochlear implants early in life and the results can be compared to the normative data (Coninx et al., 2009). A validation study with English-speaking Canadian families was conducted by our laboratory and found that the current German-derived norms are appropriate for use with English-speaking families in Canada (Bagatto, Brown, Moodie & Scollie, 2011). Currently there is a validation study being conducted in the United States with English-speaking infants who wear cochlear implants (www.ClinicalTrials.gov Identifier NCT00785707).

Additionally, a longitudinal intervention study has been conducted through the Child Amplification Laboratory at UWO in collaboration with the H.A. Leeper Speech and Hearing Clinic, Humber River Regional Hospital, and Rouge Valley Health System. This data provides further characterization of scores with infants who wear hearing aids who are typically developing as well as those with comorbidities and complex factors related to hearing aid use (e.g., inconsistent hearing aid use). The results can be found in a publication by Bagatto and her colleagues (Bagatto, Moodie, Malandrino, Richert, Clench & Scollie, 2011). Through this experience, administration of the questionnaire and the accompanying score sheet have been modified within the UWO PedAMP v1.0. These modifications are minor, and designed to facilitate use of the questionnaire with the pediatric population. No changes to the questionnaire items themselves have been made as a result of the Canadian validation study. In addition, the Network of Pediatric Audiologists of Canada were invited to examine the LittlEARS Auditory Questionnaire. These experienced clinicians offered their opinions about the use of the LittlEARS in clinical practice. Opinions were gathered regarding the clinical relevance, quality, feasibility, utility, executability, acceptability, applicability, and comparative value (Moodie, et al., 2011). When possible, modifications to the score sheet, instruction set, and training materials were made based on audiologist responses and written feedback. Ninety-two percent (92%) of the audiologists who examined the LittlEARS Auditory Questionnaire and the associated UWO PedAMP instruction set and score sheet indicated that they felt it was suitable for routine use in pediatric settings (Moodie, et al., 2011).

LittlEARS Administration Guidelines

Within the UWO PedAMP v1.0, the LittlEARS Auditory Questionnaire can be administered to children with normal hearing as well as to children with hearing loss who may or may not wear hearing aids. The LittlEARS uses a simple 'yes/no' format and has items that allow a gradual progression through the tool as the child develops. The tool was developed for infants in their first two years of life, however, pilot work has revealed that it is also suitable for children older than two years of age who may be premature, who present with atypical development, or who are in the early stages of hearing aid use. Therefore, the score sheet was revised to include a wider age range for use with children up to 48 months of (adjusted) age. It also appears to be helpful to parents of young infants who are just starting to navigate through the world of hearing loss and hearing aids. The items

provide examples which introduce the parent to early auditory behaviours, many of which their child will demonstrate early on, and prepare the parent to understand what auditory behaviours can be observed at later stages of development.

It is recommended that administration of the LittlEARS occurs at some point prior to hearing aid fitting and at regular follow-up visits (see Figures 1 & 2 in the IHP section of this manual for administration guidelines). If the child is not wearing hearing aids but has an identified hearing loss, the questionnaire can be useful for monitoring auditory development and tracking progress over time. In this case, the LittlEARS should be administered at every follow-up visit, as suggested in the administration guidelines (Figures 1 & 2). The total 'yes' score is entered on the score sheet at the point where age and score meet. A child with a score in the shaded region is considered to not be meeting auditory milestones for his/her age. A child with a score above the shaded region is considered to be meeting auditory development milestones for his/her age. When a minimum score of *27 or better is achieved*, the child's performance is at a ceiling score. If ceiling is reached, the LittlEARS should no longer be administered. Instead, the clinician can begin to administer the Parent's Evaluation of Aural/Oral Performance in Children (PEACH), either at that appointment or at the next follow-up visit. If the child is less than two years of age and achieved a score of 27 or greater, administering the PEACH may be premature due to the developmental level of some of the PEACH items. Therefore, it is recommended that the *child achieves a score of 27 or greater AND be at least 24 months of age* before administering the PEACH. Data to support this recommendation was obtained in the study mentioned above (Bagatto, Moodie, et al., 2011). The LittlEARS Auditory Questionnaire as well as the revised score sheet are included at the end of in this section of the manual, along with some case studies. The LittlEARS Auditory Questionnaire is included for reference only and may not be copied as part of the UWO PedAMP due to copyright by MED-EL. The LittlEARS score sheet was adapted from the original score sheet and may be copied as part of the UWO PedAMP v1.0. The following are Frequently Asked Questions regarding details of the administration of the LittlEARS Auditory Questionnaire in the UWO PedAMP. Case studies illustrating the use and interpretation of scores on the LittlEARS are also provided in this section of the manual.

Frequently Asked Questions

How long will it take for the respondent to fill out the LittlEARS?

According to the pilot work, this questionnaire takes about 5 to 6 minutes to complete.

Can the receptionist give the LittlEARS to the respondent to fill out in the waiting room?

Yes. The instructions indicate that the questionnaire can be completed independently by the parent/caregiver or with the guidance of the clinician without significant impact on scores.

Can the LittlEARS be administered interview-style by the clinician?

Yes. The clinician can administer the questionnaire by reading each question to the parent/caregiver. This is especially useful when the respondent does not read or write English well enough to complete the questionnaire.

In what languages are the LittlEARS offered?

The LittlEARS is offered in Bulgarian, Dutch, English, Farsi, Flemish, Finnish, French, German, Greek, Gujarati, Hungarian, Italian, Mandarin, Norwegian, Polish, Romanian, Russian, Serbian, Slovakian, Slovenian, Somali, Spanish, Turkish, Tamil, Urdu and Vietnamese.

What is the reading level of the LittlEARS?

The readability of this questionnaire is approximately Grade 4 level.

Where can I obtain the LittlEARS Auditory Questionnaire?

Information about the questionnaire and associated fee for use charge can be found on the MED-EL website at http://www.medel.com/US/Rehabilitation/Pediatric-Assessment.php

Ordering information may vary by region. Please contact your MED-EL representative.

What if the respondent cannot read or write?

The questionnaire can be given interview-style by the clinician with no significant impact on the scores. Examples are provided for each question for added clarity.

What if the respondent is not sure whether the child exhibits a certain behaviour?

The instructions indicate that if the respondent has observed the behaviour *at least once,* then an answer of 'yes' should be provided for that item. If the respondent has *never* observed the behaviour or is *unsure,* then an answer of 'no' should be provided for that item.

There are additional questions on the back of the LittlEARS Questionnaire. How do I score, or should I score, this information?

The two additional questions on the back of the LittlEARS are open-ended and are intended to provide some extra information for counselling purposes. They are not included as part of the scoring of the questionnaire.

What if the child is over two years of age?

The creators of the LittlEARS indicate that the questionnaire is appropriate for children up to two years of age. A modification of the LittlEARS Auditory Questionnaire within the UWO PedAMP v1.0 is to recommend a *score-based* rather than an *age-based* administration rule. For instance, if the

child is 18 months old and obtains a score of 27 or greater, the LittlEARS should be administered until h/she reaches 24 months of age due to the complexity of some of the PEACH items for younger children (Bagatto, Moodie, et al., 2011). On the other hand, if a 36 month old child scores 20 on the LittlEARS, the tool should be readministered until he reaches a score of 27 or greater before moving on to the PEACH. This situation may occur when the child has other medical issues such as global developmental delay, is premature, or was late identified/fitted, in which case continuing with the LittlEARS is appropriate. Examples of this are included as case studies at the end of this section.

What about adjusting for prematurity?

Currently, there is a lack of consensus regarding the approach to adjusting for prematurity. Specifically, there is uncertainty regarding when to stop adjusting and how the adjustments impact standardized tests. Therefore, this version of the guideline recommends scoring the LittlEARS using both the child's chronological age and adjusted age. Age adjustment should be calculated for a child born at 37 weeks gestational age or earlier relative to a 40 week term. The chronological and adjusted ages can be plotted on the same score sheet using different symbols and/or an arrow indicating that the scores were obtained on the same date. An example of this is provided as a case study in this section.

What about adjusting for hearing age?

Hearing age refers to the period after initial device fitting and has been historically applied to children who have profound hearing loss. It is unclear how this adjustment relates to children with lesser degrees of hearing loss or how long after hearing aid fitting adjusting for hearing age applies. It is recommended that the date of the initial hearing aid fitting be documented and used to calculate hearing age. The current LittlEARS developmental trajectory is based on normal hearing children, so scoring both chronological and hearing age is recommended at the present time until further information is gathered on the use of hearing age with this questionnaire. Our pilot data indicate that for some children, adjustment for hearing age will over-correct their score: the child's adjusted

performance exceeds that of normally hearing children. If this occurs, interpretation of scores against hearing age is not informative and counselling should proceed based on chronological age. If your audiology practice setting has a specific protocol in place where you are required to adjust for hearing age then this adjustment should be clearly documented on the score sheet.

What if the child has other medical issues (i.e., cerebral palsy, global developmental delay)?

Recent work with the LittlEARS within the UWO PedAMP indicates that the questionnaire is sensitive to factors other than hearing loss that may impact the child's auditory development (Bagatto, Moodie, et al., 2011). These factors should be considered when following the child as well as when obtaining scores on individual questionnaires. Recall that the LittlEARS scores were developed on typically developing children with normal hearing. Further data collection will contribute to improved characterization of scores and ultimately a better understanding of how other medical issues impact the administration and scoring of this questionnaire.

What about children with Auditory Neuropathy Spectrum Disorder (ANSD)?

Administration of the LittlEARS is especially important for children who have been diagnosed with ANSD. Tracking auditory milestones can provide useful information for the monitoring and intervention of these children, regardless of whether or not they are wearing hearing aids. Pilot work with this population during the development of the UWO PedAMP indicated that approximately 50% of children with ANSD who did not wear hearing aids were meeting auditory milestones for their age. This is comparable to other studies of outcome in children with ANSD (e.g., Rance, 2005). Examples of the use of the LittlEARS with children with ANSD are provided through case studies included in this section of the manual.

What if the child has not been wearing his/her hearing aids consistently?

Consistent hearing aid use has been shown to impact a child's outcome with hearing aids (Moeller, Hoover, Peterson & Stelmachowicz, 2009). There are a variety of non-medical reasons why a child

may not have consistent access to speech through the use of their hearing aids (i.e., hospitalization, parental motivation, hearing aid malfunction). These were tracked as 'Complex Factors' in our recent work (Bagatto, Moodie, et al., 2011). Children with Complex Factors demonstrated scores slightly lower than typically developing children, but do show a progression of scores as the child gets older. If reasons such as lack of parental motivation is a contributor to inconsistent hearing aid use, administration of the LittlEARS may provide information which may encourage more consistent hearing aid use. For instance, if the child is not meeting auditory development milestones for his/her age, a discussion of this finding with the parent/caregiver may provide motivation for more consistent use of hearing aids. Repeat administration of the questionnaire following a period of consistent hearing aid use may indicate improved scores, which may be attributed to more consistent auditory access. Recall that daily hours of use is tracked in the IHP Amplification Benefit Questionnaire and this information may be important for examining relationships between the LittlEARS score and consistency of hearing aid use.

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Meeting Milestones Case Study: Molly

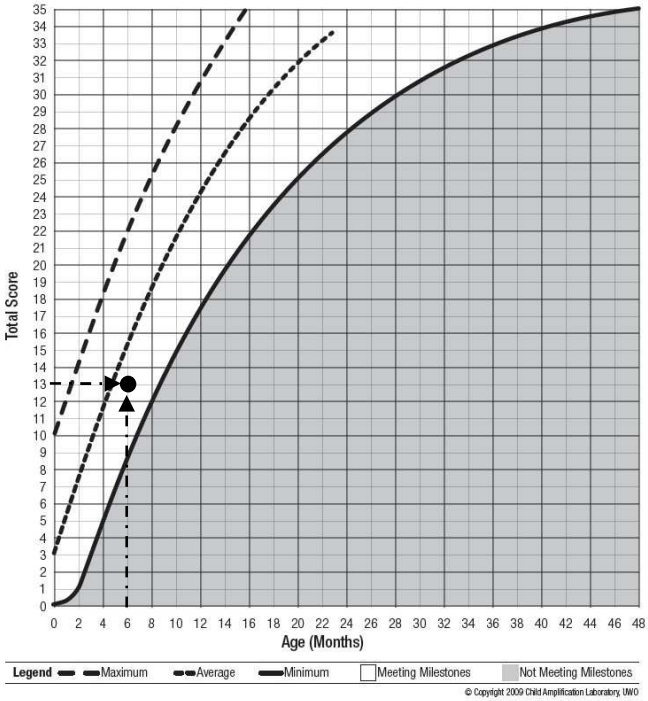
1) History

Molly is a **healthy girl** who was **born full term** without complications. She passed her hearing screening at birth and was identified as having a family history of permanent childhood hearing loss. Since this puts her at risk for late onset or progressive permanent childhood hearing loss, further audiological monitoring was recommended.

2) High Risk Surveillance

At **6 months of age**, Molly had her hearing rescreened using frequency-specific auditory brainstem response (ABR) techniques because of unreliable behavioural audiometry results. Her mother completed the LittlEARS Auditory Questionnaire while Molly was asleep for the ABR procedure. Molly's middle ear status as well as the results of her high risk surveillance ABR screening are shown in the table below. The result of the LittlEARS has been plotted on the score sheet to the right**. Age (in months) is shown on the X-axis and Total LittlEARS Score is shown on the Y-axis.**

Procedure	Left Ear	Right Ear
Impedance	WNL	WNL
ABR	Pass	Pass



3) Interpretation

Molly passed her surveillance screening as indicated by her impedance and ABR results. **The total 'yes' scores on the LittlEARS equalled 13 at 6 months of age.** This result was plotted on the above score sheet where the lines for age and score meet. The point falls within the **unshaded region**, just below the average normative values, but above minimum values. This indicates that Molly is **meeting auditory development milestones for her age.**

4) Follow-up

Due to Molly's identified risk factor, normal screening results and age-appropriate auditory development, further surveillance screening will occur at regular intervals.

Adjusted Age Case Study: Simon

1) History

Simon was born at **25 weeks gestational age** and has a twin brother. He passed his hearing screening at birth but his low birthweight puts him at risk for late onset or progressive permanent childhood hearing loss. Therefore, further audiological monitoring was scheduled.

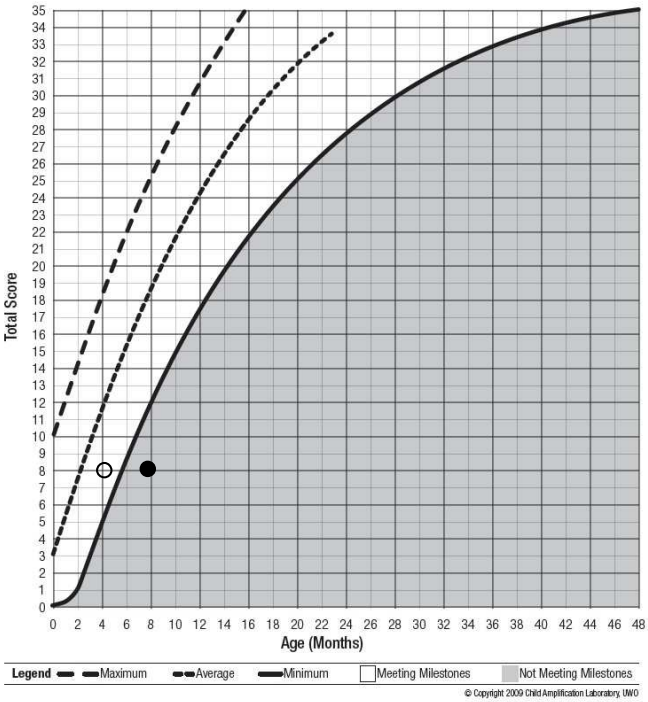
2) High Risk Surveillance

At **7.5 months chronological (4.25 adjusted) age**, Simon had his hearing rescreened using frequency-specific auditory brainstem response (ABR) techniques. His mother completed the LittlEARS Auditory Questionnaire while Simon was asleep for the ABR procedure. Simon's middle ear status as well as the results of his high risk surveillance ABR screening are shown in the table below. The result of the LittlEARS has been plotted on the score sheet to the right.

Procedure	Left Ear	Right Ear
Impedance	WNL	WNL
ABR	Pass	Pass

3) Interpretation

Simon passed his surveillance screening as indicated by his impedance and ABR results. The **total 'yes' score of 8** was noted from the parent's responses on the LittlEARS. This result was plotted on the score sheet where the lines for age and score meet for both **chronological (filled circle) and adjusted (open circle) age**. When using a **chronological age** for scoring, Simon is **not meeting auditory development milestones** because the filled circle falls within the shaded region on the score sheet. When an **adjustment for prematurity** is used for scoring, Simon's **score falls in the unshaded region** indicating he is meeting auditory milestones for his adjusted age. The results were explained to his mother using both chronological and adjusted age.



4) Follow-up

Due to Simon's identified risk factor, normal screening results, and age-appropriate auditory development when age-adjusted for prematurity, further surveillance screening will occur at regular intervals.

Adjusted Age Case Study: Gabriella

1) History

Gabriella was born at **29 weeks gestational age** and is currently a healthy child. She passed her hearing screening at birth but her low birthweight puts her at risk for late onset or progressive permanent childhood hearing loss. Therefore, further audiological monitoring was scheduled.

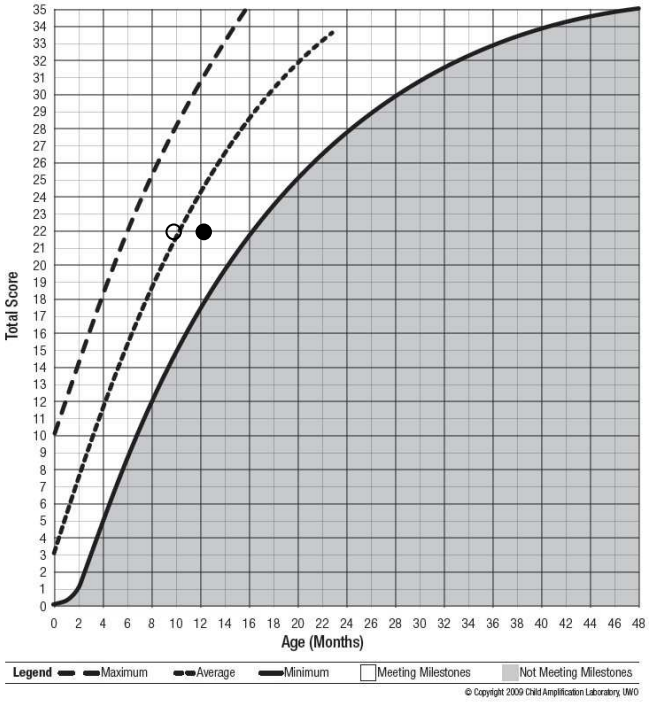
2) High Risk Surveillance

At roughly **12 months chronological (almost 10 months adjusted) age**, Gabriella had her hearing rescreened using visual reinforcement audiometry (VRA) techniques with insert earphones. Her mother completed the LittlEARS Auditory Questionnaire while Gabriella was doing VRA. Gabriella's middle ear status as well as the results of her high risk surveillance VRA screening are shown in the table below. The result of the LittlEARS has been plotted on the score sheet to the right.

Procedure	Left Ear	Right Ear
Impedance	WNL	WNL
VRA	Pass	Pass

3) Interpretation

Gabriella passed her surveillance screening as indicated by her impedance and VRA results. The **total 'yes' score of 22** was summed from the parent's responses on the LittlEARS. This result was plotted on the score sheet where the lines for age



and score meet for both chronological (filled circle) and adjusted (open circle) age. Both the chronological and adjusted age scores fall in the **unshaded region** on the LittlEARS score sheet indicating that Gabriella is **meeting auditory milestones for both her chronological and adjusted ages**. The results were explained to her mother using both chronological and adjusted age.

4) Follow-up

Due to Gabriella's identified risk factor, normal screening results, and age-appropriate auditory development regardless of an age-adjustment for prematurity, further surveillance screening will occur at regular intervals.

Not Meeting Milestones Case Study: Oliver

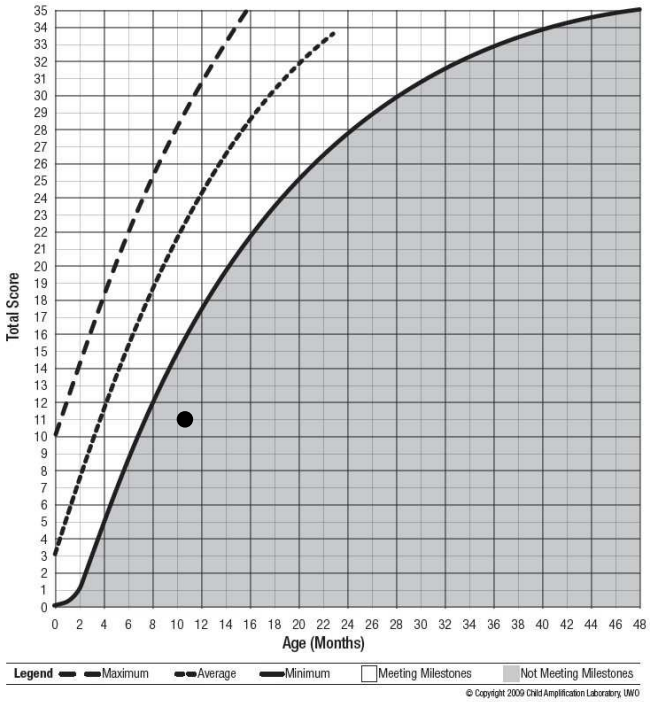
1) History

Oliver was **born full term without complications**. There is a negative family history of permanent childhood hearing loss and he passed his hearing screening at birth. Oliver is not developing age-appropriate speech and language skills and was referred for an audiological assessment.

2) Audiology Assessment

When Oliver was approximately **10.5 months of age**, a hearing assessment was attempted which included immittance, distortion product otoacoustic emissions (DPOAEs), and VRA with insert earphones. The results of the audiological assessment are summarized in the table below. Oliver's mother completed the LittlEARS Auditory Questionnaire following the case history. The result of the LittlEARS has been plotted on the score sheet to the right. An ABR was attempted a week later but could not be completed as Oliver would not sleep naturally.

Procedure	Left Ear	Right Ear
Impedance	WNL	WNL
DPOAE	Normal outer hair cell function	Could not complete
VRA (dB HL)	Could not complete	Could not complete



3) Interpretation

A complete audiological assessment was unobtainable due to Oliver's high activity level. The **total 'yes' score of 11** was obtained from the parent's responses on the LittlEARS. This result was plotted on the above score sheet where the lines for age and score meet. Oliver's score falls within the **shaded region** on the LittlEARS score sheet indicating that he is **not meeting auditory development milestones for his age**. The results were explained to his mother and a sedated ABR was offered as a way to obtain information about Oliver's hearing status.

4) Follow-up

Oliver's mother agreed to proceed with the sedated ABR given that behavioural and natural sleep assessments were unsuccessful and he is not meeting milestones for auditory development.

Not Meeting Milestones Case Study: Joshua

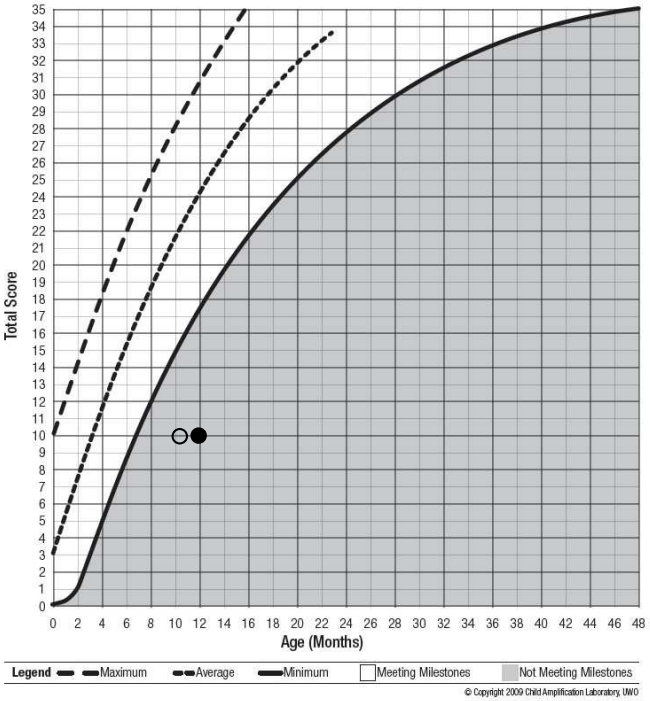
1) History

Joshua was born at **35 weeks gestational age** and has been identified with a **genetic condition** which affects his motor and neurological development. He did not pass his hearing screening at birth therefore audiological assessment was recommended.

2) Audiology Assessment

Due to medical complications resulting in frequent hospitalization following birth, Joshua's audiological assessment did not occur until almost **12 months chronological (10.5 months adjusted) age**. A full assessment was completed which included immittance, DPOAEs, and frequency-specific ABR techniques because of unreliable behavioural audiometry results. His mother completed the LittlEARS Auditory Questionnaire while Joshua was asleep for the ABR. The results of his audiological assessment are summarized in the table below. The result of the LittlEARS has been plotted on the score sheet to the right.

Procedure	Left Ear	Right Ear
Impedance	WNL	WNL
DPOAE	Normal outer hair cell function	Normal outer hair cell function
ABR (dB eHL)	0.5 kHz = 25 2 kHz = 25	0.5 kHz = 25 2 kHz = 25



3) Interpretation

The assessment results indicate that Joshua has normal hearing sensitivity. The **total 'yes' score of 10** was summed from the parent's responses on the LittlEARS. This result was plotted on the above score sheet where the lines for age and score meet for both chronological (filled circle) and adjusted (open circle) age. Both the chronological and adjusted age scores fall in the shaded region on the LittlEARS score sheet indicating that Joshua is **not meeting auditory milestones for both his chronological and adjusted ages**. The results were explained to his mother using both chronological and adjusted age and a discussion of the potential impact of Joshua's genetic condition on auditory development occurred.

4) Follow-up

Further surveillance screening will occur due to Joshua's identified risk factor for late onset or progressive hearing loss.

Not Meeting Milestones Case Study: Lauren

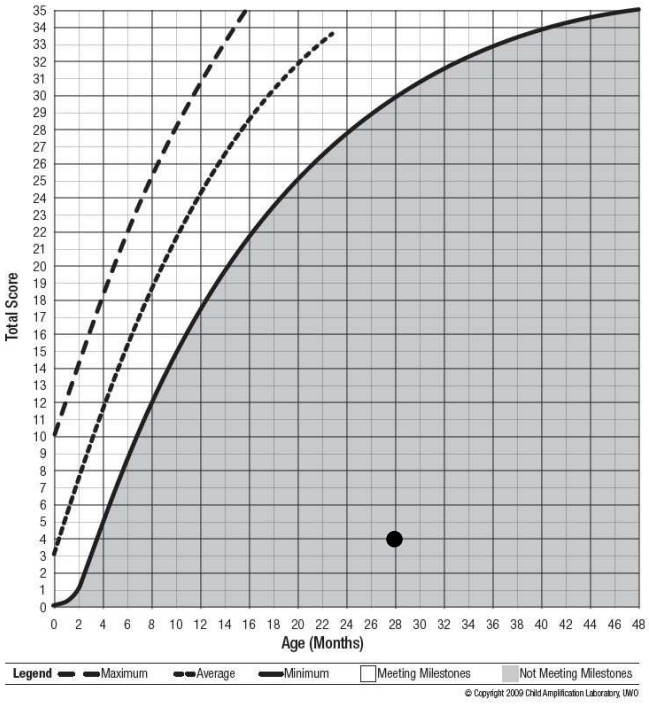
1) History

Lauren was **born full term** and has been identified as having **global developmental delay**. She passed her hearing screening at birth and was referred for audiological assessment as a young child due to her speech and language delay.

2) Audiology Assessment

Lauren's audiological assessment was conducted when she was **almost 30 months of age**. A full assessment was completed which included immittance, DPOAEs, and frequency-specific ABR because of unreliable behavioural audiometry results. Lauren's mother completed the LittlEARS Auditory Questionnaire while she was asleep for the ABR procedure. The results of her audiological assessment are summarized in the table below. The result of the LittlEARS has been plotted on the score sheet to the right.

Procedure	Left Ear	Right Ear
Impedance	WNL	WNL
DPOAE	Normal outer hair cell function	Normal outer hair cell function
ABR (dB eHL)	0.5 kHz = 25 2 kHz = 25	0.5 kHz = 25 2 kHz = 25



3) Interpretation

The assessment results indicate that Lauren has normal hearing sensitivity. The **total 'yes' score of 4** was summed from the parent's responses on the LittlEARS. This result was plotted on the above score sheet where the lines for age and score meet. Lauren's LittlEARS score falls in the **shaded region** on the score sheet indicating that she is **not meeting auditory milestones for her age**. The results were explained to her mother as well as the potential impact of Lauren's global developmental delay on auditory development.

4) Follow-up

Further surveillance screening will occur at the parent's or physician's request. The LittlEARS Questionnaire will be re-administered to track Lauren's progress with auditory development.

ANSD Case Study: Benjamin

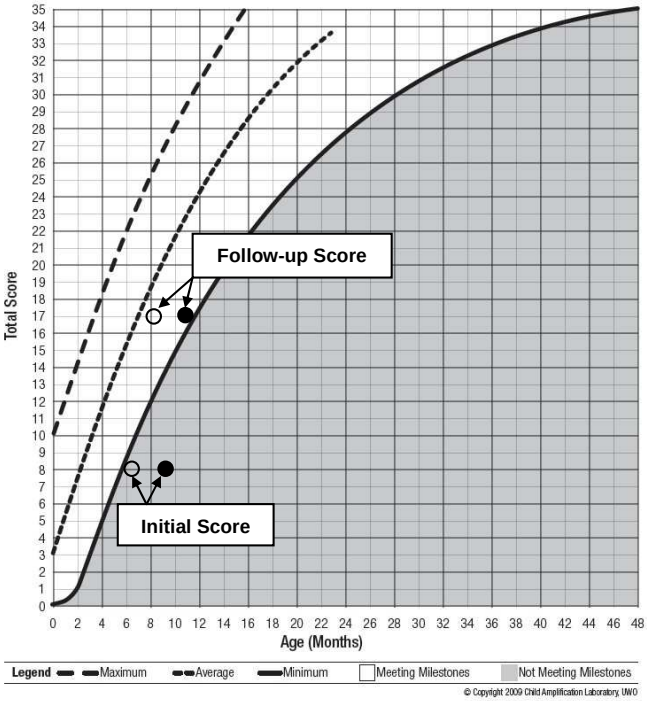
1) History

Benjamin was born at **28 weeks gestational age** and spent **10 weeks in the neonatal intensive care unit following birth**. He did not pass his initial hearing screening and was therefore referred for audiological assessment.

2) Audiology Assessment

Benjamin's initial audiological assessment occurred at approximately **9 months chronological (6 months adjusted) age** and a **follow-up appointment took place at 11 months (8 adjusted) age** in order to complete the testing. The assessment included immittance, DPOAEs, and frequency-specific and click ABR. Benjamins's mother completed the LittlEARS Auditory Questionnaire while he was asleep for the ABR procedures. The results of his audiological assessment are summarized in the table below. The result of the LittlEARS has been plotted on the score sheet to the right.

Procedure	Left Ear	Right Ear
Immittance	Tymp = WNL Reflex = absent	Tymp = WNL Reflex = absent
DPOAE	Normal outer hair cell function	Normal outer hair cell function
Frequency-specific ABR (dB eHL)	0.5 kHz = NR 2 kHz = NR	0.5 kHz = NR 2 kHz = NR
High Intensity Click ABR	Cochlear Microphonic = present ABR = absent	Cochlear Microphonic = present ABR = absent



3) Interpretation

The assessment results indicate the presence of **auditory neuropathy spectrum disorder (ANSD)** in both ears. **Scores of 8 and 17** were calculated from the LittlEARS and plotted on the above score sheet where the lines for age and score meet. Both the chronological (filled) and adjusted (open) scores are plotted. Benjamin's initial LittlEARS score falls in the shaded region indicating that he **was not meeting auditory milestones at first**. Two months later, his scores fell within the unshaded region indicating an **improvement in auditory development**.

4) Follow-up

Further audiological assessment will occur at regular intervals in order to obtain behavioural hearing thresholds and monitor auditory development. Appropriate referrals will also be initiated.

ANSD Case Study: Matheson

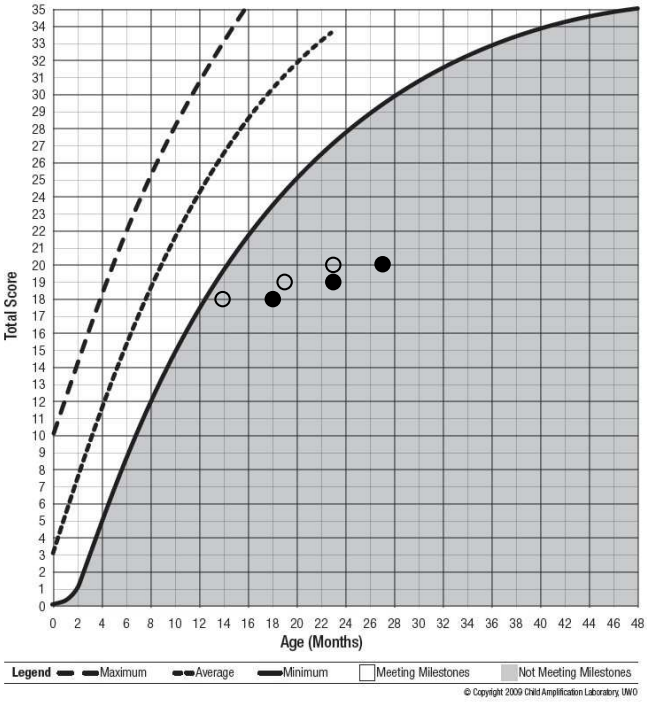
1) History

Matheson was born at **25 weeks gestational age** and spent **12 weeks in the neonatal intensive care unit following birth**. He did not pass his initial hearing screening and was therefore referred for audiological assessment.

2) Audiology Assessment

Due to significant health issues, Matheson's initial audiological assessment occurred at approximately **18 months chronological (14 months adjusted) age** and a **follow-up appointments took place at 23 and 27 months (19 and 23 adjusted) age** in order to complete the testing. The assessment included immittance, DPOAEs, and frequency-specific and click ABR. Matheson's mother completed the LittlEARS Auditory Questionnaire while he was asleep for the ABR procedures. The results of his audiological assessment are summarized in the table below. The result of the LittlEARS has been plotted on the score sheet to the right.

Procedure	Left Ear	Right Ear
Immittance	Tymp = WNL Reflex = absent	Tymp = WNL Reflex = absent
DPOAE	Normal outer hair cell function	Normal outer hair cell function
Frequency-specific ABR (dB eHL)	0.5 kHz = NR 2 kHz = NR	0.5 kHz = NR 2 kHz = NR
High Intensity Click ABR	Cochlear Microphonic = present ABR = absent	Cochlear Microphonic = present ABR = absent



3) Interpretation

The assessment results indicate the presence of auditory neuropathy spectrum disorder (ANSD) in both ears. **Scores of 18, 19, and 20** were obtained from the LittlEARS and plotted on the above score sheet where the lines for age and score meet. Both the chronological (filled) and adjusted (open) scores are plotted. Matheson's LittlEARS scores fall within the **shaded region** indicating that he **continues to not meet auditory development milestones for his age.**

4) Follow-up

Further audiological assessment will occur at regular intervals in order to obtain behavioural hearing thresholds and monitor auditory development. Appropriate referrals and intervention will be initiated.

Aided Case Study: George

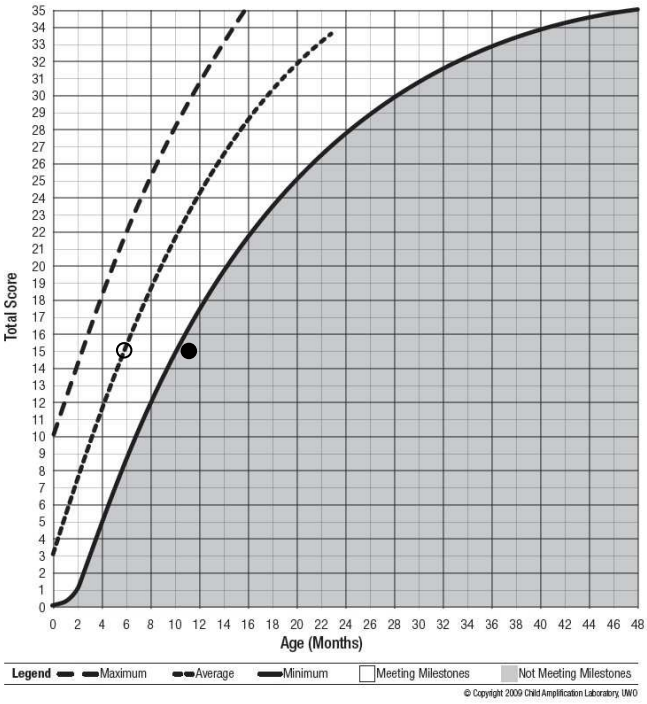
1) History

George was born full term without complications. A **bilateral moderately-severe sensorineural hearing loss (PTA=66 dB HL)** was identified at 2 months of age and hearing aids were fitted to George when he was approximately 5 months of age. The results of his **follow-up appointment at 11 months of age** are provided.

2) Hearing Aid Follow-up

Using his new earmolds coupled to insert earphones, George's hearing thresholds were re-assessed and the real-ear-to-coupler difference (RECD) was measured. The electroacoustic performance of the hearing aids was verified in the test box and adjusted to DSL v5.0a targets using the new assessment information. George's mother completed the LittlEARS Auditory Questionnaire while the clinician was adjusting the hearing aids. The hearing aid fitting details are summarized in the table below and the result of the LittlEARS has been plotted on the score sheet to the right.

Fitting Detail	Left Ear	Right Ear
RECD	Used other ear values	Measured
SII Soft 55 dB SPL	51	53
SII Average 65 dB SPL	63	64
MPO Measured	Yes	Yes



3) Interpretation

The SII scores are acceptable for George's degree of hearing loss and the MPO has been verified. This indicates that the hearing aid fitting is electroacoustically acceptable for his hearing loss. A **score of 15 on the LittlEARS** was plotted on the above score sheet using both **chronological (filled) and hearing (open) age**. George is not meeting auditory development milestones for his chronological age but he is for his hearing age. The results were explained to his mother using both scores.

4) Follow-up

Further audiological assessment and hearing aid checks will occur at regular intervals. Hearing aids will be adjusted as needed to account for changes in ear growth. Auditory development and performance with amplification will be monitored.

Aided Case Study: Colleen

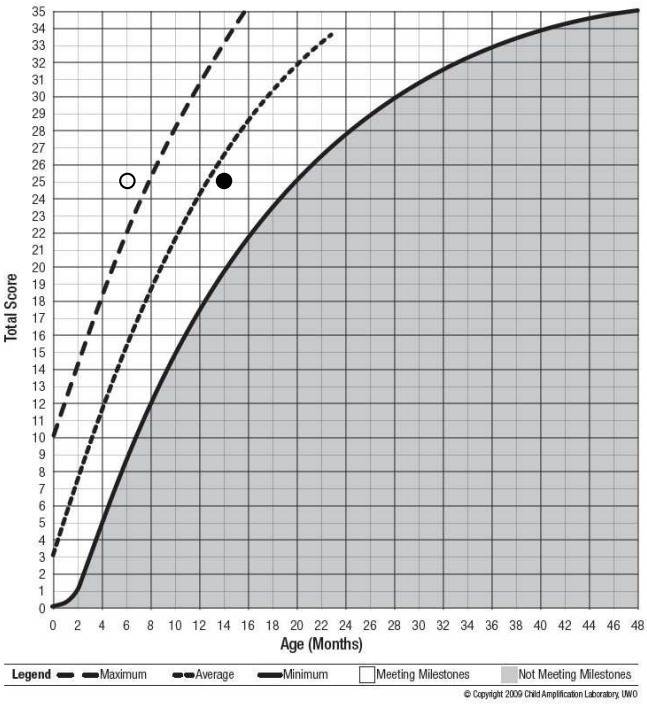
1) History

Colleen was born full term without complications. A **bilateral moderate sensorineural hearing loss (PTA=48 dB HL)** was identified at 2 months of age and hearing aids were fitted to Colleen when she was approximately 8 months of age. The results of her **follow-up appointment at 14 months of age** are provided.

2) Hearing Aid Follow-up

Using her new earmolds coupled to insert earphones, Colleen's hearing thresholds were re-assessed and the RECD was measured. The electroacoustic performance of the hearing aids was verified in the test box and adjusted to DSL v5.0a targets using the new assessment information. Colleen's mother completed the LittlEARS Auditory Questionnaire while the clinician was adjusting the hearing aids. The hearing aid fitting details are summarized in the table below and the result of the LittlEARS has been plotted on the score sheet to the right.

Fitting Detail	Left Ear	Right Ear
RECD	Measured	Used other ear values
SII Soft 55 dB SPL	77	74
SII Average 65 dB SPL	86	84
MPO Measured	Yes	Yes



3) Interpretation

The SII scores are acceptable for Colleen's degree of hearing loss and the MPO has been verified. This indicates that the hearing aid fitting is electroacoustically acceptable for her hearing loss. A score of **25 on the LittlEARS** was plotted on the above score sheet using both chronological (filled) and hearing (open) age. Colleen is meeting auditory development milestones for her chronological and hearing age. The results were explained to her mother using chronological age since hearing age is not informative in this case.

4) Follow-up

Audiological assessment and hearing aid checks will occur at regular intervals and the hearing aids will be adjusted as needed. Auditory development and performance with amplification will be monitored.

Parents' Evaluation of Aural/Oral Performance in Children (PEACH)

Background Information

The Parents' Evaluation of Aural/Oral Performance in Children (PEACH) is included as a subjective outcome evaluation tool in the UWO PedAMP v1.0. The PEACH in its original diary form is conducted using a structured interview format and has questions that address quiet and noisy situations as well as hearing device and telephone usage (Ching & Hill, 2005). The PEACH Diary requires parents to observe their child for at least one week and record their observations for the 13 scenarios over that time period. They are also asked to rate the frequency of each behaviour and provide examples of when the child did or did not exhibit a particular response. After the observation period, the audiologist meets with the parent to address each item in a face-to-face interview. The interview is structured in order to solicit detailed information from the parent, rather than yes/no answers. Information about what the child did or did not respond to is recorded by the audiologist and scoring on a five-point scale is conducted. Scoring ranges from 0 = never, or no examples were given, to 4 = always or greater than 75% of the time, or more than six examples were given, during the interview (Ching & Hill, 2007).

The creators of the PEACH have evaluated it over the past few years. The questionnaire/diary was administered to 90 parents of normal hearing children and 90 parents of children with permanent childhood hearing impairment (PCHI) to obtain normative data. The tool demonstrated good internal consistency (Cronbach's alpha = 0.88) and high test-rest reliability (r = 0.93). Normal hearing children (age range = 0.25 to 46 months) demonstrated an increase in performance from about six months of age and close to perfect performance was achieved by about three years of age. As hearing loss increased, a decrease in performance was noted in children with hearing impairment (age range = 4 months to 19 years). Descriptive statistics for the PEACH were also reported indicating an overall test mean of approximately 62%, with similar mean scores for the quiet and noise subscales. The authors noted that the children with hearing impairment were late-identified, and the functional performance of children who are early-identified may be improved (Ching & Hill, 2007). A follow-up study with children with severe-to-profound hearing loss demonstrated that the PEACH is sensitive to changes in frequency response slopes in hearing aids (Ching, Hill & Dillon, 2008).

A study looking at the relationship of cortical evoked potentials and functional measures in infants with hearing loss found the results of the PEACH Diary to be highly variable (Golding, Pearce, Seymour, Cooper, Ching & Dillon, 2007). The authors indicated that the parent's ability to observe their child varied and may have been limited by competing factors in the household (i.e., number of children, wellness of the child, lifestyle). The authors also noted that an inexperienced interviewer may have had difficulty extracting useful examples from the parents even though the interviewer received instructions on how to administer the PEACH (Golding, et al., 2007). This observation was also noted in a research study conducted in the UWO Child Amplification Laboratory (CAL) (S. Scollie, personal communication re: Ching, et al., 2008) as well as in pilot work in the development of the UWO PedAMP v1.0.

Recently, a PEACH Rating Scale has been made available and includes most of the scenarios from the original PEACH Diary (www.nal.gov.au). The PEACH Rating Scale appears to be more acceptable by clinicians and parents because the respondent and administrative burden have been reduced (Moodie, et al., 2011). The PEACH Rating Scale has been selected for use in version 1.0 of the UWO PedAMP, with children who have attained ceiling performance on the LittlEARS Auditory Questionnaire and are 24 months of age and older.

The instructions ask parents/caregivers to observe their child's behaviour in everyday life and rate their child's hearing performance over the past week across a range of hearing and communication scenarios. The nature of the rating scale allows it to be answered by the parent/caregiver during an appointment with guidance from the clinician.

PEACH Administration Guidelines

Within the UWO PedAMP v1.0, the PEACH Rating Scale (referred to as the PEACH for the remainder of this document) may be administered to children with normal hearing as well as to children with hearing loss who may or may not wear hearing aids. A comparison of the LittlEARS and the PEACH in terms of developmental range, indicates that some items on the PEACH may not be within the developmental abilities of younger infants. Roughly 17 children with moderate to moderately-severe hearing impairment were younger than 50 months of age in the PEACH normative data (Ching & Hill, 2007). Scores from these younger children and their normally hearing

peers are lower, with normally hearing children reaching ceiling performance at three years of age. Similar results have been noted in a validation study conducted by the Child Amplification Laboratory (Bagatto, In preparation). While the PEACH appears to be sensitive to levels of hearing loss, its age-sensitivity may be due to the difficulty of items for younger infants or toddlers. Having the parent of a young infant complete the PEACH may be discouraging at the early stages as some questions may not be developmentally appropriate, making it seem as though the child is not performing well (i.e., respondent burden may be too high). Although the authors of the PEACH suggest certain modifications of items for use with young infants, the specific age range for modification is not known. Therefore, **administration of the PEACH should occur at regularly scheduled follow-up visits when the child has reached a score of 27 or greater on the LittlEARS Auditory Questionnaire and is 24 months of age and older** (see Figures 1 & 2 in the IHP section of this manual for administration guidelines). This pre-requisite should ensure that the child's auditory skills are within the range of the PEACH.

Scoring details for the PEACH are provided in a table on the last page of the tool. The overall score is summed, along with summed scores for the quiet and noise subscales. Each sum (overall, quiet, noise) is converted to a percentage. A PEACH Calculator has been developed to assist with scoring and is provided at the end of this section. An accompanying score sheet was developed as part of the UWO PedAMP v1.0 and provides assistance with interpretation of individual scores. This score sheet can be found immediately following the PEACH and both are provided within this section of the manual. Data collected from normal hearing children indicated that performance asymptotes around three years of age with a score of approximately 90% (Ching & Hill, 2007). Mean overall performance for the hearing impaired children involved in this study was 62%. This value was similar for both the quiet and noise subscales (Ching & Hill, 2007). Hearing aid circuit type was not reported and may therefore have included linear. Research conducted in the CAL in collaboration with the National Acoustics Laboratory (NAL) provided benchmarks for older hearing impaired children wearing WDRC hearing aids (Scollie, Ching, Seewald, Dillon, Britton, Steinberg, et al., 2010). Many of these children were late-identified and answered the PEACH using a rating scale format. Overall PEACH scores were roughly 80% and performance on the Quiet and Noise subscales were 84% and 72% respectively. These study results have been included on the current version of the PEACH score sheet and can assist with interpretation of individual scores. The unshaded and shaded regions can be used as benchmarks against which to interpret individual scores. As the PEACH is

routinely used in clinical practice, updated normative values will be incorporated into future versions. The PEACH score sheet can be photocopied for clinical use and the PEACH can either be photocopied or downloaded from http://www.outcomes.nal.gov.au/LOCHI%20assessments.html. The following are some Frequently Asked Questions to assist with the administration of the PEACH within the UWO PedAMP.

Frequently Asked Questions

How long will it take for the respondent to fill out the PEACH?

According to the pilot work, this questionnaire takes about 10 to 12 minutes to complete.

Can the receptionist give the PEACH to the respondent to fill out in the waiting room?

The instructions do not state whether independent administration of the PEACH provides different scores compared to when completed with the guidance of the clinician. Pilot work with this tool conducted as part of the development of the UWO PedAMP indicates that there is no significant impact on scores when it is completed by the parent in the waiting area or with the clinician's help. If the clinician finds more success by having the respondent complete it in the waiting room prior to seeing the family for the appointment, it is recommended that the items be reviewed by the clinician and any issues be discussed with the respondent during the appointment. Responses on the PEACH may help guide the intervention and follow-up and should be taken into consideration.

Can the PEACH be administered interview-style by the clinician?

Yes. The clinician can administer the questionnaire by reading each question to the parent/caregiver. This is especially useful when the respondent does not read or write English well enough to complete the questionnaire.

In what languages are the PEACH offered?

Currently, the PEACH is offered in Arabic, English, Dutch, French, Farsi, Gujarati, Mandarin, Portuguese, Somali, Spanish, Turkish, Tamil, Urdu, and Vietnamese.

What is the reading level of the PEACH?

The readability of this questionnaire is approximately Grade 6 level.

Where can I obtain the PEACH?

The PEACH can be downloaded from http://www.outcomes.nal.gov.au/LOCHI%20assessments.html. There are printable and electronic versions available. The English version is at the end of this section of the manual may also be photocopied for clinical use. Other translations can be found either at the website above or at www.dslio.com.

What if the respondent cannot read or write?

The questionnaire can be administered interview-style by the clinician with no apparent impact on the child's scores. Examples are provided for each question for added clarity.

When do I administer the PEACH?

The administration guidelines of the UWO PedAMP suggest that the PEACH be administered when the child scores 27 or greater on the LittlEARS Auditory Questionnaire. Pilot work has indicated that by this stage the child is at an age and performance level where the items on the PEACH are applicable. Once the child has met suggested administration goals for the PEACH, it is recommended that the questionnaire be administered at follow-up visits which typically are at 3

month, 6 month and 1 year intervals. Event driven administration is also suggested. See Figures 1 & 2 in the IHP section of this manual for administration guidelines.

Can I administer the PEACH to a parent/caregiver of a child who is not currently wearing hearing aids?

The PEACH is intended to be answered for a child who is wearing hearing aids and/or cochlear implants. However, if baseline scores in the unaided condition are desirable, this is at the discretion of the clinician. Currently there are no normative values with which to compare scores of from a child with unaided hearing loss. When administering the PEACH, it is important that the respondent understand the reference condition (i.e., aided or unaided) when answering the questions.

In the PEACH situations, is it assumed that the speaker is using a normal vocal effort for that situation?

Yes, it is assumed that the parent/caregiver is speaking at a typical volume for that situation. For example, when in a quiet situation (i.e., Question #3), the parent/caregiver will likely be using an average vocal effort. However, when in a noisy situation (i.e., Question #5), the parent/caregiver may be using a raised vocal effort.

In the quiet situations (i.e., Questions #3, 4, 6), is the child permitted to see the parent/caregiver's face?

This is not explicitly stated in the PEACH instructions. Given that the respondent is likely reflecting on his/her most recent interactions with the child and not actively setting up the situations described in the PEACH, there is little control over this variable. In addition, parents/caregivers may have different ways of communicating with their child depending on the level of hearing loss or other variables. Therefore, it is recommended that the respondent rate these items based on how they would naturally communicate with their child in those situations.

In Question #10, what is meant by 'understanding'?

The definition of 'understanding' for this item is not specifically addressed in the development literature on the PEACH. It may be helpful to instruct the respondent to interpret this as the 'ability of your child to respond appropriately to what you say when you are communicating in the car/bus/train'.

What about adjusting for prematurity?

The PEACH scores are not age-based, so no adjustment for prematurity is required for scoring.

What about adjusting for hearing age?

It is important to take into consideration how long the child has been wearing his/her hearing aids at the time of PEACH administration, however, this has no impact on scoring because scores are not age dependent.

What if the child has other medical issues (i.e., cerebral palsy, global developmental delay)?

Pilot work with the PEACH within the UWO PedAMP indicate that the questionnaire is sensitive to factors other than hearing loss that may impact the child's auditory performance. These factors should be considered when following the child as well as when obtaining scores on individual questionnaires. Recall that the initial PEACH norms were obtained on typically developing children with and without hearing loss. Further data collection will contribute to improved norms and ultimately a better understanding how other medical issues impact the administration and interpretation of this questionnaire.

What about children with Auditory Neuropathy Spectrum Disorder (ANSD)?

Administration of the PEACH is especially important for children who have been diagnosed with ANSD. Tracking auditory performance can provide useful information for the monitoring and intervention of these children, regardless of whether or not they are wearing hearing aids.

What if the child has not been wearing his/her hearing aids consistently?

The PEACH contains a Pre-Rating Checklist which asks about the child's hearing aid use and recent health. The instructions state that the PEACH should only be completed for children who have hearing aids if the respondent answers 'yes' to all of the pre-rating checklist questions including: "Has your child been wearing his/her hearing aids and/or cochlear implant?". If a reason such as lack of parental motivation is a contributor to inconsistent hearing aid use, administration of the PEACH may provide information which may encourage more consistent hearing aid use. For instance, if the child is not performing appropriately compared to provided benchmarks, a discussion of this finding with the parent/caregiver may provide motivation for more consistent hearing aid use. Repeat administration of the questionnaire following a period of consistent hearing aid use may indicate improved scores, which may be attributed to consistent auditory access.

What are the clinical implications if a child has an acceptable score in the Quiet subscale but further review is indicated by the score in the Noise subscale?

The current score ranges can be used as benchmarks with which to compare individual scores. A child who scores well in the Quiet subscale but not in the Noise subscale would warrant further review of technology. Perhaps a comfort in noise program may be implemented or use of an FM system in situations other than the classroom can be considered. These decisions should be made on a case by case basis and in conjunction with the needs of the child and family.

What if some questions are not answered by the respondent?

There may be occasions where the situation described in the question does not apply to the child. For example, the questions relating to noisy situations may not be applicable for a given child, perhaps because of their young age and/or typical environments. In these cases, it is important to have a closer look at why the respondent did not answer a particular question and determine whether that would be typical for that child's situation. The PEACH should be scored as instructed and a discussion about the values compared to expected scores should occur with the respondent. As the child develops, more of the questions may become more relevant and the scores on the PEACH should reflect this. It is also possible that a parent could fail to answer a question if they didn't understand it or were uncertain of how to answer. For these reasons, a clinician overview of responses and an interview to clarify is very important in obtaining a valid score.

One of the items asks about telephone use – should we omit that item for younger children?

All of the items on the PEACH can be interpreted against age-appropriate indicators of hearing performance in that scenario. While we wouldn't expect a normally hearing two year old to have an adult-like telephone conversation, many can recognize a familiar talker (e.g., grandparent, parent), say "hi" and "bye", or other age-appropriate indicators of telephone communication. Discussion of this item may encourage parents to consider telephone use with their young child who has hearing loss, and may assist the clinician in determining a telephone solution that is feasible for use by the child and family.

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Typical Aided Performance Case Study: Kenny

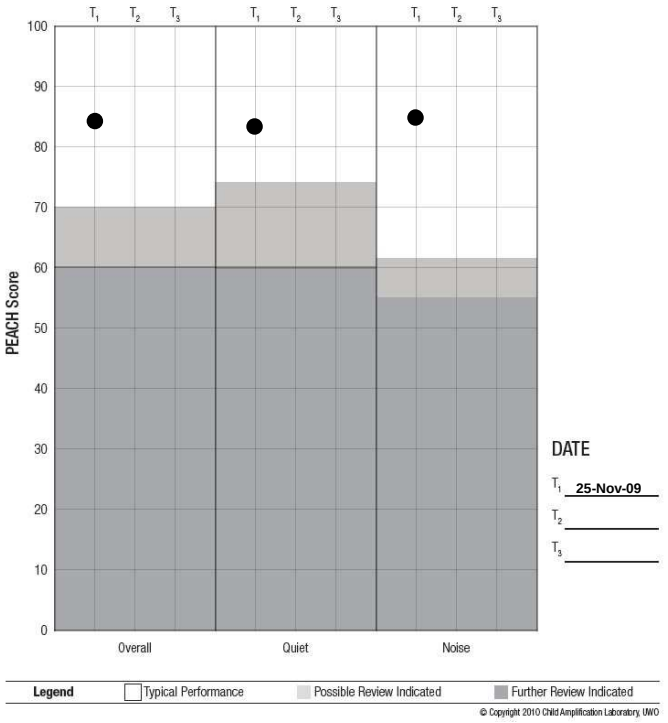
1) History

Kenny was born full term without complications. A **bilateral severe sensorineural hearing loss (PTA=72 dB HL)** was identified when he was 3 months of age and hearing aids were fitted when he was approximately 6 months of age. Recently, Kenny was diagnosed with attention deficit hyperactivity disorder (ADHD). The results of his follow-up appointment at 5 years of age are provided.

2) Hearing Aid Follow-up

Kenny's current earmolds were fitting properly and therefore coupled to insert earphones for conditioned play audiometry (CPA). RECD values were obtained with his current earmolds. The electroacoustic performance of his hearing aids was re-verified in the test box to DSL v5.0a targets. Previous **scores on the LittlEARS exceeded 27**, therefore Kenny's mother completed the PEACH and HA Benefit questionnaires while the clinician was adjusting the hearing aids. The hearing aid fitting details are summarized in the table below and the results of the PEACH have been plotted on the score sheet to the right.

Hearing Aid Fitting Details	Left Ear	Right Ear
RECD	Previously measured	Previously measured
SII Soft 55 dB SPL	40	37
SII Average 65 dB SPL	52	51
MPO Measured	Yes	Yes



3) Interpretation

The SII scores are acceptable for Kenny's degree of hearing loss and the MPO has been verified. His hours of use per day are high. Together, these indicate that the hearing aid fitting is electroacoustically acceptable, and is being used. On the PEACH, **scores of 84, 83, and 85%** were obtained on the Overall, Quiet, and Noise subscales, respectively. These scores fall within the **unshaded region** of the score sheet indicating that Kenny is **demonstrating typical aided performance** on the PEACH. Overall, this is a good result, with no concerns at this time.

4) Follow-up

Further audiological assessment and hearing aid checks will occur at regular intervals. Hearing aids will be adjusted as needed to account for changes in ear growth. Auditory performance with amplification will continue to be monitored.

Possible Performance Review Case Study: Alexxis

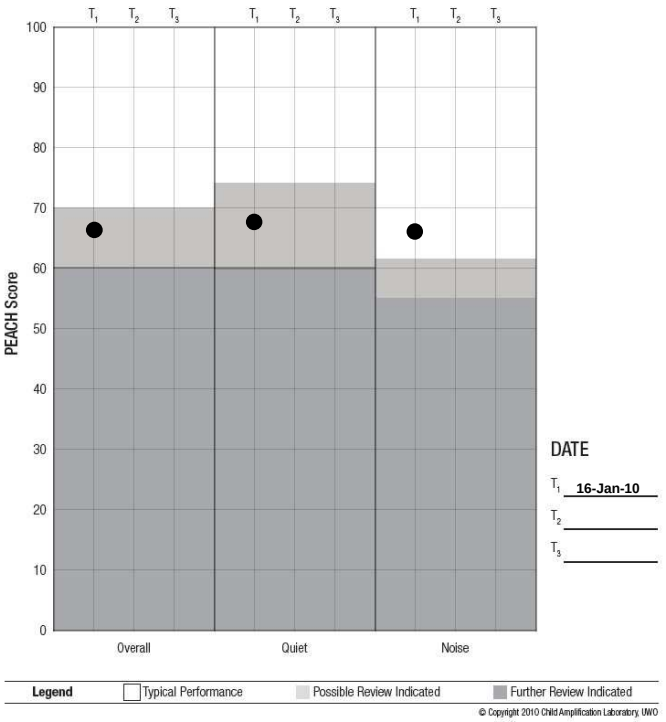
1) History

Alexxis was born full term without complications. A **bilateral mild sloping to profound sensorineural (PTA=74 dB HL)** hearing loss was identified when she was 14 months of age and hearing aids were fitted when she was approximately 18 months of age. The results of her follow-up appointment at 2.5 years of age are provided.

2) Hearing Aid Follow-up

Alexxis' current earmolds were fitting properly and therefore coupled to insert earphones for VRA. RECD values were obtained with her current earmolds for the left ear. The electroacoustic performance of her hearing aids was re-verified in the test box to DSL v5.0a targets. Alexxis' **LittlEARS score was 33** at this appointment, therefore her mother also completed the PEACH while the clinician was adjusting the hearing aids. The hearing aid fitting details are summarized in the table below and the results of the PEACH have been plotted on the score sheet to the right.

HA Fitting Details	Left Ear	Right Ear
RECD	Measured	Used LE values
SII Soft 55 dB SPL	19	22
SII Average 65 dB SPL	39	40
MPO Measured	Yes	Yes



3) Interpretation

The SII scores are acceptable for Alexxis' degree of hearing loss and the MPO has been verified. Scores of **66, 67, and 65%** were obtained on the Overall, Quiet, and Noise subscales of the PEACH, respectively. These scores fall within the **lightly shaded region** of the score sheet **indicating a possible review**. Upon further review, it is possible that a small number of items on the PEACH received low scores. These items were not yet within Alexxis' developmental range. Therefore, we should expect these scores to increase as she develops, as is normal for scores on this questionnaire to age three.

4) Follow-up

Further audiological assessment and hearing aid checks will occur at regular intervals. Auditory performance with amplification will be monitored closely.

Performance Review Case Study: Quinn

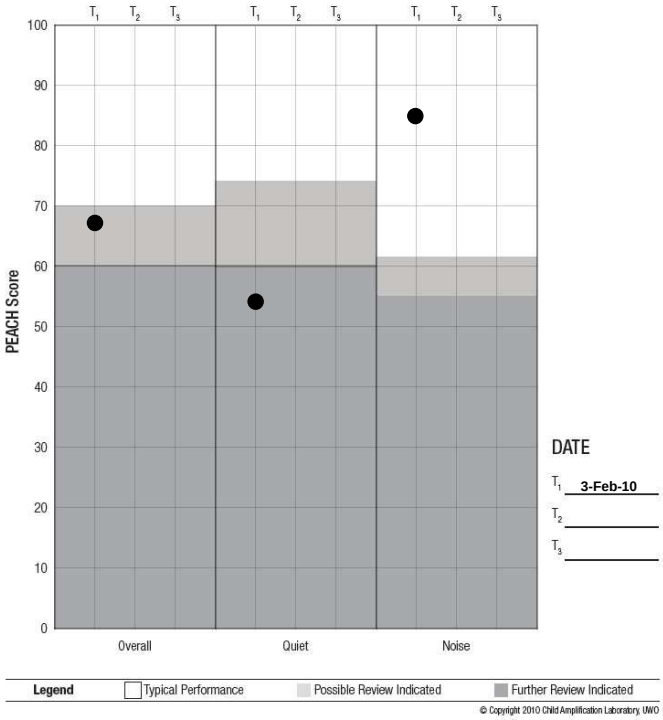
1) History

Quinn was born full term without complications. A **bilateral mild sloping to severe sensorineural hearing loss (PTA=61 dB HL)** was identified when he was 4 months of age and hearing aids were fitted when he was approximately 7 months of age. His family recently moved and the results of his follow-up appointment at 3.5 years of age at the new clinic are provided.

2) Hearing Aid Follow-up

Quinn's current earmolds were fitting properly and therefore coupled to insert earphones for CPA. RECD values were measured with his current earmolds. The electroacoustic performance of his hearing aids was verified in the test box to DSL v5.0a targets. His mother completed the PEACH while the clinician was adjusting the hearing aids. The hearing aid fitting details are summarized in the table below and the results of the PEACH have been plotted on the score sheet to the right.

HA Fitting Details	Left Ear	Right Ear
RECD	Measured	Measured
SII Soft 55 dB SPL	16	18
SII Average 65 dB SPL	28	30
MPO Measured	Yes	Yes



3) Interpretation

The **SII scores are significantly lower** than expected for Quinn's degree of hearing loss. This indicates that the hearing aid fitting is not maximizing speech audibility. Scores of **68, 54, and 85%** were obtained on the Overall, Quiet, and Noise subscales of the PEACH, respectively. The Quiet and Overall scores fall within the "Further Review Indicated" and "Possible Review Indicated" sections. It is possible that the poor SII values have impacted Quinn's auditory performance with amplification. Refitting/adjusting and monitoring is recommended.

4) Follow-up

A more appropriate hearing aid fitting will be provided, aiming to maximize speech audibility. Aided auditory performance will be monitored.