Cochlear Implants
Navigating a Forest of Information…
One Tree at a Time

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http://clerccenter2.gallaudet.edu/KidsWorldDeafNet/e-docs/CI/index.html

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Training the Ear to Listen

The implant surgery is complete and the "map" has been set. Access to sound has been achieved, and it is time to begin the process of training the "new" sense of hearing to be functional for the purpose of understanding sounds in the environment and learning spoken language. The process and rate of attaching meaning to sound will differ for each child.

The following components will be addressed:
- considerations for training,
- equipment troubleshooting,
- the stages of listening and speaking development,
- skill assessment,
- curriculum guidelines,
- adjusting communication variables,
- sign language as a support to listening, and
- about auditory-verbal therapy.

Considerations for Training

The process of "making sense of sound" will differ for each child. Some children will readily make connections between sound and the world around them in natural ways, while others may need structured, methodical practice to make the connections to understand sound. Regardless of the type of intervention—naturalistic, structured**,** or a combination of both—there are few who would dispute the importance of *training the ear to listen* to facilitate optimal outcomes with a cochlear implant.

Amy McConkey-Robbins describes the difference between training via a **didactic** (directly taught) approach to auditory training in comparison to a **generalization** (incidental learning in the natural environment) approach. In "Two Paths of Auditory Development for Children with Cochlear Implants," in *Advanced Bionics' Loud and Clear Newsletter (*Volume 1, Issue 1, 1998) (PDF), McConkey-Robbins discusses the following important considerations:
- a child's potential for incidental learning and generalization is greatest in the early years and slowly decreases with age;
- all implanted children require a combination of didactic and incidental teaching;
- with all things being equal, the younger the child at the time of implantation, the greater the influence of incidental learning and the less the need for didactic instruction; and
- the older the child at the time of implantation, the greater the need for didactic instruction to foster auditory development.

While the hope is that children will learn to integrate sound through natural listening experiences, outcomes with many implanted children support the importance of structured listening training. Random, ongoing auditory input does not automatically translate to comprehension.

In addition, training alone is not a guarantee of similar "listening outcomes" for each child with an implant. It is important to keep in mind that, regardless of extensive training, outcomes will vary for each child based on the many variables that impact a child's performance with an implant (see Factors Influencing Performance).

For example, the expectations and progress rate for a child who is implanted in the early years when language is typically emerging are observed to be significantly different than for a child who is implanted late, beyond the typical language learning years. A young child may learn to listen, in a developmental sequence, with only limited didactic training, while an older child, arriving at the implant process with minimal listening experience, may require extensive, structured listening training. Whether an individual is young or old, an experienced or inexperienced listener, the new sense of "electronic" listening does not automatically translate to understanding. The path to bringing meaning to sound is unique to each implanted individual and outcomes cannot be guaranteed.

Equipment Troubleshooting

The first step to optimal listening with an implant is a consistently functioning device. It is imperative that a cochlear implant be in working order daily and have an appropriate "map" for a child to obtain maximum benefit from their implant. Ongoing opportunities should be scheduled with the hospital implant center to monitor the chosen map to assure that it continues to meet the child's needs.

> **For more information about mapping a child's speech processor:**
>
> Fitting the Speech Processor

Why Monitor the Map?

As the brain adjusts to sound, what may have at first been comfortable and "loud enough" becomes insufficient and "not enough." This adjustment to sound may be clearly apparent or can sometimes go unnoticed, similar to a light on a dimmer that grows dim so slowly as to almost be imperceptible until it becomes too dark. A child may also inadvertently have electrodes that have been set for too much stimulation, causing discomfort. If this occurs and is not remedied, the child could possibly begin to see listening as a negative experience and may resist using the cochlear implant. If a child is functioning with an inappropriate map, this will negatively impact progress with the implant.

There are two types of checks that can be completed daily both at home and in school on a cochlear implant—an equipment check and a check of the child's functional listening.
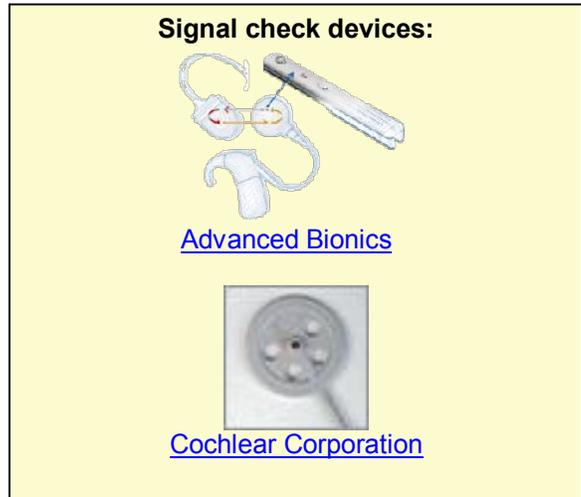
Equipment Check

It is not possible for parents and teachers to listen to a child's cochlear implant as one would listen to a hearing aid; however, there are other checks of the equipment that should be completed daily.

Include the following in a daily check:

- Use a **signal check device** (available from the implant manufacturers) to check the integrity of the transmitted signal when connected. A light indicates that all systems are working when the implant is on the child.
- Check all batteries daily (a weak battery will make a difference).
- Check coils and cables for wear and tear.

For a more detailed description of daily equipment checks and instructions for when a problem occurs, refer to further troubleshooting guidelines available at the following Web sites:

- The Parent's Guide to Cochlear Implants
- Equipment Check for Cochlear Corporation
- Johns Hopkins Listening Center: Troubleshooting Guide (Cochlear, Advanced Bionics, Med El)

> **Signal check devices:**
>
> Advanced Bionics
>
> Cochlear Corporation

Functional Listening Check

In addition to checking the equipment, it is important to check a child's performance with the equipment on a daily basis. One such check, familiar to many, is the **Ling Six Sound Test**. This check involves presenting a series of specific speech sounds at a consistent loudness and distance from a child to document his or her sound awareness. When a child demonstrates a change in sound awareness from an established baseline response, this may reflect:

- a possible change in a child's listening potential that may require attention to his or her map, or
- an equipment malfunction.

This quick and easy check involves the following steps:

- Have the student sit at a distance of about three feet wearing his or her implant.
- Cover your mouth with a listening hoop (a

> **Instructions for making the listening hoop**
> (from *Bringing Sound to Life—Principles and Practices of Cochlear Implant Rehabilitation*)
>
> Materials needed:
>
> - 8-inch embroidery hoop
> - speaker cloth (available from http://www.radioshack.com/)
> - Directions for assembly:
> - Cut a DOUBLE layer of fabric in a circle two to three inches larger than the hoop.
> - Separate the two rings of the embroidery hoop.
> - Place two layers of fabric over the smaller hoop.
> - Place the larger hoop over the fabric and the smaller hoop, keeping the edges even.
> - Keep the fabric taut as the rings are put together.
> - Trim the edges of the fabric.
> - Glue around the trimmed edge of the fabric and the edge of the hoop.
> - Allow time for the glue to dry.

specially designed barrier to present sound without distortion). This hoop can be made using an embroidery hoop with two layers of acoustic speaker cloth.

- Individually present each of the following six sounds: "mm," "oo," "ah," "ee," "sh," and "s." (These sounds represent the variety of the frequencies present in speech.)
- Have the child respond to sound (raise a hand, place a block into a container, etc.) when it is audible.

Note: This task can be completed only after a child is old enough to produce a conditioned response to sound.

This task does not indicate that a child can identify or understand the sounds presented.
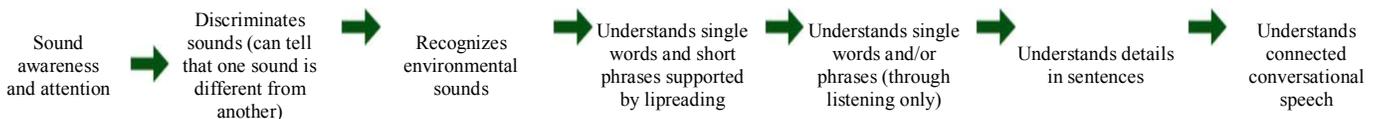
Notes about the Ling Six Sound Test:

- Present each sound at a quiet level. If you present a sound too loud, it is difficult to determine when a mapping shift may have occurred. You want to confirm that the child is consistently aware of "very quiet" sounds.
- Be sure to vary the pause time between sounds. Children readily pick up on a pattern and false positive responses will occur. Occasionally intersperse "no sound" during the check to see if the child is responding appropriately. That is, signal "listen," hold up the listening hoop, and then say nothing. The child needs to feel confident saying that he or she doesn't hear anything.
- If you notice a change in response that does not appear to be related to behavior, contact the child's family or hospital implant center audiologist to discuss the issue.

The Stages of Listening and Speaking Development

There are many stages that come before a child begins to understand his or her first word through an implant. He or she must first develop the pre-requisite skills that provide the foundations for word understanding. The child must first be aware of a range of sounds and be able to differentiate between those sounds before he or she will ever be able to understand them.

The following progression details a typical hierarchy a child may follow in learning to listen and understand. There are many aspects and components of each of these levels.

Receptive listening skill development:

Sound awareness and attention → Discriminates sounds (can tell that one sound is different from another) → Recognizes environmental sounds → Understands single words and short phrases supported by lipreading → Understands single words and/or phrases (through listening only) → Understands details in sentences → Understands connected conversational speech

It is important to remember that a child's ability to use spoken language is closely tied to what he or she is hearing, and that listening and speaking skills development is intertwined. The following is a typical progression of spoken skill development.

Expressive skill development:

Attempts to use voice for communication purposes → Imitates appropriate duration, pitch, and intensity patterns of speech in structured situations → Imitates specific sounds in syllables and words in structured situations → Uses simple words and phrases spontaneously → Uses details in sentences → Uses connected conversational speech
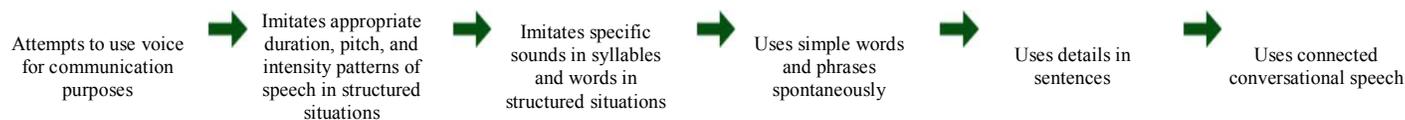
Skill Assessment

It is necessary to determine a child's functioning level related to both receptive and expressive spoken language at the time of implantation and to develop a plan to facilitate the progression through the necessary stages to arrive at spoken language understanding and use.

Questions to determine a child's receptive functioning level:

- Which sounds is the child aware of and in which environments?
- Is the child conditioned to respond to sound?
- Is the child attending to sound naturally or does he or she need to be directed to listen?
- What does the child understand and in what conditions? (How loud? How far away? How many listening choices? How many times was it repeated?)

Questions to determine a child's expressive level:

- How does the child utilize spoken language to communicate?
- Does the child have intelligible speech? If so, in what situations?
- What specific sounds can the child say/imitate/produce spontaneously?

There is a variety of formal and informal tools available to assist in gathering information about a child's functioning. For an explanation of suggested assessment tools and scales to consider, go to: http://clerccenter.gallaudet.edu/CIEC/resources2.html#suggestedscales.

Two popular tools that are readily available at no charge to document receptive listening integration skills are the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS) and the Functional Auditory Performance Indicators (FAPI).

For young children, the IT-MAIS is a criterion-referenced test that utilizes a parent interview technique to determine how a young child is integrating sound into his or her life. Available through Advanced Bionics, the IT-MAIS is based on a similar tool for older individuals called the Meaningful Auditory Integration Scale (MAIS). The questions document functioning in three areas: vocalization behaviors, sound alerting, and deriving meaning from sound. The responses can be used to guide planning for auditory training.

> **For further information about the use of this scale:**
>
> Advanced Bionics, *Loud and Clear Newsletter*, Volume 4, Issue 1, Infants and Implants: Listening Skills in Very Young Children (PDF)

The FAPI: An Integrated Approach to Auditory Skill Development documents a child's listening skills in seven related areas: sound awareness, sound meaning, auditory feedback, sound localization, auditory discrimination, short-term memory, and linguistic auditory processing. This tool is available online at: http://www.csdb.org/chip/resources/docs/fapi6_23.pdf (PDF).

After assessment is complete, the next step is to set goals that address development of both listening and speaking skills. As a plan is initiated, it is always critical to balance development of these skills into the context of a child's overall language, communication, and educational experience. For further information, see Choosing a Communication Methodology.

Curriculum Guides

There are numerous curriculum guides designed to move a child through the hierarchy of listening skills using a structured, sequential approach. A description of and purchase information for the following commonly used guides can be found in the Resources for Children and Families section of the Laurent Clerc National Deaf Education Center's Cochlear Implant Education Center site.

- *Bringing Sound to Life: Principles and Practices of Cochlear Implant Rehabilitation*

- *Speech Perception Instructional Curriculum Evaluation (SPICE)*

- *Top Ten Strategies for Parents* (parent manual, professional manual, videotape)

- *Learn to Talk Around the Clock*

- *Classroom Goals: Guide for Optimizing Auditory Learning Skills*

- *Cottage Acquisition Scales for Listening, Language, and Speech*

- *St. Gabriel's Curriculum for the Development of Audition, Language, Speech and Cognition*

- *CHATS: The Miami Cochlear Implant, Auditory and Tactile Skills Curriculum*

- *Listen, Learn, and Talk* (Cochlear Corporation)

- *Spoken Communication for Students Who are Deaf or Hard of Hearing: A Multidisciplinary Approach*

- *AuSplan (Auditory Speech Language): A Manual for Professionals Working with Children Who Have Cochlear Implants or Amplification*

Specifically for young children:

- *My Baby and Me*

- *Listen Little Star* (A Listening Program)

Adjusting Communication Variables

With careful attention, the listening difficulty of any communication experience can be adjusted. Learning how to adjust communication variables is at the core of helping a child derive meaning from sound and central to the concept of "auditory training." *Bringing Sound to Life: Principles and Practices of Cochlear Implant Rehabilitation.* (Koch, M. http://bionicear.com/professionals/rehabmaterials.asp) describes this important concept as the "challenge factors."

When the following factors related to content and presentation of information are modified during either a structured listening activity or in the natural environment, any listening situation can be controlled to be either readily accessible or challenging.

These content-related factors can be modified:
- the familiarity of vocabulary,
- the number of items in a choice set (i.e., three choices, four choices, open set),
- the acoustic contrast of items in a choice set (i.e., shoe versus elephant), and
- the number of critical elements (i.e., big red shoe, ball under the bed).

These presentation-related factors can be modified:
- the rate of presentation,
- the acoustic highlighting (emphasis on key words),
- the visibility of a carrier phrase (a phrase leading up to a key word or words), and
- the number of repetitions.

Another important strategy to assist children in deriving meaning from sound is the "sandwich" technique. The sandwich technique involves linking information sequentially via auditory and visual modes.

Note: Depending on a child's communication methodology, provision of visual information in the "sandwich" may be through either sign language or speechreading. Two examples of the sandwich technique are as follows:

> **For more about the sandwich technique and the components of auditory training:**
>
> Advanced Bionics, *Loud and Clear Newsletter,* Volume 3, Issue 1, Bringing Sound to Life (PDF).

- *Auditory-Visual-Auditory:* say it—sign it —say it **or** say it— say it adding speechreading—say it

- *Visual-Auditory-Visual:* sign it—say it —sign it —say it adding speechreading —say it —say it using speechreading

Through modification of the "challenge factors" and use of the sandwich technique, communication encounters and structured listening tasks can be designed specifically to the communication needs and goals of each child.

Sign Language as a Support to Listening

Some children obtain their cochlear implant with established competencies and comfort levels with sign language use. Sign language will hold differing roles for each child with an implant and those roles may change over time. A child's level of sign language use will impact educational and communication choices as well as auditory and speech training strategies. Mary Pat Moeller, Ph.D., Director of the Center for Childhood Deafness at Boys Town National Research Hospital in Omaha, Nebraska (Advanced Bionics Workshop: Options For Success in Chicago, American Speech-Language-Hearing Association pre-conference workshop, 2003), describes four levels of sign language use for children with implants:

> **For further information about the role of sign language use for children with a cochlear implant:**
>
> Children with Cochlear Implants: Where Does Sign Language Fit In?

- *foundational user*—sign language is used as a bridge to oral development (for the early identified infant)
- *transitional user*—sign language has been a part of the child's life, yet the goal is to transition to an oral environment
- *strategic user*—the child continues to rely on a combination of spoken and signed language
- *dominant sign user*—the child is an established American Sign Language (ASL) user who receives an implant at a later age and who will develop useful skills, yet progress is usually observed to be slower than children implanted very young or children with strong early experiences using spoken language

With the appropriate supports, sign language can be used to facilitate spoken language development. For sign language to be a support of spoken language, attention must be given to the following.

- Make links between signed and spoken language.
  - ➢ Model and expand known signs into spoken language. For example, when a child signs *ball*, verbalize back, "Yes, that's a ball."
  - ➢ Incorporate the use of sequential language use/sandwich technique (say it—sign it—say it or sign it—say it—sign it).
  - ➢ For older students, help them make links between spoken language and ASL. For example, explain how a word or a sentence looks in ASL and how it corresponds to English.

- Adjust the degree of sign language use.
  - ➢ Determine how and when to utilize ASL, Sign Supported Speech, and speech only.
  - ➢ Control the degree of sign language use within the content/context of the situation.

> ➤ Set up opportunities during which sign language is **not** available and alternative listening strategies are utilized (modification of the challenge factors).

Note: There is ongoing discussion regarding problems surrounding the use of signing and speaking at the same time. Historically, for deaf children with compromised access to sound, research has suggested that simultaneous communication negatively impacts the transmission of both the signed and the spoken message (Johnson, R., Liddell, S., Erting, C., Gallaudet Research Institute, 1989). For children with an implant, however, this discussion is being revisited in light of the increased access to the spoken message provided by the implant. Further research is needed to determine if sign language as a support to spoken English can facilitate improved development of English as a complete language. How and when Sign Supported Speech may be appropriate should be closely monitored in light of the language and communication characteristics of other students in the environment, as it does not provide a clear language to many students who do not have sufficient access to auditory information either through a cochlear implant or through hearing aids.

- Provide opportunities for spoken language use.
  - ➤ Provide individualized training in specific listening skills (didactic instruction) based on the goals of each child. (See Curriculum Guides above.)
  - ➤ Provide information auditorily only in contextual, familiar environments.

About Auditory-Verbal Therapy

"The Auditory-Verbal approach is based upon a logical and critical set of guiding principles which enable children who are deaf or hard of hearing to learn to use even minimal amounts of amplified residual hearing or hearing through electrical stimulation (cochlear implants) to listen, to process verbal language, and to speak," according to Auditory-Verbal International. An Auditory-Verbal approach includes utilization of a sequential structured system of strategies that rely only on the sense of hearing to provide access to language information. Listening skills are developed through individual training sessions as well as through a lifestyle of learning through listening.

Auditory-Verbal therapy differs from Auditory-Oral therapy in that the Auditory-Oral approach may include use of speechreading information to supplement the sense of listening for obtaining information. The Auditory-Verbal approach focuses solely on promoting the sense of listening to obtain information. The sequence of training and specific strategies utilized during Auditory-Verbal therapy may be similar to

> **For more information about the philosophy and strategies utilized in the Auditory-Verbal approach:**
>
> Learning to Listen Foundation
>
> Auditory-Verbal Learning Institute

those detailed in other auditory training hierarchies; however, true Auditory-Verbal training is provided only by professionals trained in the specific strategies included in the Auditory-Verbal approach.