Language Outcomes After Cochlear Implantation

Hillary Ganek, MA, CCC-SLP, LSLS Cert. AVTa,*, Amy McConkey Robbins, MS, CCC-SLPb, John K. Niparko, MDa

Whereas the impact of hearing loss in an adult varies considerably, the impact of a sensorineural hearing loss in infancy and early childhood can be pervasive. Virtually every aspect of communication and spoken language learning is supported by early access to the phonology of speech.1

For more than 2 decades, the proportion of cochlear implants (CIs) provided to young children with hearing loss has increased. Auditory thresholds of children with CIs provide improved access to auditory information beyond that available to deaf children using conventional amplification (hearing aids), offering a critical substrate for auditory learning.2 To the extent that a CI can encode the sounds of speech with precision, the device can provide opportunities for learning spoken language.

LANGUAGE ACQUISITION IN CHILDREN WITH CIs

The primary goal of implantation in children is to facilitate communication in the modality that is native to the families of the vast majority of deaf children: spoken language. Language is defined as a vehicle for shaping and relating abstractions for communication3 in which meaning is independent of the immediate situation. Practical use of speech is based on the assignment of a single name to various appearances and situations under varying conditions. Spoken language involves a conversion of thought into speech, and relies on mental representations of phonological (sound) structure and syntactic (phrase) structure.3 The CI, because it provides improved access to sound and phrase structure, may improve spoken language outcomes.

a Department of Otolaryngology–Head and Neck Surgery, The Listening Center at Johns Hopkins, The Johns Hopkins University, 601 North Caroline Street, Baltimore, MD 21287, USA

b Communication Consulting Services, 8512 Spring Mill Road, Indianapolis, IN 46260, USA

* Corresponding author.
E-mail address: hganek1@jhmi.edu


0030-6665/12/$ – see front matter © 2012 Elsevier Inc. All rights reserved.
Published studies now provide substantial evidence regarding the effects of CIs on language development in children. Robbins\textsuperscript{4} has identified trends that have emerged from those studies:

**Earlier Age at CI is Associated with Better Communication Development**

This finding is robust and has been verified in multiple studies by researchers using different assessment tools. The research literature suggests a substantial advantage for language acquisition in children receiving their CIs at young ages in comparison with older ages.\textsuperscript{5–7} Niparko and colleagues\textsuperscript{8} used a controlled prospective, longitudinal, multisite design to evaluate age at implantation in relation to spoken language development as part of the Childhood Development after Cochlear Implantation (CDaCI) study. Children implanted prior to 18 months of age followed language development trajectories similar to hearing peers. Implantation after 18 months created less favorable trajectories.

These findings should compel us to examine just how early deaf children may need to receive a CI if language-learning gaps relative to hearing children are to be avoided. Even for children whose language-learning rate after implantation does not match that of normal-hearing (NH) peers, rates postimplantation have been shown to be consistently faster than those established preimplantation. In addition, higher increases in comprehension and expression were associated with greater residual hearing before implantation, higher parent-child interaction scores, and higher socioeconomic status.\textsuperscript{8}

Nicholas and Geers\textsuperscript{9} used spontaneous language samples and the Preschool Language Scale to evaluate 76 children whose age at cochlear implantation ranged from 12 to 36 months and who had used oral-only communication since implantation. Children implanted at the youngest ages, between 12 and 16 months, were more likely to achieve age-appropriate spoken language. By contrast, children implanted after 24 months of age did not catch up with NH peers when tested at age 4.5 years. The investigators concluded that children who receive a CI as late as age 3 years may experience great difficulty catching up with NH age mates.

Manrique and colleagues\textsuperscript{10} studied 130 CI children using the Peabody Picture Vocabulary Test and the Reynell Scales. Their findings suggested that children implanted before 2 years of age exhibited better language development than those implanted after age 2.

The effect of age at cochlear implantation was studied using scores from the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS) in 3 groups of children who had received a CI at the age of 12 to 18 months, 19 to 23 months, or 24 to 36 months, respectively.\textsuperscript{11} Scores from each age group, obtained at pre-CI, then at 3, 6, and 12 months post-CI, were compared with IT-MAIS scores obtained from a large group of children with normal hearing.\textsuperscript{12} The results were consistent with those cited above: The most impressive scores were obtained from children in the youngest-implanted group, in which more than half of the subjects achieved scores after 6 months of CI use that matched the scores of NH peers. Although substantial gains in scores associated with CI use were also obtained from the two groups implanted at older ages, the trend was less dramatic for those implanted between ages 19 and 23 months, and still less dramatic for those implanted between ages 24 and 36 months. In addition, the scatter in scores was much wider for the oldest than the youngest group, indicating that it became harder to predict post-CI performance as children’s age at implantation increased.

The basis for improving the language-learning trajectory with young age at CI relates to sensitive periods and neural plasticity. Using the latency of the P1 cortical auditory evoked potential as a measure of central auditory pathway maturity, Sharma and...
colleagues found that children implanted at 3.5 years or younger showed age-appropriate latency responses by 6 months post-CI. These investigators concluded that in the absence of normal stimulation, a sensitive period persists for about 3.5 years during which the human central auditory system remains maximally plastic. Other central nervous system factors play a role in language outcomes. For example, there is superior potential for younger children to learn language incidentally. Although children who are older at the time of CI may still benefit from incidental learning, it is likely that their rehabilitation and environment will need to address greater deficits.

Improved speech processing strategies provide more communication enhancement. The amount and quality of information provided by the speech processor has a measurable effect on language. Data from Geers and colleagues have shown that children whose CIs were upgraded on a regular basis with state-of-the-art speech-processing improvements outperformed children using older speech-processing technologies. A wide dynamic range and optimal growth of loudness characteristics contribute substantially to a child’s ability to hear speech. Accordingly, outdated processors should be revised in favor of technology that can enhance the child’s listening experience.

Children with CIs Outperform their Profoundly Deaf Peers Who Use Hearing Aids

Faster rates of language learning and higher overall language achievement levels are consistently documented in CI children relative to their unimplanted, deaf peers. The average profoundly deaf child with hearing aids learns language at about half the rate of NH children, acquiring 6 months of language in 1 year’s time. This trend for deaf children to acquire language, on average, at only about half the level of NH peers is found repeatedly in the literature, going back to such studies as those by Osberger. If the thresholds of hearing for a profoundly deaf child are improved to a level those similar to those experienced by a hard-of-hearing child, this conversion represents an enormous improvement in auditory learning potential, given the differences in performance that have been documented between children with profound versus aidable sensorineural hearing loss.

CIs Enable Some Children to Acquire Language at a Rate Similar to that of Normal-Hearing Children

The CI changes the trajectory of spoken language learning in most recipients, elevating the rate of learning relative to the pre-CI period. Several studies demonstrated that the average child who received a CI learned approximately 1 year of language in 1 year’s time. Blamey and colleagues documented a rate of language learning in a group of CI children that was considerably slower than that reported in other studies. However, some children in the Blamey and colleagues study had not received their CI until as late as age 8 years, a factor that likely contributed to the more modest improvements in language. As more data have been analyzed, especially from large-scale studies, it is clear that language outcomes are substantially more favorable if implantation occurs before a wide and persistent gap develops between chronologic and language age. In addition, it is estimated that 40% of deaf children have additional disabilities. An increasing number of children from that group, which makes up a substantial percentage of all deaf children, are receiving CIs. Among that group, a language-learning rate comparable to that of children with normal hearing would be the exception rather than the rule. This finding underscores the need to consider that certain conditions should prompt a thorough consideration.
Many Children Remain Delayed in their Language Skills Even After Implantation

In a nationwide sample of 8- to 9-year-olds who received a CI between 24 and 35 months of age, only 43% achieved combined speech and language skills within the average range, relative to NH peers. Recall that significant delays in language development already exist in most children by the time they receive their CI, even in those who are implanted early. As Tyszkiewicz and Stokes note, a 2-year-old hearing child has a highly tuned auditory system used since birth, generating a large auditory repertoire. The 2-year-old who is implanted has a very different starting position, with little of this knowledge in place. To prevent a continued delay, children must either learn language at a rate faster than normal after CI, or receive their CIs early enough to prevent an insurmountable chronologic language gap from forming in the first place. Unfortunately, language-learning rates that exceed those of hearing children are rare.

A Wide Range of Language Benefit is Observed Across Children

Studies of language ability in CI children consistently yield a wide range of performance outcomes. This wide range is found in virtually every study of CI users and requires that data be interpreted with caution, particularly when these data are presented as average performance. Large standard deviations in data limit the usefulness of looking at “average” scores. Regardless of the specific device used, some children do extremely well with their implants, performing at the upper end of the continuum, whereas a small number of children receive limited benefit from their implants. The attempt to identify the factors that might account for this variability requires a multivariate use.

Children Using both Oral and Total Communication Improve in their Language Skills After CI; but as a Group, Oral Communication Users Outperform Those Using Total Communication

This trend is robust, having been reported in a variety of observational studies using different assessment procedures. However, these studies are without controls, thus preventing analyses of covariates and confounders (eg, those related to specifics of the hearing history and the family environment). Underlying language skills are the domain in which total communication (TC) children with CIs have competed most favorably with oral communication (OC) children, when each group of children is tested in its preferred modality—that is, TC children tested in sign plus speech, OC children tested in oral-only mode. Under these conditions, Geers and colleagues found no significant differences in language comprehension or verbal reasoning between OC and TC children with CIs who were implanted by age 5 years. However, better performance of the OC children emerged when other aspects of language were assessed, including expressive vocabulary, morphosyntactic use, utterance length, and narrative form—all measured via spontaneous language samples. This advantage of the OC over the TC group was apparent even when the TC children were credited with signed as well as oral productions.

As mentioned, methodological challenges persist in this research related to confounding influences. TC and OC children may not be equal at the start of their intervention. It is not clear whether the mechanisms by which language is enhanced via a CI are the same for children using OC and TC. These studies almost all used subjects implanted before the age of 5 years. If children with long-standing profound deafness are implanted when they are older than 4 years, the likelihood that they will require sign to augment language learning is very high. This is especially true for language presented in academic settings where the pace of presentation is rapid and the amount of material introduced is voluminous. The advantages of the OC over the TC group have
been even more striking in studies assessing speech perception and speech production in children with CIs.\textsuperscript{31,32}

\textbf{Grammatical Development, Including Syntax and Morphology, is Mastered More Slowly than Other Language Skills in Children with CIs}

Even in CI children who demonstrate language comprehension within the average range, expressive use of morphologic markers is often delayed.\textsuperscript{5,15,16,22,29} Deficits in this domain also persist longer than deficits in other language areas in NH children with specific language impairment,\textsuperscript{33,34} suggesting that morphosyntactic skills are a fragile aspect of language, vulnerable to delays. This vulnerability is compounded for children with hearing loss because morphologic markers are almost always in word-final position in English, and consist of high-frequency consonants such as s, z, and t that are often poorly audible, especially in conversation.\textsuperscript{35}

Cochlear implantation also affects the development of early communication skills such as eye contact and turn-taking. Tait and Lutman\textsuperscript{36} found that these skills begin to develop within 6 months of implantation.

\textbf{LITERACY SKILLS IN CHILDREN WITH CIs}

The nature of a child’s language development, whether manual or oral, will depend on the quantity and quality of exposure to a complete language system. Early and appropriate language stimulation appears to be an important factor in the acquisition of visual language as manifest in comprehension (reading) and expression (writing), as well as in acquisition of spoken language. For example, reading comprehension ability among deaf 15-year-old students who use American Sign Language as their primary mode of communication is at the third-grade level, whereas the average 15-year-old hearing student reads at a tenth-grade level.\textsuperscript{37}

Reading requires a combination of abilities including sound and symbol correspondence, strong vocabulary skills, and an extensive world knowledge. Sound symbol is the ability to decode a word by associating written letters with the reader’s phonologic system. Historically, children who are deaf have not been able to access the entire phonologic system. Therefore they have relied more on whole-word recognition than on sound and symbol correspondence. Strong vocabulary skills allow readers to apply more cognitive analysis to processing complex syntax and become more successful readers.\textsuperscript{38,39} Children who are deaf typically have vocabulary deficits likely rooted in limitations in phonological processing, particularly those referencing abstract concepts.\textsuperscript{40} Such deficits can prevent the full processing capacity needed to understand higher-level texts.

Early readers bring their world knowledge to their first literacy experiences. Children who are deaf often face a parent-child communication barrier that prevents exposure to the kinds of conversation about higher-level abstract concepts that provides hearing peers with a foundation for reading comprehension.\textsuperscript{41} Without these preliteracy skills, children without access to sound struggle to develop age-appropriate reading skills.\textsuperscript{42}

Data reported by Tomblin and colleagues\textsuperscript{15} indicate that reading levels among schoolchildren with CIs, however, approaches that of their hearing peers with extended CI experience. Geers\textsuperscript{43} notes that whereas many children with CIs achieve literacy skills within the average range for their hearing peers, others do not do as well. High nonverbal IQ scores, good CI function, an oral mode of communication, and overall language competence including comprehension, production, and the use of narrative forms are all associated with better literacy outcomes.\textsuperscript{44,45}
Pisoni and Geers\cite{46} investigated the impact of working memory on measures of speech perception, speech intelligibility, language processing, and reading in implanted children with prelingual deafness. The investigators evaluated correlations between children’s ability to recall lists of digits presented in the auditory-only modality and their performance on these measures. Moderate to high correlations were found between auditory memory and performance in each outcome area, suggesting that working memory plays an important role in mediating performance across these higher communication tasks. Pisoni and Geers postulate that there is commonality in the perceptual processes used in these tasks. The ability to formally register speech sounds, coupled with rehearsal, can be used to encode and retrieve the representations of spoken words from lexical memory.

**AUDITORY REHABILITATION AFTER COCHLEAR IMPLANTATION**

The uniqueness of the listening experience enabled by a CI is underscored by qualitative differences in how sound perception is elicited in comparison with other strategies of auditory rehabilitation. For example, a hearing aid filters, amplifies, and compresses the acoustic signal, thereby delivering a processed signal to the cochlea for transduction. By contrast, a CI receives, processes, and transmits acoustic information by generating electrical fields. Electrical stimulation bypasses nonfunctional cochlear transducers and directly depolarizes auditory nerve fibers. Implant systems convey an electrical code based in those selected features of speech that are critical to phoneme and word understanding in normal listeners, without the advantages of signal preparation provided by cochlear mechanisms of sound processing that render complex sounds listenable and discriminable. As noted, the CI listening experience also differs from normal audition in the timing of when that experience begins. These factors directly affect CI rehabilitation.

Rehabilitation needs should be considered in the context of prelingual versus postlingual onset of deafness. The postlingually deafened child, having experienced profound hearing loss after the acquisition of language, typically shows more rapid improvements in speech recognition with the device.\cite{47} From an auditory training perspective, postlingually deafened children are often characterized as more like the postlingually deafened adult than like the prelingually deaf child. Rehabilitation with the postlingually deafened child is often short term, with emphasis on communication strategies and on mapping the new percepts from the implant onto an existing linguistic code. By contrast, the prelingually deaf child with a CI must use information from the implant to develop such a code de novo, with early auditory training necessarily emphasizing early constructs of spoken language.

Robbins\cite{4} described 12 guiding premises, reiterated here, that underlie the rehabilitation for prelingually deaf children with CIs. These premises are the synthesis of research findings and clinical experience with a broad range of implanted children. The reader will note that much of what enhances learning in CI children is consistent with developmental learning in all children. Because the sensory deficit in the case of deaf children with CIs interferes with spoken language acquisition, developmental approaches, while still allowing a child to gain insights into comprehension and production, need to be taken to their fullest extent over a protracted period of time.

**PREMISES 1 AND 2: OVERARCHING GOALS**

*Premise 1. The Child Must Learn to Attach Meaning to What is Heard Through the CI*

To learn a spoken language via a CI, two conditions must be met. First, the listener must have sufficient (not necessarily perfect) auditory access to the language
code—the vowels, consonants, and suprasegmental patterns that make up that language. In other words, one must be able to hear a language to learn it. Auditory access is essential, but not sufficient, for language acquisition. A second, critical condition must also be met: The sounds must gradually be attached to meaning. Attaching meaning to the sounds transmitted by a CI is a critical task, whether it is a postlingual child who must remap the new signal onto an existing linguistic code or a child with prelingual deafness who must develop the code de novo. The CI and its technology provide access, but rehabilitation, parental follow-up, a nurturing listening- and spoken-language environment at home and at school, and the child’s emergent cognitive ability is necessary to allow him or her to create the opportunities for meaning to be established. The older the child at the time of implantation, the more specific and intensive the training must be to ensure that sound is rendered meaningful.

**Premise 2. The Ultimate Goal for All Children with Hearing Loss, Including Those with CIs, is Communicative Competence**

This premise means that the child can adequately express and understand human communication at a level commensurate with his or her age and/or cognitive ability. Modes of communication for children with hearing loss are on a spectrum from mostly oral to mostly visual (Fig. 1). Some children with CIs will learn to rely heavily on their listening abilities. For others, communicative competence will include the use of sign language or cued speech, either full-time or only in academic settings, or only for receptive clarification. There is an assumption, though, that if parents have sought a CI, they value their child’s auditory and spoken language skills and intend to devote energy to improving them. Not all families of children with hearing loss share these values, and parent choice should always be respected. Parents should be encouraged to select the options for their child that reflect the values they hold as parents, consistent with their goals for their child’s future.

**PREMISES 3, 4, 5: THE LEARNING ENVIRONMENT**

**Premise 3. Skills Learned in a Therapy Setting Must be Transferred Out of the Therapy Room and into the Classroom, Home, and Other Aspects of the Child’s Everyday World**

Clinicians must develop and practice skills within the therapy room but always with the greater goal that those skills will generalize out of the therapy room, into the child’s classroom, home setting, and other everyday environments.

Studies and clinical experience support the notion that the parents are primary agents in their child’s communicative competence and overall development. Clinicians should view their role largely as one of helping parents facilitate their child’s communication progress all day, every day, within the typical range of activities and interactions that comprise family life. For older children whose parents are not at school every day, it is especially important to convey the message that parents are...
essential to their child’s success. Sharing of information between home and school has great benefit for all involved and can be accomplished in a variety of ways, including through a communication notebook that travels from home to school and back. Parents can also be encouraged to complete an interview such as the Children’s Home Inventory for Listening Difficulties (CHILD) that reflects the child’s auditory behaviors in the home. Clinical experience suggests that strong parental involvement can sometimes negate the effects of a weak educational setting, whereas the reverse is far less likely.

**Premise 4. Rehabilitation Sessions Should Integrate Goals of Speech, Language, Perception, and Pragmatics Within an Environment that has Appropriate Social/Emotional Context**

Compelled by law and school policy, clinicians typically write rehabilitation plans that compartmentalize the various domains of communication, writing separate goals for the child in each of these domains. In essence, as clinicians we break apart the complex, unified phenomenon of communication into artificially separate pieces. Our challenge in rehabilitation is to address those goals but to do so in a way that integrates or reunifies the pieces into a whole. This goal is one that is not always achievable in every rehabilitation session. Sometimes we must practice and over-learn a particular skill through a traditional drill method that is unlike natural communication. This practice is acceptable, as long as the clinician seeks to put that skill back into purposeful communication as soon as the child is capable. We seek to use what Fey²⁴ has termed a “hybrid” approach to intervention, balancing structured practice with naturalistic interactions.

**Premise 5. Parents are the Most Potent Influence on the Child’s Progress**

Due to the identification of hearing loss in babies via universal newborn hearing screening (UNHS) in the United States and other countries, and the growing number of children with hearing loss implanted as infants and toddlers, an increasing number of clinicians are serving this population. Some clinicians are not trained to work with babies or to provide services within a model of family-centered intervention. Such intervention focuses on the parents and the family as a whole, rather than on therapizing the child with a CI (Fig. 2). Moeller⁴⁸ cites statistics from Dunst⁴⁹ that 2 hours per week, perhaps spent in therapy, make up only 2% of a toddler’s waking hours,
whereas everyday activities such as diapering and feeding occur at least 2000 times before the child’s first birthday. This statistic is a convincing statement about the power of families, rather than clinicians, to be the change agents in their child’s communication after cochlear implantation. Parents who take advantage of only 10 interactions each waking hour of a child’s day will have provided more than 36,000 teachable moments between ages 1 and 2 years.

PREMISES 6 TO 10: CONTENT AND EXPERIENCE

Premise 6. Almost All Children with CIs Require a Combination of Didactic Instruction and Incidental Learning to Acquire Spoken Language

Auditory development in children with profound deafness has been traditionally viewed as requiring rote training. This viewpoint implied that the child required didactic instruction to achieve each of the listening skills along a hierarchy of auditory development, and virtually hundreds of such skills were required to achieve mastery. The assumption was that the child learned only what was directly taught.

This approach was not unreasonable, given limitations in conveying the highly nuanced information contained in speech to deaf children before the advent of multi-channel CIs. That is, many profoundly deaf children with hearing aids were pattern perceivers, able to recognize only patterns of auditory information rather than discriminate the fine temporal and spectral structure of speech.

In fact, CIs provide the potential for deaf children to make use of incidental learning to an unprecedented degree. Incidental spontaneous learning provides the means by which NH children acquire spoken language and, theoretically, provides the most efficient, socially motivated, and naturalistic way to learn a native language. Nevertheless, the signal provided by the implant is not complete; even CI recipients using state-of-the-art speech-processing technology receive a degraded auditory signal. In addition, many children receive a CI after a period of auditory deprivation during which they have learned to process information visually. Even with the improved auditory signal provided by the CI, these youngsters may need systematic and intensive training to reach their full auditory potential. Thus, both didactic instruction and incidental learning have advantages for the CI child. In general, the older the child is at the time of cochlear implantation, the more structured, didactic instruction is generally required in rehabilitation.

Premise 7. A Diagnostic Teaching Approach to CI Therapy Yields the Most Benefit, Both to Children and to Parents and Teachers

Such an approach seeks to identify what the child can do and to adjust the level of difficulty of tasks. Here, the child is always challenged to achieve greater communication autonomy while the conditions that can either enhance or impede learning are always under assessment. This approach stands in contrast to a traditional therapy approach in which goals are set for a child and in each session similar activities are used. The underlying assumption of a traditional approach is that, with continued practice over multiple sessions, a child will increase the accuracy of the skill—a “practice makes perfect” philosophy. This approach is reinforced by the way individualized education programs are usually written, often using a format such as “Johnny will demonstrate x skill x number of times using a set of x alternative responses with x% accuracy.”

In a diagnostic teaching approach the setting of appropriate individual goals is still critical, but the clinician uses the child’s performance during each session to determine directions needed for subsequent sessions. If a child is successful with an activity under quiet conditions in a session, the child practices it during the next
session to reach a level of automaticity, then the activity is made more challenging in the following session. The clinician continually monitors which factors are favorable or unfavorable to the child’s learning, focusing prominently on the positive aspect of the question: “What are the things that help this child learn most efficiently?” A diagnostic teaching approach works well for a flexible and creative clinician who is willing to try new things, knowing that even if a technique fails with a child, something valuable has been learned—that is, what approach not to use. Clinicians can team up with the classroom teacher to share factors identified in therapy that may be useful or challenging to the child in the classroom setting, and vice versa.

**Premise 8. Content from a Child’s Educational Program Should be Used as Material in Rehabilitation for Maximum Reinforcement and Most Efficient Use of Instructional Time**

Rather than using stimuli unrelated to the child’s other goals, clinicians are encouraged to use concepts, vocabulary, music, and other current classroom materials within therapy activities. Clinicians who assure teachers that their goal is to make the teacher’s job easier, not harder, will often build alliances with regular education staff that promote goodwill throughout the child’s years at the school. These alliances become all the more important as a greater number of children with CIs are fully included in regular education settings.

**Premise 9. Music is a Complex Auditory Experience that Dovetails with Auditory and Spoken Language Development and, Thus, Should be Integrated Within Intervention**

An increasing number of research and observational reports suggest that CI children seek out and appreciate music to a degree that is qualitatively different from that of adults who receive CIs. Clinical experience strongly supports the use of music as an integral component, rather than a separate domain, of rehabilitation with CI children. There are multiple beneficial effects of integrating music into a therapy session and encouraging its use at home, including articulation suprasegmental accuracy, language development, listening development, social skills and turn taking, and cultural assimilation.

**Premise 10. Infants and Toddlers with Implants Require an Approach that is Quite Different from that for Children Implanted After this Age. Therapy with CI Babies is Not Just About Developing Words or Auditory Skills**

Early communication skills are seen to flow from experiences in which an infant and caregiver share affective states, joint attention, and intentions to communicate. Communicative abilities that develop during infancy form the foundation for emerging language. Clinicians should emphasize the importance of parents providing stimulating communication to infants as a key step in their development.

**PREMISES 11 AND 12: MONITORING PROGRESS**

**Premise 11. Auditory Milestones that have been Established May be Used to “Red Flag” Children who are Progressing at a Slower than Expected Rate**

Research and clinical findings have documented the auditory milestones achieved by the average child with a CI during the first year of device use. Three different groups of CI children reflect different preimplant characteristics and show different patterns of skill achievement. When a child is identified as progressing at a slower rate than expected, red flags are raised and specific steps taken, allowing clinicians to intervene as early as possible and identify the source of the problem.
Premise 12. Formal Assessment Tools, Although Important for Monitoring Progress, May Paint an Inadequate Picture of a CI Child's Overall Competence with Spoken Language

Formal assessments conducted with CI children are necessary to support a format of progress in the child's communication. However, careful analysis of results is warranted. The problem lies in the interpretation of the tests, not in the tests themselves. Because tests other than spontaneous language samples are artificial measures of language that use probes such as picture pointing of 4 pictured choices, they may bear little resemblance to real-life communication demands. Children with hearing loss often have extensive experience with this type of format, and may perform well on structured tests that have a repetitive nature. Therefore, interpretations should be cautious when children with CIs score within the average range on test instruments, because these instruments may not be sensitive to the more subtle and higher-level demands of inference, problem solving, and topic shifts that characterize real-world conversation.

REFERENCES