# Cochlear Implant Patient Assessment

## Evaluation of Candidacy, Performance, and Outcomes

*Second Edition*

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# Role of the Speech-Language Pathologist in the Assessment of Pediatric Cochlear Implant Candidacy

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## INTRODUCTION

In the preoperative cochlear implant candidacy process, teams must consider the ways hearing loss has affected a child's development; therefore, team members, apart from the audiologist and surgeon, play a crucial role in determining cochlear implant candidacy. Speech-language pathologists (SLPs), for example, have training necessary to assess a child's speech, language, and academic skills (American Speech-Language-Hearing Association, 2001). Assessments from SLPs can provide information about a candidate's current level of functioning and rate of development. Furthermore, the SLP may help provide insight into expected outcomes for a child once he or she has a cochlear implant; thus, information from an SLP can help a team make an informed decision about a child's candidacy and provide possible expectations for a child post-implant.

Many assessments are available to measure a child's communication skills. To effectively administer and interpret those assessments, professionals must understand the purpose of the instrument and the skills it actually measures. This chapter provides a description of general principles of standardized assessment, along with descriptions of specific evaluation tools and metrics that are widely used by SLPs working with children with hearing loss. In addition, this chapter discusses evaluation and therapy schedules necessary for children with hearing loss prior to cochlear implantation.

## PRINCIPLES OF STANDARDIZED EVALUATION

SLPs often use standardized assessments for evaluations. Standardized assessments are designed to be administered in the same way to all children.

Generally, standardized assessments can be divided into two categories: norm-referenced assessments and criterion-referenced assessments. These types of assessments can serve very different purposes. A norm-referenced assessment instrument is designed to determine if a child's skills (speech, language, etc.) are delayed compared with a sample of his or her peers. Essentially, these assessments serve to answer the question: Is a child delayed, or is he or she functioning within the range of normal (McCauley & Swisher, 1984)? To answer this question, norm-referenced tests assess broad skill sets. Criterion-referenced assessments, on the other hand, help to answer the question: Is a child able to perform a given skill/task to a certain criterion level? The criterion-referenced assessment does not compare a child with his or her peers but rather is based on the theory that a child should have mastered a set of skills by a given age, and assesses the child's mastery of those skills (Swaminathan, Hambleton, & Algina, 1974). Criterion-referenced tests tend to assess specific skill sets. Understanding the difference between information derived from a norm-referenced versus criterion-referenced assessment is critical for interpretation of results.

## Norm-Referenced Assessments

Norm-referenced assessments are designed to identify delayed skill sets, not to capture change over short periods of time. Specific items on norm-referenced assessments are included as a part of the instrument because they reliably distinguish between delayed versus typically developing children. These items are not thought to be representative of a child's performance across the entire range of a given skill. For example, the Clinical Evaluation of Language Fundamentals (fifth edition) assessment "Sentence Comprehension" subtest has an item requiring children to "point to [the picture that shows] the boy who is sitting under the big tree is eating a banana (Wiig, Semel, & Secord, 2013)." A child's inability to complete this task does not indicate that he or she does not understand concept words like "under" or how to follow directions, nor does it indicate that a child who can answer this question has adequate sentence comprehension skills. Rather, this item was chosen because, in combination with the other items on this instrument, performance on the item reliably separates children who do and do not have typical sentence comprehension skills; thus, performance on individual items from a norm-referenced assessment should not be used to discuss individual skill sets of a child, but only to talk broadly about whether a child is delayed or not.

## Criterion-Referenced Assessments

Criterion-referenced assessments are designed to measure mastery of certain skill sets without reference to the performance of other children (Popham & Husek, 1969). These assessments often contain items ordered by level of difficulty. A child's performance on a criterion-referenced item or group of items should indicate mastery of a set of skills (Popham & Husek, 1969). For example, the PALS-PreK Letter Naming subtest requires children to identify the names of letters of the alphabet (Invernizzi, Sullivan, Meier, & Swank, 2004). If a child is unable to name specific letters, an examiner can conclude that the child's performance is indicative of his or her letter-naming skills. Because criterion-referenced assessments are designed to capture a child's mastery of a skill, they can be used to monitor progress.

Why must an SLP understand the difference between norm-referenced and criterion-referenced standardized measures? In reporting information back to a cochlear implant candidacy team, the SLP must be able to accurately interpret his or her findings. A norm-referenced measure can tell the team whether or not a child is experiencing delays, and in which domains, as compared to children with normal hearing of the same age. A criterion-referenced measure, on the other hand, can identify more specific skills that are delayed and may be useful for tracking postimplant progress.

# ASSESSING CHILDREN WITH HEARING LOSS

An SLP involved in the cochlear implant candidacy process is charged with determining a

child's current level of communicative functioning and potential outcomes postimplantation; thus, the SLP needs to be able to analyze a specific assessment's validity for measuring the skills of an individual child with hearing loss. Central to this task lays the question: Does the instrument capture a child's skill proficiency or ability? Proficiency is a child's skill level in comparison to a fluent adult model (Bachman & Savignon, 2002). Ability, on the other hand, is a child's capacity or potential to acquire skills (McNamara, 1995). This distinction between proficiency and ability in children with hearing loss is an important one during assessment interpretation, and subsequently for cochlear implant candidacy decisions and counseling.

Proficiency can be impacted by a child's environment; he or she may not display certain behaviors due to lack of opportunities to learn, not lack of ability. In addition to a child not being able to perform a skill because of his or her hearing status, the proficiency of the child may be also impacted by factors such as the socioeconomic status of his or her home environment. The ability to label objects, for example, may be impacted by a child's actual knowledge of the name of that object but may also be influenced by his or her family's experience with naming objects or with those specific objects at home (Lidz & Pena, 1996). Some cultures do not regularly label objects. Consequently, in a testing situation a child's deficient object labeling may not be representative of a lack of skill but rather reduced procedure familiarity.

A child's environment should not impact his or her innate ability or inability to acquire a skill (McNamara, 1995). For example, a child who lacks the ability to use the social rules of language may not be able to do so even when environmental factors (i.e., lack of familiarity with procedure) are improved; thus, a child's abilities may be predictive of his or her performance following implantation. Unfortunately, ability separate from environmental influence is difficult to measure (McNamara, 1995). Proficiency, change over time, and learning tasks are often used as indicators of a child's underlying ability (Lidz & Pena, 1996).

SLPs who work with children with hearing loss should have an understanding of specific assessments and whether they tap a child's ability or proficiency. Many assessments used with children, norm referenced or criterion referenced, were not specifically designed to address the needs of children with hearing loss. As a result, professionals who administer and interpret standardized assessments for children with hearing loss should be able to analyze the actual skills measured by the instrument. For example, many standardized assessments do not allow the examiner to repeat items to a child; thus, a child with hearing loss may miss an item measuring a language skill not because the child lacks that skill, but because he or she did not hear the question the first time. In this case, the assessment is not measuring a child's real language proficiency, but rather his or her ability to hear the question. This instrument, therefore, may be representative of a child's question-answering proficiency in a testing environment, but not his or her language proficiency or ability (i.e., answering questions within daily activities). For every assessment tool used to evaluate a child with hearing loss, a professional must consider the skill actually being assessed in relation to the conclusions he or she draws.

In the following sections, specific common assessment instruments for children with hearing loss are described to assist professionals in determining the utility of information presented for implant candidacy.

## Specific Assessments

### *Assessments of Speech Production*

Assessments of speech production, or articulation, are used to evaluate a child's phonological development, a key domain of oral language (see Table 4–1). The measures used to describe speech production vary by age of the child being evaluated. During infancy, patterns of speech production are observable and predictable even before children begin to use language. Vocalization and babble can provide valuable information about a child's articulatory development and possibly present red flags for delayed development (Robbins, 2005). Children with hearing loss have delayed early babbling behaviors, which may function as a precursor to their later speech delays (Moeller et al., 2007).

**Table 4–1.** Speech Production Assessment Instrument Reference Chart

| *Measure Name* | *Type of Measure* | *Domains Assessed* | *Age Range* | *Information Collected* |
|---|---|---|---|---|
| Rosetti Infant Toddler Language Scales (RI-TLS) | Criterion-Referenced | *Subtests*: Interaction-Attachment, Pragmatics, Gesture, Play, Language Comprehension, Language Expression | 0 to 36 months | Direct Observation, Behavior Elicitation, Parent Report |
| Cottage Acquisition Scales for Listening, Language and Speech-Second Edition (CASSLS) | Criterion-Referenced | *Forms available*: Preverbal, PreSentence, Simple-Sentence, Complex Sentence, Sounds and Speech | 0 to 8 years | Direct Observation, Behavior Elicitation, Parent Report |
| St. Gabriel's Curriculum for the Development of Audition, Language, Speech, and Cognition | Criterion-Referenced | Audition, Speech, Cognition, Social Interaction, Fine Motor Skills, Gross Motor Skills | 0 to 6 years | Direct Observation, Behavior Elicitation, Parent Report |
| Goldman-Fristoe Test of Articulation-3 (GFTA-3) | Norm-Referenced | Articulation | 2 to 21 years | Behavior Elicitation |
| Khan-Lewis Phonological Analysis- Third Edition (KLPA-3) | Criterion-Referenced (to be used in combination with GFTA-3) | Phonological Processes (Articulation) | 2 to 21 years | Behavior Elicitation |
| Arizona Articulation Proficiency Scale- Fourth Edition (AAPS-4) | Norm-Referenced | Articulation | 1.5 to 18 years | Behavior Elicitation |

Accordingly, careful characterization of a child's speech skills serves to demonstrate that a child is or is not developing appropriate precursor skills to good speech patterns, an important consideration in the cochlear implant candidacy process.

Because examiners cannot directly elicit infant speech patterns, most evaluation data during infancy come from direct observation and parental reports. Many SLPs use articulation inventories or lists of phonemes a child may produce (standardized or not) to determine whether a child's vocalizations are developing at an expected rate. For example, SLPs know that children who are typically developing are expected to produce canonical babble by the age of 10 months (Oller & Eilers, 1988). This benchmark may serve as an indicator to a professional that an infant's speech is or is not developing at the expected rate; however, speech patterns this early in development are broadly variable and should be interpreted as such.

Criterion-referenced checklists that evaluate speech production, along with several domains of behavior, can be useful for children with hearing loss. Many developmental scales use the principles of criterion-referenced instruments. The Rosetti Infant–Toddler Language Scale (RI-TLS) (Rossetti, 1990) is one example of a developmental scale used to measure language development, including speech production. This instrument requires an examiner to observe and elicit behavior, as well as solicit parental reports to determine whether a

child possesses age-appropriate communicative skills. Behaviors on this scale are divided into the following domains: interaction-attachment, pragmatics, gesture, play, language comprehension, and language expression. Mastery within a domain is established when a child displays all of the behaviors within a given age range (e.g., 21 to 24 months); thus, delays are calculated as a percentage of a child's chronologic age. For example, a child with skills at 9 to 12 months who is 18 months old displays a 33% delay according to the RI-TLS.

Criterion-referenced instruments measuring multiple domains can help a cochlear implant team determine whether a child's speech-production development is consistent with his or her other skills. For example, a child with no delay in play skills but a 33% delay in speech-production skills clearly has a language-specific delay not predicted by his or her other skill proficiency. This result indicates that the access to sound that a child has is not sufficient for normal receptive language development. Other instruments used in a similar fashion to evaluate the speech production of infants and toddlers with hearing loss include the Cottage Acquisition Scales for Listening, Language and Speech (Wilkes, 2001) and St. Gabriel's Curriculum for the Development of Audition, Language, Speech, and Cognition (Tuohy, Brown, & Mercer-Moseley, 2005).

Speech-production patterns of typical preschool children are also highly variable. Articulation errors are still common at this age; however, patterns of error remain fairly predictable, and a child's errors that fall outside of these patterns (atypical errors) are less likely to correct naturally over time (Ohde & Sharf, 1992). A thorough evaluation of a preschool child's articulation and consequent intelligibility can provide a cochlear implant team with important information about a child's speech perception and possibly continued development (Eisenberg, 2007).

Speech-language pathologists have a broader range of instruments to choose from for preschool and school-age children because these children are able to produce and imitate words and sentences. The Goldman-Fristoe Test of Articulation-3 (GFTA-3), for example, is a norm-referenced test that requires children to produce single words in isolation or in sentences (preferably spontaneously) (Goldman & Fristoe, 2015). Each consonant in the English language is produced in word-initial, word-medial, and word-final positions. The number of errors tells an SLP whether or not the child's general articulation skills are age appropriate. As with other norm-referenced assessments, this instrument describes whether a child's articulation proficiency is within the range of normal for his or her age.

The GFTA-3 can be used in conjunction with the Khan-Lewis Phonological Analysis (KLPA-3) to describe a child's production error patterns (Khan & Lewis, 2015). This instrument identifies error patterns (i.e., backing, final-consonant deletion) based on a child's performance on the GFTA-3. Together, data from these instruments can be valuable to a cochlear implant team in determining whether a child's articulation is age appropriate and whether a child's patterns of articulation appear typical or atypical. In other words, a child who does not appear to have typical patterns of articulation may be a candidate for a cochlear implant because he or she is not developing speech-production skills appropriately.

The Arizona Articulation Proficiency Scale (AAPS-4) is another widely used, norm-referenced articulation assessment (Fudala & Stengall, 2017). Like the GFTA-3, the AAPS-4 requires children to produce single words to label pictures. The AAPS-4 measures both consonant and vowel production; however, it does not measure each of the English consonants in different word-placement positions. Vowels are among the earliest produced sounds by children, and most children master vowel sounds before they master consonant sound production (Ohde & Sharf, 1992). Children with hearing loss, on the contrary, frequently display prolonged difficulty producing correct and consistent vowel sounds (Eisenberg, 2007). Consequently, the AAPS can provide valuable information to a cochlear implant team about a child's proficiency producing vowel sounds.

### Assessments of Language

Language assessments can evaluate many domains of children's development, including vocabulary, grammar, and pragmatics. Prior to implantation, a team should have an understanding

of how hearing loss has affected that child's ability to develop language. Many criterion-referenced and norm-referenced assessments are available to SLPs to evaluate both early and late stages of language development. Several common assessments of each type are described below. These descriptions, however, are not all encompassing; many additional assessments of language exist.

As with assessments of speech production, language assessments used with infants are primarily criterion referenced and based on parental reports or direct observation. One common criterion-referenced assessment of infant and toddler vocabulary is the MacArthur-Bates Communicative Development Inventory (Fenson et al., 2006). This instrument is based on parental reports; parents are asked to identify words, gestures, and phrases from daily life that a child is able to understand or produce. Instruments such as the CDI are useful for evaluating patterns of vocabulary knowledge and comparing a child's total number of vocabulary words to the number of words expected for his or her age. This information can demonstrate to a cochlear implant team that a child is or is not developing early vocabulary at an expected rate.

Common norm-referenced assessments of expressive and receptive vocabulary include the Peabody Picture Vocabulary Test (PPVT-5), The Expressive Vocabulary Test (EVT-3), the Receptive One Word Picture Vocabulary Test (ROWPVT-4), and the Expressive One Word Picture Vocabulary Test (EOWPVT-4) (Dunn, 2019; Martin & Brownell, 2010a, 2010b; Williams, 2007). Receptive assessments (PPVT-5 and ROWPVT-4) require children to point to one of four pictures best represented by the examiner's label, whereas expressive assessments (EVT-3 and EOWPVT-4) require children to label a picture or group of pictures. A raw score is derived based on the number of correctly labeled or identified pictures and then compared with the scores of a child's same-age peers. These instruments are useful for determining whether or not a child has delayed vocabulary skills; however, these types of assessments do not describe a child's depth of vocabulary knowledge, nor do they represent patterns of knowledge (i.e., knows many individual labels but not superordinate category labels).

Many SLPs choose to use omnibus assessments of language development, especially as children begin to acquire grammar. Norm-referenced assessments for preschool-aged children include the Clinical Evaluation of Language Fundamentals (preschoovl edition), the New Reynell Developmental Language Scales, and the Preschool Language Scale (fifth edition), as well as many others (Edward, Letts, & Sinka, 2011; Semel, Wiig, & Secord, 2004; Zimmerman, Steiner, & Pond, 2010). These instruments assess a variety of domains (Table 4–2), requiring children to complete tasks such as following directions, identifying pictures, completing sentences, and answering questions. These instruments then yield subtest and total language scores that a professional can compare with those of children of that child's same age. As with other norm-referenced assessments, these instruments do not reveal patterns of language errors because they only sample a few specific behaviors. Subtest scores, in fact, should be interpreted carefully; individual subtests may not share the overall sensitivity and specificity characteristics of a given instrument (Plante & Vance, 1995). Data from these assessments, however, can demonstrate to a cochlear implant team that a child has not developed language skills consistent with age expectations.

Some SLPs may also choose to administer criterion-referenced, omnibus assessments of language. The RI-TLS, for example, yields information about receptive and expressive language development. Many SLPs who work with children with hearing loss use scales specifically designed for children with hearing loss. For example, the Cottage Acquisition Scales for Listening, Language, and Speech (Wilkes, 2001) include checklists of skills within various domains, including listening comprehension, vocabulary, and grammatical development. Checklists represent various levels of language development, including pre-verbal, pre-sentence, simple sentence, and complex sentence levels. Similarly, the SKI-HI Language Development Scale (second edition; Watkins, 2004) provides parent and professional checklists of developmentally ordered receptive and expressive language skills. SLPs can determine, based on structured observation, whether or not a child has mastered those skills expected for his or her

**Table 4–2.** Language Assessment Instrument Reference Chart

| *Measure Name* | *Type of Measure* | *Domains Assessed* | *Age Range* | *Information Collected* |
|---|---|---|---|---|
| MacArthur-Bates Communicative Development Inventory (CDI) | Criterion-Referenced | *Forms*: Words and Gestures, Words and Sentences | 8 to 30 months | Direct Observation<br>Parent Report |
| Peabody Picture Vocabulary Test- Fifth Edition (PPVT-5) | Norm-Referenced | Receptive Vocabulary | 2.5 to 90 years | Behavior Elicitation |
| Receptive One Word Picture Vocabulary Test- Fourth Edition (ROWPVT-4) | Norm-Referenced | Receptive Vocabulary | 2 to 18 years | Behavior Elicitation |
| Expressive Vocabulary Test- Third Edition (EVT-3) | Norm-Referenced | Expressive Vocabulary | 2.5 to 90 years | Behavior Elicitation |
| Expressive One Word Picture Vocabulary Test (EOWPVT-4) | Norm-Referenced | Expressive Vocabulary | 2 to 18 years | Behavior Elicitation |
| Clinical Evaluation of Language Fundamentals-Preschool Edition (CELF-P2) | Norm-Referenced | *Composite Scores*: Core Language, Receptive Language, Expressive Language, Language Content, Language Structure | 3 to 6 years | Behavior Elicitation |
| New Reynell Developmental Language Scales (RDLS) | Norm-Referenced | Receptive Language, Expressive Language | 1 to 6 years | Behavior Elicitation |
| Preschool Language Scale- Fifth Edition (PLS-5) | Norm-referenced | *Subtests*: Auditory Comprehension, Expressive Language | 0 to 6 years | Direct Observation, Behavior Elicitation, Parent Report |
| Rosetti Infant Toddler Language Scales (RI-TLS) | Criterion-Referenced | *Subtests*: Interaction-Attachment, Pragmatics, Gesture, Play, Language Comprehension, Language Expression | 0 to 36 months | Direct Observation, Behavior Elicitation, Parent Report |
| Cottage Acquisition Scales for Listening, Language and Speech (CASSLS) | Criterion-Referenced | *Forms available*: Preverbal, Presentence, Simple-Sentence, Complex Sentence, Sounds and Speech | 0 to 8 years | Direct Observation, Behavior Elicitation, Parent Report |

*continues*

**Table 4–2.** *continued*

| Measure Name | Type of Measure | Domains Assessed | Age Range | Information Collected |
|---|---|---|---|---|
| St. Gabriel's Curriculum for the Development of Audition, Language, Speech, and Cognition | Criterion-Referenced | Audition, Speech, Cognition, Social Interaction, Fine Motor Skills, Gross Motor Skills | 0 to 6 years | Direct Observation, Behavior Elicitation, Parent Report |
| SKI-HI Language Development Scale-Second Edition | Criterion-Referenced | Receptive Language, Expressive Language | 0 to 5 years | Parent Report |
| Clinical Evaluation of Language Fundamentals-Fifth Edition (CELF-5) | Norm-Referenced | *Composite Scores*: Core Language, Receptive Language, Expressive Language, Language Content, Language Structure | 5 to 21 years | Behavior Elicitation |
| Oral and Written Language Scales (OWLS) | Norm-Referenced | *Scales*: Listening Comprehension, Oral Expression, Written Expression | 3 to 21 years | Behavior Elicitation |
| Comprehensive Assessment of Spoken Language (CASL-2) | Norm-Referenced | Receptive Language, Expressive Language | 3 to 21 years | Behavior Elicitation |
| Test of Pragmatic Language- Second Edition (TOPL-2) | Norm-Referenced | Pragmatic Language | 6 to 18 years | Behavior Elicitation |
| Test of Auditory Comprehension of Language- Fourth Edition (TACL-4) | Norm-Referenced | Receptive Language | 3 to 9 years | Behavior Elicitation |
| The Word Test: Adolescents | Norm-Referenced | Vocabulary | 12+ years | Behavior Elicitation |
| The Word Test: Elementary | Norm-Referenced | Vocabulary | 6 to 11 years | Behavior Elicitation |

age. An advantage of these instruments is that they provide detailed examinations of specific language skills.

Assessments available to school-age children often assess higher-level language skills, such as making inferences or explaining word meanings. Information taken from these assessment instruments may be useful to cochlear implant teams evaluating the candidacy of an older child, such as one with a progressive loss. Some omnibus, norm-referenced language assessments for school-age children include the Clinical Evaluation of Language Fundamentals- Fifth Edition (Wiig, Semel & Secord, 2013), the Oral and Written Language Scales (second edition; Carrow-Woolfolk, 1995) and the Comprehensive Assessment of Spoken

Language—Second Edition (see Table 4–2) (Carrow-Woolfolk, 2017). These assessments require children to use their language skills to complete tasks such as comprehending paragraphs, following directions, and generating sentences. These instruments, like other norm-referenced assessments, yield general standard scores to compare a child's language skills with those of other children of the same age.

Because language deficits of school-age children may be subtle or limited to a certain language domain, many assessments target more specific language skills. The Test of Pragmatic Language (second edition) (Phelps-Terasaki & Phelps-Gunn, 2007), for example, rather than testing grammar or vocabulary knowledge, specifically assesses a child's ability to use language socially. The Test of Auditory Comprehension of Language (fourth edition) (Carrow-Woolfolk, 2014) assesses auditory comprehension skills but not expressive language. The Word Test-3 (Bowers, Huisingh, LoGiudice, & Orman, 2014) taps semantic knowledge and organization by requiring children, for example, to name categories, generate synonyms, and name category members. Each of these instruments can provide information about deficits related to hearing loss that cause a child to continue to struggle academically. Such information is valuable to the cochlear implant team as they consider barriers to achieving language-skill proficiency.

## Assessments of Auditory Skills

Evaluation of a child's candidacy for a cochlear implant should include assessments of his or her use of limited auditory skills in real-world situations (Table 4–3). An SLP can observe and assess the auditory behaviors of children over the course of a few visits. Auditory assessments can help a team determine whether a child's auditory behaviors are consistent with his or her responses to speech sounds in the audiology booth.

The Early Speech Perception Test (ESP) (Moog & Geers, 1990) is a criterion-referenced assessment instrument used by professionals to evaluate a child's ability to discriminate different types of sounds. A child is asked to differentiate between sounds of differing gross durations ("aaa" versus "hop hop hop"), between words of differing duration ("birthday cake" versus "bird"), and between words of the same duration with different phonemes ("bed" versus "book"). Young children can choose toys to match target words, and older children

**Table 4–3.** Auditory Functioning Assessment Instrument Reference Chart

| *Measure Name* | *Type of Measure* | *Domains Assessed* | *Age Range* | *Information Collected* |
|---|---|---|---|---|
| Early Speech Perception Test (ESP) | Criterion-Referenced | Auditory Discrimination and Identification | 3 to12 years | Behavior Elicitation |
| Auditory Perception Test for the Hearing Impaired-Third Edition (APT/HI-3) | Criterion-Referenced | Auditory Discrimination and Identification | 5+ years | Behavior Elicitation |
| Cottage Acquisition Scales for Listening, Language and Speech (CASSLS) | Criterion-Referenced | *Forms available*: Pre-Verbal, Pre-Sentence, Simple-Sentence, Complex Sentence, Sounds and Speech | 0 to 8 years | Direct Observation, Behavior Elicitation, Parent Report |
| St. Gabriel's Curriculum for the Development of Audition, Language, Speech, and Cognition | Criterion-Referenced | Audition, Speech, Cognition, Social Interaction, Fine Motor Skills, Gross Motor Skills | 0 to 6 years | Direct Observation, Behavior Elicitation, Parent Report |

can point to pictures to demonstrate their discrimination skills. Benchmarks set by the authors (e.g., 8 of 12 correct responses) help professionals to determine whether a child has mastered the different levels of auditory discrimination.

The Auditory Perception Test for the Hearing Impaired, Third Edition (APT/HI-3) (Allen, 2015) is another criterion-referenced instrument appropriate for school-age children. This instrument requires children to complete a series of receptive tasks of varying difficulty, including discriminating between sounds differing in suprasegmental features, between words with differing syllable numbers or consonants, and between sentences containing different words. The demands of this instrument (pointing to pictures in a booklet) are similar to the demands of other standardized tasks children are asked to complete; thus, a child's performance on the APT/HI-3 or the ESP may help an SLP to determine whether a child performs poorly on these instruments due limited auditory skills, limited language proficiency, or a combination of the two.

The measurement of functional auditory responses is difficult to separate from measurement of vocabulary and language knowledge. Consequently, results from either of these instruments should be interpreted with caution. Both instruments require children to recognize that spoken words can be consistently paired with objects or pictures, and to recall which spoken words are paired with any given set of objects. For example, a child may be able to discriminate between a one-syllable word and a three-syllable word, but he or she may demonstrate difficulty selecting "bird" versus "ice cream cone." Errors on either the ESP or the APT/HI-R could be influenced by lack of vocabulary knowledge rather than auditory skills. The interpretation of these instruments should therefore be combined with parent and clinician observation to determine how a child uses audition in his or her daily life. It may be that higher levels of auditory skill cannot be artificially separated from language knowledge.

### Assessments of Academic Skills

Children who are candidates for cochlear implants after entering preschool have often been exposed to academic skills, most of which are language based. A thorough analysis of a child's communicative proficiency prior to receiving a cochlear implant, therefore, should include an assessment of his or her academic knowledge. An evaluation of a child's mastery of these skills can provide information about a child's ability to learn in a classroom setting.

Reading and writing are academic skills that are closely linked to language proficiency. Assessments of early literacy skills can predict later reading and writing achievement (Storch & Whitehurst, 2002). Because literacy outcomes of children with hearing loss are notoriously poor, cochlear implant teams may want to consider the impact of hearing loss on a child's early literacy abilities. Two norm-referenced assessments of early literacy skills are the Test of Preschool Early Literacy (TOPEL) (Lonigan, Wagner, & Torgesen, 2007) and the Comprehensive Test of Phonological Processing (CTOPP) (Wagner, Torgesen, & Rashotte, 1999). These assessments measure skills related to later literacy achievement, such as phonological awareness, phonological working memory, letter-sound identification, and print awareness. These instruments yield scores that allow professionals to compare a child to his or her same-age peers.

Many criterion-referenced assessments of literacy skills are also available. The Phonological Awareness Literacy Screening assessments (Pre-K, K, and 1, 2, 3) (Invernizzi, Meier, Swank, & Juel, 2004) are useful measures of literacy skills that include phonological awareness, print awareness, and early decoding abilities. These instruments evaluate a child's ability to complete literacy-related tasks. For example, if a child entering kindergarten should be able to identify sounds corresponding to letters, the PALS-Pre-K letter-sound subtest could be administered to see which sounds a child knows and does not know. The results of this kind of measure demonstrate to a cochlear implant team whether a child has been able to acquire the knowledge necessary to continue achieving academically.

Other assessments of academic concept knowledge include the Boehm Test of Basic Concepts (third edition) (BTBC) (Boehm, 2000) and the Bracken School Readiness Assessment (third edition) (BSRA; Bracken, 2007). The BTBC requires

children to show knowledge of concepts (such as "missing" or "below") by pointing to parts of pictures. The results of this assessment, however, should be interpreted with caution for children with hearing loss. Picture representations of these concepts often highlight the correct response within the picture. For example, the picture for the target "different" shows one different picture among several identical other pictures. Children with hearing loss may consistently display understanding of the concept by responding to salient pictured cues (one "different" picture among many that are the same) rather than responding to a known vocabulary word (comprehension of the word "different"). The BSRA assesses content knowledge of colors, letters, numbers, sizes, and shapes based on receptive and expressive responses. Both assessments can be used effectively to measure the academic concept knowledge of young children with hearing loss.

Older children often participate in formal academic assessment, and results from these assessments can also be useful to a cochlear implant team. Norm-referenced assessments of reading and other academic concepts, such as the Woodcock Reading Mastery Test (third edition) (Woodcock, 2011) or the Woodcock Johnson Test of Achievement – III (Woodcock, McGrew, & Mather, 2001), allow teams to compare a child's performance with that of other children of his or her age. Both instruments contain several subtests (Table 4–4), allowing professionals to evaluate a child's performance across several academic domains. Information from these instruments indicates to a team whether a child is performing academically at the level expected of his or her same-grade/age peers with normal hearing.

General education teachers and teachers of the deaf who interact regularly with students also can provide valuable insight to a cochlear implant team. Teachers often set benchmarks and use criterion-referenced assessments to monitor progress. As a result, classroom teachers of older children can provide important perspectives: a child's rate of academic growth may indicate that he or she is able or unable to keep up with work presented to children of his or her same grade. The Screening Instrument for Targeting Educational Risk (SIFTER) is a rating scale teachers can use to compare a child's academics, attention, communication, classroom participation, and school behavior to those of other children in the classroom (Anderson, 1989). The cochlear implant team can use teacher reports across standardized assessments to determine if lack of access to sound contributes to that child's ability to perform academic tasks in the classroom.

## Considerations for Special Populations

A cochlear implant team is charged with determining a child's current level of functioning and his or her potential for development with a cochlear implant. This goal becomes even more difficult in evaluations of children who are not considered part of "mainstream" culture. For example, children who are non-mainstream dialect speakers or children who are bilingual cannot be adequately evaluated by assessments of language developed for monolingual, mainstream dialect English-speaking children. A thorough assessment of a non-mainstream language user requires additional knowledge and consideration.

To measure the language proficiency and ability of these children, professionals have some options available, but many assessments require additional work and preparation. SLPs may be able to find assessments normed on those particular special populations. For example, the Expression One Word Picture Vocabulary Test-4 (Spanish Bilingual Edition) (Martin, 2011) was normed on a group of bilingual Spanish/English-speaking children. Instruments with bilingual norms, however, are scarce currently and certainly not available for all groups of bilingual children. An SLP may also choose to evaluate a child using a criterion-referenced assessment. In this case, the SLP must determine whether or not that child should have mastered a given set of skills despite his or her language differences. Criterion-referenced assessments can be used descriptively, but of course, they should be interpreted with caution. Finally, SLPs may choose to use nonstandard methods, such as dynamic assessment, to measure growth in children from these populations. Only professionals with deep understanding of the implications of dynamic assessment procedures, which can include test-teach-retest paradigms and administration

**Table 4–4.** Academic Skill Assessment Instrument Chart

| *Measure Name* | *Type of Measure* | *Domains Assessed* | *Age Range* | *Information Collected* |
|---|---|---|---|---|
| Test of Preschool Early Literacy (TOPEL) | Norm-Referenced | Print Awareness, Phonological Awareness, Oral Vocabulary | 3 to 5 years | Behavior Elicitation |
| Comprehensive Test of Phonological Processing (CTOPP-2) | Norm-Referenced | Phonological Awareness, Phonological Memory, Rapid Naming | 5 to 24 years | Behavior Elicitation |
| Phonological Awareness Literacy Screening Measures (PALS-PreK, PALS-K, PALS-1-3) | Criterion-Referenced | Name Writing, Alphabet Knowledge, Beginning Sound Awareness, Rhyme Awareness, Nursery Rhyme Knowledge, Print and Word Awareness, Letter Sounds, Spelling, Word Recognition, Passage Reading, Comprehension, Fluency | Preschool to 3rd Grade | Behavior Elicitation |
| Boehm Test of Basic Concepts- Third Edition (BTBC) | Norm-Referenced | Basic Concept Knowledge | Kindergarten to 2nd Grade | Behavior Elicitation |
| Bracken School Readiness Assessment-Third Edition (BSRA) | Criterion-Referenced | Color Knowledge, Letter Knowledge, Numbers/ Counting, Comparison/ Size Knowledge, Shape Knowledge | 3 to 6 years | Behavior Elicitation |
| Woodcock Reading Mastery Test- Third Edition (WRMT-3) | Norm-Referenced | *Subtests*: Phonological Awareness, Listening Comprehension, Letter Identification, Word Identification, Rapid Automatic Naming, Oral Reading Fluency, Word Attack, Word Comprehension, Passage Comprehension | 4.5 to 79 years | Behavior Elicitation |
| Woodcock-Johnson Test of Achievement- III (WJTA-III) | Norm-Referenced | *Subtests*: Letter-Word Identification, Reading Fluency, Passage Comprehension, Word Attack, Reading Vocabulary, Spelling, Writing Fluency, Writing Samples, Editing, | 2 to 90 years | Behavior Elicitation |

**Table 4–4.** *continued*

| Measure Name | Type of Measure | Domains Assessed | Age Range | Information Collected |
|---|---|---|---|---|
| Woodcock-Johnson Test of Achievement-III (WJTA-III) | | Spelling of Sounds, Punctuation and Capitalization, Calculation, Math Fluency, Applied Problems, Quantitative Concepts, Story Retell, Understanding Directions, Picture Vocabulary, Oral Comprehension, Sound Awareness, Academic Knowledge | | |
| Screening Instrument for Targeting Educational Risk (SIFTER) | Criterion-Referenced | Academics, Attention, Communication, Participation, Behavior | Preschool to School Age | Teacher Report |

modifications, should interpret these results (Lidz & Pena, 1996).

Although many of these methods are imperfect and/or time intensive for measuring the language ability or proficiency of these groups of children, cochlear implant teams are still obligated to evaluate these children to the best of their ability. It is not appropriate to "wait" for a child to develop adequate proficiency in the dominant language. Rather, professionals should be familiar with both languages to which a child is exposed and critically evaluate a child's performance across both languages to determine whether or not a child needs additional access to sound.

## PREIMPLANTATION THERAPY CONSIDERATIONS

Even prior to receiving a cochlear implant, speech-language therapy can be a useful tool for the purposes of intervention and evaluation, despite the fact that a child may not have access to the full range of speech sounds. The following sections describe the purpose of therapy during the preimplant period of a child's development.

### Therapy Following Identification

Following identification of a child's hearing loss, many parents are unsure how best to communicate with their child. Research indicates that hearing parents of children with hearing loss do not interact with their children in the same way as parents of children with normal hearing (Lavelli, et al., 2018). As a result, children with hearing loss may have even fewer opportunities to experience typical interactions and communication than children with typical hearing, beyond those opportunities lost, due to limited access to sound.

An SLP or other early-intervention professional can be particularly valuable to families during the period immediately following identification. During this period, the interventionist can serve at least two purposes: (a) to educate parents about the future development and obstacles for their child with hearing loss and to provide support, and (b) to help parents interact with their child, ensuring that opportunities to learn basic communication skills are maximized. Most children with hearing loss are born to parents with typical hearing (Mitchell & Karchmer, 2004). As a result, at the time of identification most parents have little to no knowledge about hearing

loss or its impact on communication development. A clinical SLP is in a prime position to help parents gradually make sense of the overwhelming amount of information with which they are presented. Additionally, even without focusing on spoken language, parents can help their children with hearing loss to learn early communication skills. Children with hearing loss can learn to respond to communicative attempts, to gesture to direct attention, and to use a variety other communication methods. Interventionists can guide parents through basic communicative routines with their child with hearing loss.

## Therapy Following Hearing Aid Fitting

Children eligible to receive cochlear implants generally, by definition, do not gain sufficient benefit from hearing aids (Eisenberg, Kirk, Martinez, Ying, & Miyamoto, 2004); however, even minimal residual access to sound from hearing aids can improve a child's communicative development. Basic awareness of the presence or absence of sound at any level is the first step toward developing auditory skills. An SLP can help parents work toward optimizing opportunities to connect sounds with objects and actions prior to cochlear implantation.

Drawing a child's attention to sounds in his or her environment is one of the earliest recommendations made to parents of children with hearing loss (Niparko, 2000). An SLP can help parents to recognize and draw their child's attention to sounds during everyday activities. Parents' ability to recognize and draw attention to different types of sound, such as continuous noises (i.e., a running dishwasher) or intermittent noises (i.e., a microwave beep) can assist a child's development of basic sound discrimination. These early activities set a precedent for drawing a child's attention to sound postimplantation.

## Therapy Following Baseline Speech-Language Skill Evaluation

Following a child's initial speech-language evaluation, continued regular visits to an SLP allow the SLP to track the auditory, speech, and language development of a child. The SLP can provide information to a cochlear implant team about how access to sound or a lack of access to sound impacts an individual child's development. Progress monitoring, in addition to baseline data, informs a team's expectations and consequently future recommendations for a child.

Regular therapy visits prior to implantation set a precedent for ongoing therapeutic intervention post-implantation. Developing a good relationship with an SLP is important for both parents and children. These early therapy sessions can help families and SLPs to develop effective therapist-parent communication early. During this time, SLPs have the opportunity to discuss developmental principles and normal and deviant language learning. These discussions give parents early understanding of the principles that guide therapy following implantation. In addition, children learn to participate in play activities, both adult led and child led, and the therapist can begin to understand what motivates and does not motivate a child.

# CONCLUSION

The SLP plays a crucial role in determining cochlear implant candidacy. The SLP can make predictions about expected communication outcomes for a child once he or she has a cochlear implant. Given the individual linguistic profiles, auditory skills, and life experiences of children with hearing loss, the role of the SLP should go beyond simply reporting test scores and performances; instead, the SLP, as a member of the cochlear implant team, should provide a sufficiently individualized profile of the child's communicative strengths and needs for the team to make a well-informed decision as to this child's potential benefit of implantation.

# REFERENCES

Allen, S. G. (2015). *Auditory perception test for the hearing impaired*. (3rd ed.). San Diego, CA: Plural Publishing.

American Speech-Language-Hearing Association. (2001). *Knowledge and skills required for the practice of audiologic/aural rehabilitation*. http://www.asha.org/policy.

Anderson, K. L. (1989). *Screening identification for targeting educational risk*. Denver, CO: The Educational Audiology Association.

Bachman, L., & Savignon, S. (2002). The evaluation of communicative language proficiency: A critique of the ACTFL oral interview. *Modern Language Journal, 70*, 380–390.

Boehm, A. E. (2000). *Boehm Test of Basic Concepts* (3rd ed.). San Antonio, TX: The Psychological Corporation.

Bowers, L., Huisingh, R., LoGiudice, C., & Orman, J. (2014). *The Word Test—3: Elementary*. Moline, IL: LinguiSystems.

Bracken, B. A. (2007). *Bracken School Readiness Assessment* (3rd ed.). San Antonio, TX: The Psychological Corporation.

Carrow-Woolfolk, E. (1995). *Oral and Written Language Scales (OWLS).* Los Angeles, CA: Western Psychological Services.

Carrow-Woolfolk, E. (2014). *Test for Auditory Comprehension of Language (TACL-3)* (3rd ed.). Austin, TX: Pro-ed.

Carrow-Woolfolk, E. (2017). *Comprehensive Assessment of Spoken Language*—Second Edition *(CASL-2).* Torrance, CA: Western Psychological Services.

Dunn, D. M. (2019). *Peabody Picture Vocabulary Test* (5th ed.). Bloomington, MN: NCS Pearson.

Eisenberg, L. S. (2007). Current state of knowledge: Speech recognition and production in children with hearing impairment. *Ear and Hearing, 28*, 766–772.

Eisenberg, L. S., Kirk, K. E., Martinez, A. S., Ying, E. A., & Miyamoto, R. T. (2004). Communication abilities of children with aided residual hearing. *Archives of Otolaryngology—Head & Neck Surgery, 130*, 563–569.

Fenson, L., Marchman, V., Thal, D., Dale, P., Reznick, S., & Bates, E. (2006). *The MacArthur Communicative Development Inventories: User's guide and technical manual* (2nd ed.). Baltimore, MD: Brookes Publishing.

Fudala, J. B., & Stengall, S. (2017). *Arizona Articulation Proficiency Scale (AAPS-4)* (4th revision). Torrance, CA: Western Psychological Services.

Goldman, R., & Fristoe, M. (2015). *Goldman Fristoe Test of Articulation (GFTA-3)* (3rd ed.). Minneapolis, MN: Pearson Inc.

Invernizzi, M., Meier, J. D., Swank, L., & Juel, C. (2004). *Phonological Awareness Literacy Screening (PALS).* Charlottesville, VA: University of Virginia Press.

Invernizzi, M., Sullivan, A., Meier, J., & Swank, L. (2004). *Phonological Awareness Literacy Screening PreK (PALS-PreK)*. Charlottesville, VA: University of Virginia Press.

Khan, L., & Lewis, N. (2015). *Khan-Lewis Phonological Analysis* (3rd ed.). Minneapolis, MN: Pearson, Inc.

Lavelli, M., Majorano, M., Guerzoni, L., Murri, A., Barachetti, C., & Cuda, D. (2018). Communication dynamics between mothers and their children with cochlear implants: Effects of maternal support for language production. *Journal of Communication Disorders*, *73*, 1–14.

Lidz, C., & Pena, E. (1996). Dynamic assessment: The model, its relevance as a nonbiased approach, and its application to Latino American preschool children. *Language, Speech, and Hearing Services in Schools, 27*, 367–372.

Lonigan, C. J., Wagner, R. K., & Torgesen, J. K. (2007). *Test of Preschool Early Literacy (TOPEL).* Austin, TX: Pro-ed.

Martin, N. (2001). *Expressive One-Word Picture Vocabulary Test-4: Spanish-bilingual edition*. Novato, CA: Academic Therapy Publications.

Martin, N. A., & Brownell, R. (2010a). *Expressive One-Word Picture Vocabulary Test-4 (EOWPVT-4).* Novato, CA: Academic Therapy Publications.

Martin, N. A., & Brownell, R. (2010b). *Receptive One-Word Picture Vocabulary Test-4. (ROWPVT-4).* Novato, CA: Academic Therapy Publications.

McCauley, R. J., & Swisher, L. (1984). Use and misuse of norm-referenced tests in clinical assessment: A hypothetical case. *Journal of Speech and Hearing Disorders, 49*, 338–348.

McNamara, T. K. (1995). Modeling performance: Opening Pandora's box. *Applied Linguistics 16*, 159–179.

Mitchell, R. E., & Karchmer, M. A. (2004). Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies, 4*, 138–163.

Moeller, M. P., Hoover, B., Putman, C., Arbataitis, K., Bohnenkamp, G., & Peterson, B., . . . Stelmachowicz, P. (2007). Vocalizations of infants with hearing loss compared with infants with normal hearing, part I: Phonetic development. *Ear and Hearing, 28*, 605–627.

Moog, J. S., & Geers, A. (1990). *Early speech perception test for profoundly hearing-impaired children*. St. Louis, MO: Central Institute for the Deaf.

Niparko, J. (2000). *Cochlear implants: Principles and practices* (2nd ed.). Baltimore, MD: Lippincott, Williams and Wilkins.

Ohde, R. N., & Sharf, D. J. (1992). *Phonetic analysis of normal and abnormal speech*. New York, NY: Macmillan.

Oller, D. K., & Eilers, R. E. (1988). The role of audition in babbling. *Childhood Development, 59*, 441–449.

Phelps-Terasaki, D., & Phelps-Gunn, T. (2007). *Test of pragmatic language* (2nd ed.). East Moline, IL: Linguisystems.

Plante, E., & Vance, R. (1995). Diagnostic accuracy of two tests of preschool language. *American Journal of Speech and Language Pathology, 4*, 70–76.

Popham, W. J., & Husek, T. R. (1969). Implications of criterion referenced measurement. *Journal of Educational Measurement*, *6*, 1–9.

Edward, S., Letts, C., & Sinka, I. (2011). *New Reynell Developmental Language Scales*. London, UK: GL Assessment.

Robbins, A.M. (2005). Clinical red flags for slow progress in children with cochlear implants. *Loud and Clear, 1*, 1–8.

Rossetti, L. (1990). *Rosetti Infant-Toddler Language Scale (RI-TLS).* East Moline, IL: LinguiSystems.

Semel, E., Wiig, E., & Secord, W. A. (2004). *Clinical Evaluation of Language Fundamentals—Preschool (CELF-P2)* (2nd ed.). San Antonio, TX: The Psychological Corporation.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology, 38*, 934–947.

Swaminathan, H., Hambleton, R. K., & Algina, J. (1974). Reliability of criterion-referenced tests: A decision-theoretic formulation. *Journal of Educational Measurement, 11*, 264–267.

Tuohy, J., Brown, J., & Mercer-Moseley, C. (2005). *St. Gabriel's curriculum for the development of audition, language, speech, cognition, early communication, social interaction, fine motor skills, and gross motor skills* (2nd ed.). Sydney, Australia: St. Gabriel's Auditory-Verbal Early Intervention Centre.

Wagner, R. K., Torgesen, J., & Rashotte, C. (1999). *Comprehensive Test of Phonological Processing (CTOPP).* Austin, TX: Pro-ed.

Watkins, S. (2004). *SKI-HI Language Development Scale,* 2nd Edition. North Logan, UT: HOPE, Inc.

Wilkes, E. M. (2001). *Cottage Acquisition Scales for Listening, Language, and Speech* (2nd ed.). San Antonio, TX: Sunshine Cottage School for Deaf Children.

Wiig, E. H., Semel, E., & Secord, W. A. (2013). *Clinical Evaluation of Language Fundamentals (CELF-5)* (5th ed.). Bloomington, MN: Pearson, Inc.

Williams, K. (2007). *Expressive Vocabulary Test (EVT-3)* (2nd ed.). Bloomington, MN: NCS Pearson.

Woodcock, R. M. (2011). *Woodcock Reading Mastery Test* III. San Antonio, TX: Pearson.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson III Test of Achievement*. Itasca, IL: Riverside Publishing.

Zimmerman, I. L., Steiner, B. S., & Pond, R. E. (2010). *Preschool Language Scale (PLS-5)* (5th ed.).