Vocabulary Assessment of Deaf and Hard-of-Hearing Children From Infancy Through the Preschool Years

Amy K. Prezbindowski
Children's Therapy Unit at Good Samaritan Hospital

Amy R. Lederberg
Georgia State University

The purpose of this article is to inform researchers and practitioners about potential challenges in the selection, administration, and interpretation of results of measures of vocabulary assessment when working with deaf and hard-of-hearing children. This article reviews methods that can be used to assess vocabulary of children through the age of 5 years, including naturalistic observation, parent report measures, and standardized vocabulary tests. The authors also describe procedures to assess word-learning processes available to children to facilitate vocabulary acquisition. General cautions regarding the use of assessment tools with deaf and hard-of-hearing children are reviewed, as well as cautions for specific assessment measures. Finally, based on available research, suggestions are offered regarding what each assessment test can tell us about deaf and hard-of-hearing children's vocabulary development.

"From the moment deaf children are placed in school settings, language development is a primary educational goal. The accurate and authentic assessment of a deaf child's language proficiencies and language development is crucial" (Jamieson, in press). In recent years, language assessment has become especially challenging as deaf and hard-of-hearing (D/HH) children are enrolled in intervention programs at increasingly younger ages.[1] Concurrently, vocabulary has become the cornerstone of language assessment for researchers and teachers of young children with hearing loss because it is appropriate from the earliest stages of language development. This article focuses on methods and tests that can be used with these young children to assess vocabulary development. It extends and complements recent studies that consider issues of assessment of overall language development of school-age D/HH children (Easterbrooks & Baker, 2002; Jamieson, in press; Moeller, 1988).

As with all language assessments, vocabulary assessments of individual children are important for establishing baseline competences, developing educational goals, designing appropriate educational interventions, documenting progress, and evaluating the effectiveness of language intervention. Another advantage of vocabulary assessments for individual children is that comparable assessments are frequently available for a variety of language learning environments (e.g., spoken and/or signed English). On the group level, researchers and educators use assessments to determine the effectiveness of particular interventions (e.g., universal newborn screenings, Mayne, Yoshinaga-Itano, Sedey, & Carey, 2000a; cochlear implants, Blamey et al., 2001) and to consider the effects of variables on language development (e.g., parental involvement in education, Calderon & Naidu, 2000; Moeller, 2000).

Fortunately, a wide variety of assessment techniques are available to assess vocabulary. Each has strengths and weaknesses of which professionals need to be aware in order to make informed decisions about assessment practices. Prior to reviewing the different assessment techniques, three areas of caution are addressed that

We thank Patricia E. Spencer, Joy Caroline Harvey, and Sandra Huston for their ideas and thoughts, which have influenced the ideas contained in this manuscript, and the teachers who provided invaluable insight into vocabulary assessment while participating in our research. Correspondence should be sent to Amy K. Prezbindowski, Children's Therapy Unit, Good Samaritan Hospital, 402 15th Ave SE, Puyallup, WA 98372 (e-mail: amyprezbindowski@goodsamhealth.org).

  DOI: 10.1093/deafed/eng031

generally apply to all of them: the language environment, the examiner, and the validity of the results.

The Language Environment

The language input that a D/HH child receives across contexts (home, school, and community) and over time can create a challenge when choosing an assessment tool (Jamieson, in press). Because of variation in input, it may not be clear whether vocabulary should be assessed using spoken English or another spoken language, American Sign Language (ASL), or simultaneous communication (SC; i.e., spoken English and Manually Coded English Systems, MCE). Many D/HH children are exposed to more than one language during their childhood (Coryell & Holcomb, 1997; Spencer, 2002). The communication system that parents use with their children in the home may differ from the one used in the children's school. For example, hearing parents may communicate in English or another spoken language at home (e.g., Spanish) while their D/HH children are taught using a sign system at school (MCE or ASL). The 5% of deaf children who are born to deaf parents are likely to have consistent exposure to ASL at home from the time of birth, but may be enrolled in schools where they are exposed to signed or spoken English. Other sources of change in language input instigated by the family include the family's moving from one school district to another where the options for educational programming differ, parents' changing language systems to better meet their family's communication needs, and D/HH children's receiving cochlear implants. Clearly, the goal of the assessment must be considered while choosing an assessment tool. If the goal is to determine how much language a child has acquired overall, then a child who is exposed to different language environments needs to be assessed in all languages (Jamieson, in press). On the other hand, if the goal is to assess how well a child would function within a classroom using a specific communication modality, then assessment of the child's vocabulary in that modality or language is sufficient.

The Examiner

Vocabulary assessment is dependent not only on the adequacy of the instrument used (to be discussed extensively later), but also on the examiner's ability to use the instrument accurately. To ensure accuracy during testing, the examiner must be fluent in the language of the D/HH child. Unfortunately, a qualified professional who is fluent in a given language system (e.g., ASL or Spanish) may be unavailable. The use of an interpreter during assessments to solve this problem can create additional complications (Jamieson, in press). The interpreter may not understand the "baby signs" of a young child, the D/HH child may have an altered performance with the presence of an additional person in the room, and the standardization of the administration of the test may be jeopardized when assessment questions are translated into another language.

Additional problems occur when the examiner does not have extensive knowledge of the language of D/HH children (Easterbrooks & Baker, 2002). Underestimation of vocabulary may occur if the examiner is not familiar with D/HH children's poorly signed or spoken words. Overestimation of vocabulary may occur when the children's answers are based on nonverbal cues (e.g., facial expression) or imitation.

Parents play the role of the examiner for some assessment techniques. These include survey-type tests in which parents indicate whether their children know specific vocabulary words. However, parents may not be "experts" in the language used most frequently by their children (e.g., sign) and thus may not be in a position to record accurately their children's expressive and receptive vocabularies. Alternatively, some parents seem to be prone to granting their children "credit" for vocalizations and gestures which are not true words (Spencer, 1993). Each of these scenarios may result in either an under or overestimation of the D/HH child's vocabulary.

Validity of Results

Assessment techniques are only useful to the extent that they measure what they purport to measure (called concurrent validity). This review reports research that indicates that there are techniques that will result in a valid assessment of a child's current vocabulary knowledge if administered by an informed examiner. However, the predictive validity of vocabulary assessments is largely unproven. Therefore, assessment results should

not be interpreted as measuring children's potential for vocabulary growth.

In summary, many D/HH children have been exposed to more than one communication system during their formative years of language development. Although the ideal approach to vocabulary assessment is one that takes into consideration all of the spoken and signed languages to which a child has been exposed, often there are neither assessment tools nor examiners qualified to conduct assessments in all of these languages.

Instruments Available for Vocabulary Assessment

The majority of vocabulary assessments focus on estimating the number of words a child knows. The size of a child's lexicon is assessed either receptively (i.e., words understood) or expressively (i.e., words produced). Because of the variety of language systems used by D/HH children (e.g., spoken English, MCE, and ASL), a word is typically defined as any recognizable conventional, arbitrary (i.e., linguistic) symbol. Three methods are available to measure vocabulary size: language samples, parent-teacher report, or direct testing of the child.

Naturalistic and elicited language samples

Language samples are frequently the cornerstone of language assessment (Easterbrooks & Baker, 2002). Although typical language samples consist of 100 utterances, there is evidence that reliable assessments should include two to three times that number (Muma, 1998). They can be collected in a variety of settings (e.g., during free play or during a structured situation, such as sequenced pictures or picture books) and with a variety of language partners (e.g., parent, teacher, researcher). Vocabulary can be measured by counting the number of different words used by the child (a measure of the breadth of vocabulary knowledge) or the total number of words (a measure of verbosity) (Watkins & Kelly, 1995). Type-token ratio (number of different words/total number of words), a third unit of measurement sometimes calculated, does not seem to be a sensitive measure of individual differences in lexical abilities (Watkins & Kelly).

Cautions. Language samples can provide descriptive information about a child's vocabulary. However, research with hearing children suggests that language samples fail to provide valid information about the breadth of vocabulary knowledge for young children, especially during early development (Fenson et al., 1994). During the early stages of vocabulary development, individual words are infrequent and their occurrence is unpredictable. In addition, many words occur only in specific contexts that may not appear in the data collection session. Consequently, Bates, Bretherton, and Snyder (1988) concluded that language samples from hearing toddlers during the second year of life did not show sufficient internal reliability and failed to predict later language development.

There are several areas of concern that are specific to obtaining language samples of D/HH children who are acquiring signs. First, the language ability of the child's interactive partner may affect the quantity and quality of the language used in the language sample. D/HH children acquiring signs frequently do not share a common language with their hearing parents. There is a wide variation in the ability of hearing parents to sign to their children, with many parents only using sign rarely, if at all, with their children (Lederberg & Everhart, 1998; Mayberry, 1992; Spencer, 1993). In the latter cases, parents may be unable to scaffold interactions with formal language that elicit their child's optimal language performance. In addition, D/HH children may rely more on nonverbal communication than language when interacting with partners who do not understand their language. As a result, although hearing parents and D/HH children may engage in interactions that are characterized by creativity and affection, these interactions may not provide the opportunity for children to demonstrate the extent of their language abilities (Everhart & Lederberg, 1991; Lederberg & Prezbindowski, 2000).

The context for language samples may also affect their validity. Research suggests that signing during free play occurs infrequently, even by experts in sign language such as deaf mothers (Harris, 1992). Playing with toys makes sign language communication a challenge because of the need to divide visual attention between the objects and the communication (Harris). In addition, extensive signing is incompatible with using hands

to play with toys, thus leading to an underestimate of a child's vocabulary development.

Another challenge inherent in collecting naturalistic language samples is the logistics of recording, transcribing, and analyzing the language sample. Capturing language behavior (especially when signed) on videotape requires elaborate equipment set-ups, usually including more than one camera so that most of the signing can be seen. Although the collection of these language samples has become relatively common in laboratory settings, this arrangement can put the child and communication partner in a restricted and atypical context. Furthermore, once a language sample is obtained, special skills are required to interpret and transcribe the range of expressive communication systems that a young signing child may be using (e.g., spoken English, MCE, ASL, or a combination of these).

Words spoken by young D/HH children usually are difficult to understand, thus making recorded speech extremely difficult to comprehend due to the somewhat degraded signal obtained through videotape. These two factors often make transcription unreliable if not impossible without special audio equipment that includes microphones on the adult or the child to improve the recording quality (Julia Davis, personal communication, 2001).

Finally, the time involved in analyzing language samples can be cost prohibitive. Transcribing a 30-min language sample of a hearing child takes approximately 3 to 10 hours (Fenson et al., 1994). Transcribing both oral and signed languages requires even more time, especially if the child's oral speech is poor (Lederberg & Everhart, 1998).

Research with D/HH children. Research indicates that the validity of vocabulary assessment through language samples varies with context and age. As with hearing children, language samples of D/HH children in early language development (i.e., with lexicons of fewer than 50 words) obtained in free play with mothers seem to underestimate the children's lexical knowledge and do not correlate with other measures of language (Anderson & Reilly, 2002; Shafer & Lynch, 1981; Spencer, 1993). One study suggests that this type of language sample may be more appropriate for older preschoolers. Nicholas (2000) found that, while word diversity remained at the same low level from 12 to 30 months, the number of different words that 43 oral deaf children used in a 30-min episode of free play with their mothers increased from 30 to 54 months. In addition, word diversity correlated with the children's language ages on the communication domain of the Vineland Adaptive Behavior Scales. However, this latter finding could be due to the wide chronological age range of the children (12 to 54 months), rather than the validity of the word production scores.

Structured-elicited language samples of D/HH children with skilled partners (either researchers, teachers, or mothers who are fluent in the children's language) may have more validity than free-play samples. The signed word production (both number of different words and total number of words) of deaf 4-year-olds with a researcher using a picture book to elicit language has been found to correlate with the children's scores on a standardized receptive vocabulary test (Everhart, 1993; Everhart & Lederberg, 1991). In contrast, none of these vocabulary measures correlated with word production with hearing mothers in free play. In addition, free play with the researcher was not transcribed because children's language production with the researcher seemed impoverished compared to their production in the story elicitation context.

In a study of ASL vocabulary development of deaf children with deaf parents, Anderson and Reilly (2002) videotaped language samples that "ranged from 1 hour to 2.5 hours and captured periods of free play as well as structured tasks designed to elicit language production" (p. 88). They found that specific signed words produced during the sample were consistent with those reported by mothers on an ASL word checklist for 10 children from 17 to 34 months of age. On the other hand, 3 children under 17 months produced no words in their language samples, similar to the findings by Bates et al. (1988) with hearing toddlers.

What can this assessment method tell us? Naturalistic observations are the only way to assess how children use vocabulary in ongoing interactions and therefore are essential for assessing functional communication. In addition, language samples may provide a valid and reliable indicator of vocabulary knowledge for children who are past the early levels of vocabulary if such samples are ex-

tensive, include elicitation procedures, and are obtained with individuals who are fluent in the children's language system. These measures may be useful in comparing vocabulary knowledge within samples of D/HH children. Progress may also be measured if the same context and examiner are used. However, because context and language abilities of examiners are not standardized, language samples are less useful than other methods for comparisons across studies. For parent–child dyads who do not share a fluid communication system, naturalistic observations provide an opportunity to ascertain the extent to which dyads are able to use formal language to communicate with each other. In these circumstances, however, it is important to interpret the exchanged language as a measure of how well a dyad communicates rather than as a reflection of the child's word knowledge.

Parent and teacher report

Instruments relying on a parent's report of a child's vocabulary were devised to address many of the problems that language sampling poses for assessing young hearing and D/HH children (Fenson et al., 1994). These measures include parental diaries and vocabulary checklists.

Diaries. One of the oldest methods for assessing vocabulary is to have parents write down their child's new vocabulary words as they occur (Leopold, 1949). The attraction of parental diaries is their potential to be a record of the whole corpus of children's growing vocabulary, especially during initial vocabulary development. In addition, rich dairies that described context as well as acquisition of words have provided unique important details about the nature of the early vocabulary development of hearing children (e.g., Dromi, 1987). Such rich dairies have only been obtained from parents who are professionals (e.g., psycholinguists, speech pathologist, psychologists). Obtaining diary data from typical parents is much more difficult. Keeping a diary of children's vocabulary is a time-consuming process and relies on the adult to record words as they occur or to recall words produced by the child during a day. Researchers report difficulty in obtaining consistent, accurate diaries from hearing mothers of deaf children (Ertmer & Mellon, 2001; Gregory & Mogford, 1981; Griswold & Commings, 1974). Therefore, in general, a parental dairy is not a useful assessment tool. However, a detailed dairy maintained by a highly skilled parent would be a valuable source of information regarding the vocabulary development of D/HH children.

Vocabulary checklists. The search for an assessment instrument that is more practical and reliable than parent diaries and language samples has led both researchers and practitioners to develop vocabulary checklists (Fenson et al., 1994; Gregory & Mogford, 1981; Howell, 1984). When completing a checklist, parents are asked to recognize (not recall) words that are part of their children's vocabulary. Two decades of research on normative early English-language development has resulted in the creation of the MacArthur Communication Development Inventory (CDI), which has become the standard parent checklist for measuring early language development in hearing children (Fenson et al., 1994). The Words and Gestures form of the CDI was developed for hearing infants between 8 and 16 months of age (Fenson et al., 1993). To complete this report, parents are asked to read a list of 396 words arranged into categories (e.g., animals, vehicles, toys, food and drink, clothing, furniture and rooms, action words, descriptive words) and identify words that their children understand (receptive vocabulary) and produce (expressive vocabulary). The Words and Sentences form of the CDI was developed for hearing children from 16 to 30 months of age and includes a 680-word expressive vocabulary checklist (Fenson et al., 1993). Because accurate judgment of children's comprehension of words becomes more difficult as their vocabulary expands, this latter protocol does not measure receptive vocabulary.

When used with hearing children, the two CDI forms have high internal reliability, correlate with language samples taken concurrently, and predict later language development better than measures derived from language samples (Fenson et al., 1994). Data from the checklist can be used to estimate lexicon size (by counting the number of items checked) and to identify which particular words the child knows. Percentile and age-equivalent scores for a child's lexicon size can be derived from normative data based on results from more than

1800 hearing children (Fenson et al., 1993). Normative data are even available for individual words.

Mayne, Yoshinaga-Itano, Sedey, and Carey (2000a; 2000b) have published normative data for the English CDI for young D/HH children enrolled in the Colorado Department of Health Intervention Program (CHIP), a statewide early intervention program. Norms for expressive vocabulary were based on a sample of 368 CDIs completed by hearing parents of 202 D/HH children ranging in age from 8 to 37 months old. Norms for receptive vocabulary were based on 168 CDIs completed by hearing parents of D/HH children, ages 8 to 22 months. There are separate norms for children in four subgroups based on age of identification (before and after 6 months) and cognitive disabilities (less than and greater than 80 Cognitive Quotient). In addition, the Marion Downs National Center (n. d.) maintains a Web site that contains data for a larger sample of D/HH children from the CHIP program.

The success of the CDI has lead to the development of comparable instruments in many different languages, including Spanish, Italian, Japanese, and Swedish (Fenson et al., 1994). Recently, an alternate form of the CDI has been published for ASL (Anderson & Reilly, 2002). This protocol is comprised of 537 signs and is designed to assess expressive sign vocabulary. It has been normed on 69 deaf children of deaf parents between the ages of 8 and 36 months who are learning ASL as their first language.

Cautions. One challenge in using the CDI is deciding which version should be completed for children who are exposed to bilingual language environments (e.g., English, Spanish, ASL). The CDIs were designed to capture the most common words learned early in a child's language development and, although there is overlap, different words appear on the various versions of the CDI reflecting early words used in each language. For example, there is an entire category of words for animal sounds on the English CDI that is not included on the ASL version. On the other hand, words specific to deaf culture (e.g., TDD/TTY) are listed on the ASL CDI, but are not in the English version. Anderson and Reilly (2002) state that the grammatical structure of ASL results in more early emphasis on verbs in this visual language compared to an emphasis on nouns in English. Furthermore, there are more words on the English CDI than on the ASL version (680 words compared to 537) with an overlap of 462 between the two versions.

It is also unclear how to compare lexicons across different language systems (e.g., between English and ASL). Differences in the way some word meanings are lexicalized in speech and sign may affect the number of words for which a child receives credit on the CDI (Lederberg & Spencer, 2001; Schick, 2002). For example, some concepts that are represented by a single word in English (e.g., KITTEN) require either fingerspelling (K-I-T-T-E-N) or multiple signs (BABY + CAT) in ASL. Deaf children who are in the single-word stage would not be expected to produce the two words to express the concept kitten; and even if they did they would not be "credited" with another word. Deaf children of deaf parents typically do not produce fingerspelling until after they have 100 words in their vocabulary (Anderson & Reilly, 2002).

On the other hand, in ASL and some signed English systems, the "sign" for many words common to children's early vocabulary (e.g., pronouns and body parts) is made by pointing. Thus, it is difficult to determine if D/HH children in the one-word stage are truly expressing the word/sign "EYE" or if they are merely pointing to that body part. When assessing children communicating in spoken English, a child would not receive credit for simply pointing. Thus, body parts are not included on the ASL version of the CDI, although these words are certainly among children's earliest vocabulary.

For D/HH children acquiring English (signed or spoken), the English CDI is probably the most appropriate form to be completed. However, it is not clear how to deal with those sections of the form that seem inappropriate for these children. Bornstein, Selmi, Hayes, Painter, and Marx (1999) specifically instructed parents to credit children for points expressing body parts and pronouns when used appropriately, while Lederberg, Prezbindowski, and Spencer (2000) gave examiners the "standard" directions from the CDI and thus did not give any special instructions concerning these words.

The language competency of the parent completing the form may be another issue when using the CDI. Hearing mothers of D/HH children who are acquiring

sign are typically novices in their children's language system. Lederberg and Spencer (2002) found that mothers who seem to know little sign are willing to complete a CDI form, even if their children's lexicon is entirely composed of signs. The validity of such data seems questionable. In addition, children may not receive "credit" for oral speech because their parents are unable to comprehend misarticulated words. One option for contending with this challenge when parents are not fluent in their children's first language (either because they are not English speaking or because they do not know sign) is to have an individual other than the parent, such as the child's teacher, complete the inventory. The standard administration of the CDI requires participation by parents, which is something that may be difficult to obtain for many children. When D/HH children attend schools with small class sizes that focus on language, teachers may be able to complete the CDI (Lederberg et al., 2000). However, normative data exist only for parent-completed CDIs.

These test norms are clearly not "normative" for D/HH children. Almost all D/HH children are language delayed according to the CDI norming table. For example, in the Mayne et al. studies (2000a; 2000b), D/HH children scored below the 25 percentile of the hearing norms. The hearing norms may not even be representative of *hearing* children's language growth. Although the hearing normative sample is large, it is not a national representative sample, as it has an overrepresentation of college-educated parents (Fenson et al., 1993).

The recent creation of D/HH norms for the English CDI (Mayne et al., 2000a, 2000b) and the ASL CDI (Anderson & Reilly, 2002) from late infancy to early preschool is an essential step in providing a context for interpreting D/HH children's vocabulary scores. It is important, however, to understand their limitations. Norms for hearing children for the English version of the CDI were derived from more than 1800 scores, while samples for the D/HH norms for the English and ASL CDIs were much smaller (Anderson & Reilly, 2002; Mayne et al., 2000a, 2000b).

Another concern is that these norms are not based on a representative sample of D/HH children. Mayne et al. (2000b) report that 73% of the scores used in their sample were from children receiving intensive early intervention services from CHIP by the age of 6 months. The D/HH norms for the English CDI are likely to represent what deaf children can achieve in optimal, rather than average, circumstances. Similarly, the ASL-CDI norms were only established with deaf children of deaf parents and are not normative for deaf children with hearing parents (Anderson & Reilly, 2002).

One caution specific to the receptive vocabulary norms for the English CDI is that the most linguistically advanced 16% of the 20- to 22-month-old D/HH children (the oldest age group assessed) were excluded from the norm tables because their vocabularies were already too extensive to measure receptive vocabulary reliably (Mayne et al., 2000b). Therefore, the norms may underestimate receptive vocabulary for the oldest age group of D/HH children.

Research with D/HH children. Despite these challenges, research indicates that the number of words checked on the CDI can be a valid and reliable indicator of D/HH children's lexicon. Anderson and Reilly (2002) presented clear evidence that the ASL-CDI is a reliable and valid assessment of the lexicons of deaf children with deaf parents. In their study, test-retest reliability on 25% of their sample (n = 16) over a period of 5–7 months was very high, r = .91 (range = .82–1.00). This also indicates that the ASL-CDI has good predictive validity for this population. Concurrent validity was also high. Comparisons of the signs children produced in extensive language samples compared to signs endorsed by parents on the CDI revealed a validity score of .87 (range = .71–1.00).

Research with the English CDI also suggests that it is a valid assessment of young D/HH children enrolled in early intervention programs. In a study of 42 deaf and 47 hearing toddlers (x age = 23 months), Bornstein et al. (1999) found that word counts from parental report on an earlier version of the CDI significantly correlated with the expressive and comprehension subscales of the Reynell Developmental Language Scales (RDLS) (Reynell & Huntley, 1985). Partial correlations, controlling for age, averaged .65, (range = .47 to .81 for sample subgroups).

In their norming studies, Mayne et al. (2000a; 2000b) found that scores on the CDI were significantly related to age of identification (before and after 6

months), and to scores on the situation-comprehension subscale of the Minnesota Child Development Inventory, a measure of nonverbal cognitive abilities. On the other hand, the degree of hearing loss and mode of communication did not affect CDI scores, which suggests that the particular challenges in completing the English-CDI for signed and/or spoken English does not affect the resulting scores, at least on the group level.

Teacher-completed CDIs also may be a valid assessment of individual differences in the lexical knowledge of preschool D/HH children. Word counts on teacher-completed CDIs for 19 D/HH preschoolers (3–5 years of age) enrolled in a state school for the deaf correlated significantly with a number of words children knew on the single-word subtest of the Grammatical Analysis of Elicited Language-Presentence Level (GAEL-P), r = .77 (Lederberg et al., 2000). In a longitudinal study of 50 D/HH children, word counts for English CDIs, completed by teachers approximately 12 months apart, were significantly correlated (r = .58), thus indicating good test-retest reliability and predictive validity for the English-CDI (Lederberg, Spencer, & Huston, 2003). This latter study included D/HH children in oral and SC environments; test-retest correlations were .64 and .54, respectively.

What do these assessment measures tell us? When parents are willing and capable of completing the form, a parent-reported CDI is a simple and easy assessment of a young child's vocabulary, measuring both lexicon size and knowledge of particular words. For infants and toddlers too young for direct testing, it is the only way to document emerging vocabulary. The CDI can also be used to assess vocabulary knowledge for older children until lexicons exceed 570 words (Fenson et al., 1993). Identification of the nature and extent of any language delay can be made by comparing individual children's scores with hearing norms (Fenson et al., 1993) or with appropriate norms for D/HH children (Anderson & Reilly, 2002; Mayne et al., 2000a, 2000b). Because parents complete the form, it is particularly well suited to early intervention programs that focus on parents as facilitators of their children's development (e.g., it is a component of the Family Assessment Multidisciplinary Interactive Learning for Young Deaf and Hard of Hearing Children used by the CHIP program, (Stredler-Brown & Yoshinaga-Itano, 1994). In addition, vocabulary knowledge of children who are acquiring spoken languages other than English can also be assessed on alternative forms of the CDI (Fenson, et al., 1994). For children enrolled in center-based preschools, teachers can use the English CDI to assess their students' vocabulary knowledge, until the children's lexicons exceed 570 words.

The CDI can be used as part of evaluation of early intervention programs. The data collection of early receptive and expressive vocabulary of D/HH children in Colorado provide evidence that those who are cognitively typical can learn vocabulary beginning in late infancy at a rate much closer to that of hearing children than previously expected (Mayne et al., 2000a). Programs may be able to use the norms established with children from the CHIP program to assess if their programs are as effective in teaching vocabulary to young D/HH children.

In addition to assessments of lexicon size, the CDI can yield a representation of D/HH children's vocabulary growth over time. This information can be obtained by regularly updating the original CDI form to include new words that the child has learned since the last assessment. For example, Figure 1 shows growth in lexicon size over time for 5 children using data from CDIs that were updated frequently by the children's teachers (Lederberg & Spencer, 2002). Growth curves are useful at both the individual and group levels. At the individual level, they indicate the rapidity with which a child is acquiring words. Changes in rate of growth (i.e., the slope) can indicate a qualitative shift in word-learning abilities. For instance, most hearing toddlers learn new words very slowly during early development, starting at only one word per month and gradually increasing to three words per week. The majority of hearing toddlers, after acquiring 50 words, become rapid word learners, and there is an acceleration in the growth rate of their lexicon, with some even learning as many as 8 new words per week (Goldfield & Reznick, 1990). Although only a few case studies have been published, the growth rate of D/HH children seems to be much more variable (Lederberg, in press). Some experience acceleration (e.g., child 1 in Figure 1), while others are limited to slow gradual word learning (e.g., child 5 in Figure 1; Lederberg & Spencer,

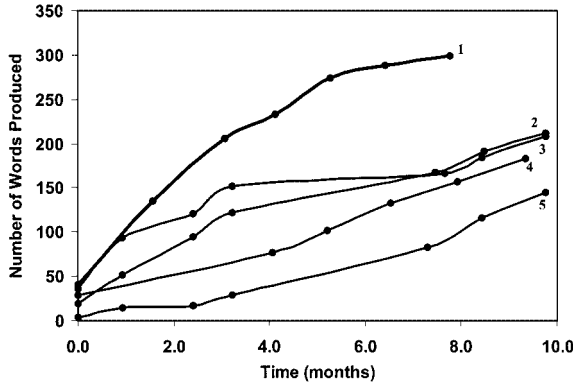

Figure 1. Rate of growth in the number of different words in the lexicon of 5 D/HH children over a 10-month period as reported by teachers on the English CDI.

2002). The growth curve of an individual child can provide insight into the word-learning processes available to learn new words (described below). The rapidity with which a child acquires new words may also be used as one indicator of the extent to which he or she is benefiting from an early intervention or school program. For children with lexicons of greater than 50 words, repeated assessment with limited vocabulary growth may cue school personnel that a child's programming needs to be altered. However, more research is needed to better describe the range of growth patterns to be expected for D/HH children and which variables (e.g., cognitive abilities, age of identification, hearing loss) lead to different trajectories. Specifically, research that uses growth-curve analyses of CDI data of groups of D/HH children is needed to provide such normative data.

Finally, the CDI provides information on the specific vocabulary items that are part of a child's lexicon. This information can be useful in establishing intervention goals as well as assessing the success of past goals. For example, in our research, teachers reported using the CDI to document progress on Individual Education Plan (IEP) goals such as, "child will acquire 30 new words this trimester." The teachers stated that although they had previously listed similar goals (which are highly relevant to D/HH children in preschool classrooms), they had no easy way to document attainment of the goals. In addition, because the CDI assesses knowledge of specific words, teachers report that they are more sensitive to gaps in an individual child's knowledge and therefore which words need to be stressed in their classrooms. Thus, the CDI may be a valid assessment of children's vocabulary knowledge as well as a tool to guide teachers and parents in their efforts to facilitate children's vocabulary growth.

Direct testing. Direct testing of child language is usually done with standardized instruments that serve to elicit evidence of production or comprehension of words. Children are asked either to label an object or picture (to test expressive vocabulary) or to select an object or picture labeled by the examiner (to test comprehension or receptive vocabulary). These tests do not attempt to tally an actual census of words; they provide a sample from which to generalize, comparing a child's number of correct responses to norms for the test. Children's performances can be recorded as raw scores, age equivalences, percentiles, or standard scores. For D/HH children, this comparison is most frequently used to compute an "equivalent language age," or the age at which the average raw score in the norming sample is equal to the raw score of the child assessed (Blamey, in press). There are two tests developed for the assessment of hearing children that have been used frequently with D/HH preschool children. In addition, there are three tests that have been specifically created to measure vocabulary of D/HH children. Each test is described below.

Peabody Picture Vocabulary Test

The most popular test to assess receptive vocabulary is the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997). The PPVT is an individually administered measure of receptive vocabulary, normed for hearing individuals from age 2 years 6 months (2;6) through adulthood. In the standardized administration, children point to one of four pictures that correspond to the target word *spoken* by the examiner. However, for D/HH children in SC environments, the test is frequently given by presenting the words in spoken and signed English (e.g., Moeller, 2000). There are extensive data supporting the concurrent and predictive validity of the PPVT with hearing children (Dunn, & Dunn). Although a small percentage of children in the normative sample had hearing losses, there are no separate norms for D/HH children.

Expressive One-Word Picture Vocabulary Test

The Expressive One-Word Picture Vocabulary Test (EOWPVT) is a measure of expressive vocabulary that requires children to name objects, actions, and concepts depicted in a progression of pictures (Academic Therapy Publications, 2000a; Gardner, 1979). The test is designed for use with hearing children aged 2;0 through 18;11 years. Two decades of research supports the concurrent and predictive validity of this test with hearing children. In addition, the Marion Downs National Center (n.d.) has posted age "norms" on their Web site based on 106 D/HH preschoolers (ages 3;8 to 6;5) enrolled in the CHIP program.

The Receptive One-Word Picture Vocabulary Test (ROWPVT) (Academic Therapy Publications, 2000b) is a companion test that has been co-normed with the EOWPVT so that meaningful comparisons between receptive and expressive vocabulary can be made. Although well normed with hearing children, there is no published research using the ROWPVT with D/HH children.

Carolina Picture Vocabulary Test

The Carolina Picture Vocabulary Test (CPVT; Layton & Holmes, 1985) is the only published vocabulary test that has norms for deaf children (Bradley-Johnson & Evans, 1991). This 130-item test of receptive vocabulary was specifically developed for D/HH children who use sign as their primary communication method. The particular items on the test were selected from previous vocabulary lists developed for deaf children and from lists of signed words in the dictionary *Signing Exact English* (Layton & Holmes, 1985). Therefore, this test appears to have good content validity for deaf children who are acquiring an English-based sign system. Patterned after the PPVT, it requires children to point to the correct picture (out of four) that depicts the word signed by the examiner (e.g., ball). The test was standardized with examiners using sign only (without speech). The test was normed on 761 deaf children ages 2;6 to 16 years. However, the normative sample only included 18 children aged 2;6 to 4 years and 19 children aged 5 years. Therefore, Layton and Holmes caution that "with such a small sample, it makes interpretation of the CPVT tentative for younger children" (p. 6). Percentile scores are given for children above 4 years of age, and age equivalency scores only begin at 4 years of age.

Receptive ASL Vocabulary Test

A Receptive ASL Vocabulary Test has recently been developed (Schick, 2002). The test is designed to assess receptive vocabulary knowledge for children from 4 to 8 years of age who are acquiring ASL as a first language. Although the format is similar to the PPVT, the target words differ and were selected based on three criteria: (a) common ASL words that were not borrowed from English, (b) minimal regional variation, and (c) no obligatory nonmanual parameters (e.g., facial expressions). In addition, the test was constructed to decrease the chances that sign iconicity could be used to select the correct referent. The test has clear content validity for children acquiring ASL. However, at this point, there are no norms or validity data available.

The Grammatical Analysis of Elicited Language-Presentence Level (GAEL-P)

The Grammatical Analysis of Elicited Language-Presentence Level (GAEL-P) is the lowest level of a series of tests developed by Moog and Geers to assess expressive and receptive language levels of oral D/HH children aged 3;0 to 5;11 years (Bradley-Johnson & Evans, 1991; Moog, Kozak, & Geers, 1983). The GAEL-P includes a vocabulary ("Single Word") section that assesses D/HH children's ability to comprehend and produce labels (all nouns) for 30 objects. Moog et al. (1983) selected the 30 nouns because they were among the first 100 words acquired by oral deaf children. To test expressive vocabulary, the examiner individually presents the 30 objects to the child and requests that the child label each. To test receptive vocabulary, an examiner presents the child with groups of four of the same 30 objects and orally states the name of one of them. The child is to point to the target object. The objects are arranged such that "each set of four words are easily discriminable both visually and acoustically" (Moog et al., 1983).

The GAEL-P was normed on 150 oral D/HH children, aged 3 to 5 years with "educationally significant hearing losses" (Moog et al., 1983, p. 59). The manual

also reports norms for a sample of younger hearing children (2;6 to 3;11 years), allowing comparison of a child's score to either D/HH or hearing children. Norms are only available for the whole test, rather than for the vocabulary subtest. Therefore, raw scores (number of objects correct) must be used to measure vocabulary knowledge.

Cautions. A primary caution in using any of these last five tests with D/HH children regards the extent to which one can extrapolate conclusions about the size of D/HH children's vocabulary from the children's scores on the test. On tests developed for hearing children, such as the PPVT and EOWPVT, items are presented in order of difficulty based on assessment of the progression of vocabulary acquisition for hearing children. However, D/HH children may learn words in a different order from hearing children for a variety of reasons, including words' phonological characteristics (Blamey, in press; Moeller, 1988), the acquisition of words at a later age and in a school-based rather than home-based environment. For example, D/HH children may learn academic concepts (e.g., colors, animal names) before the names of items included on these tests (e.g., garbage, spoon). Thus, the items on the test may not adequately "sample" D/HH children's lexicon.

The comparison of a D/HH child's performance on a standardized measure to that of other children may be problematic regardless of whether the norms were established using a sample of hearing or D/HH children. Norms provide tables that allow an examiner to compare an individual child's scores with a representative sample of children of a similar age, but the hearing children included in the normative samples are clearly not representative of D/HH children. For instance, a child scoring at the twentieth percentile on the PPVT (compared to hearing children) may actually be typical for D/HH children.

The usefulness of standard scores and percentile ranks based on hearing norms as a means of documenting *progress* of D/HH children who are language delayed may be especially limited. Hearing children's rate of acquisition of vocabulary is faster than that of many D/HH children; it is estimated that D/HH children's average growth rate ranges from half to two thirds that of hearing children (Blamey et al., 2001; Connor, Heiber, Arts, & Zwolan, 2000; Moeller, Osberger, & Eccarius, 1986). Therefore, the standard scores of most D/HH children, even when they experience vocabulary growth, become lower with age.

Standardized tests based on norms for D/HH children pose their own problems. The samples of children from which norm tables are derived for D/HH children tend to be much smaller than those of instruments for hearing children (e.g., 50–150 children versus 1000+ children; Layton & Holmes, 1985; Mayne et al., 2000a, 2000b; Moog et al., 1983). This is understandable, as data collection for norm samples is expensive and time consuming, especially because hearing loss is a low-incidence condition and administering the target protocol requires special skills (e.g., proficiency in sign language). However, smaller norm samples are more prone to sample bias. The norming samples for the GAEL-P and the CPVT were not only small, but they also targeted specific subpopulations of D/HH children. The GAEL-P was restricted to children learning only spoken English, and relevant descriptive information about the small sample (e.g., degree of hearing loss, socioeconomic status, age of identification) is not available in the manual (Moog et al., 1983). The CPVT had an overrepresentation of residential school children and very few children under the age of 5 years. Since the quality and content of deaf education programs varies considerably across the country, these norms may not be representative of the range of vocabulary performance of D/HH children.

A third issue to consider about direct testing is that none of these tests has been standardized for children who are acquiring sign and speech (i.e., in SC environments). Therefore, standardized procedures are rarely used to assess the vocabulary of these children. For the PPVT, EOWVT, and GAEL-P, the translation of test items into sign (for receptive tests) and the scoring of an examinee's answers (for productive tests) can introduce errors in scoring and interpreting test scores because of variation in signs used by examiners and examinees. Signs for many English words vary regionally and across signing systems (e.g., the initialization of signs in SEE; Coryell & Holcomb, 1997). Translation for children acquiring ASL is even more problematic because the ASL lexicon is not based on English (Schick, 2002). Even the CPVT, which specifies the sign to be used in the test,

may be better administered in a nonstandardized format. Since some of the test's recommended signs are not used universally, the use of these signs may not accurately assess children's knowledge of that word. In addition, many D/HH children use information from both spoken and signed words for their understanding of language (Capirci, Montanari, & Volterra, 1998). Therefore, presenting words in sign only (as is done in the standardized CPVT format) will not accurately assess receptive vocabulary knowledge.

Another important concern when administering receptive tests such as the PPVT or the CPVT in sign is that the iconicity of some signs might make it easier for D/HH children to guess the target picture, thus leading to an overestimation of the children's vocabulary knowledge (Schick, 2002; White & Tischler, 1999). For example, the "roundness" of the sign for "ball" may lead deaf children who do not know the word to select the picture of a round object. Indeed, when *hearing* first, fourth, and ninth graders were administered the CPVT in sign language, they were able to correctly guess the referent 70% of the time, despite the fact they knew none of the signs (White & Tischler).

Assessment of children acquiring spoken English is complicated by the assumption that performance on these tests is related to children's lexical knowledge and not speech perception or production abilities. This assumption may not be true for some D/HH children (Blamey, in press; Moeller, 1988). There are many ways that speech abilities can influence children's performance on these tests. For example, instructions for tests of expressive vocabulary specifically state that articulation errors should not affect scoring (Academic Therapy Publications, 2000a; Moog et al., 1983). It is frequently difficult to determine whether a child has produced a misarticulated word or a nonsymbolic vocalization (Blamey, in press). Such judgments may produce an unreliable estimation of children's expressive vocabulary. Receptive vocabulary tests such as the PPVT may underestimate deaf children's lexical knowledge because perceptual discriminablity of the four choices for each word has not been controlled.

Research with D/HH children. Research suggests that standardized tests may be useful for assessing vocabulary knowledge of older preschoolers. Moeller (2000) found that D/HH 5-year-olds' scores on the PPVT and the EOWPVT were highly and significantly correlated (r = .81). In addition, scores on the PPVT were significantly correlated with general language measures, as measured by either the Preschool Language Scale, 3rd edition (PLS-3) (Zimmerman, Steiner, & Pond, 1992) or the RDLS (Reynell & Huntley, 1985) (r = .74–.80). Blamey et al. (2001) found that PPVT age equivalent scores were also highly correlated (r = .88) with a general language measure (as measured by The Clinical Evaluation of Language Fundamentals; Semel, Wiig, & Secord, 1995) for 87 D/HH children attending oral primary schools (4 to 12 years of age). However, because they did not control for chronological age, this latter finding must be treated with caution. All of these correlations are similar to the ones reported for hearing children (Academic Therapy Publications, 2000a; Dunn & Dunn, 1997).

Preschool children's scores on the PPVT do not seem to be artificially inflated by the presentation of the test items in sign. In Moeller's (2000) study, test items were signed and spoken for the children who were enrolled in total communication programs (46% of sample). There was no significant effect of mode of communication for PPVT test scores. In addition, for 92% of the 112 D/HH children, age equivalent scores were lower on the PPVT than the EOWPVT. Dodd, McIntosh and Woodhouse (1998) found mean age equivalent scores from the PPVT and the RDLS to be similar when administered in simultaneous communication to 16 D/HH preschoolers (mean age = 47 months). Sign iconicity may only affect older children's receptive vocabulary scores (M. P. Moeller, personal communication, July 18, 2002).

Lederberg et al. (2000) found that the number of words produced and comprehended on the Single Word Subsection of the GAEL-P for 19 D/HH children correlated with word counts on the CDI. A small-scale study with 20 D/HH children found high test-retest reliability and concurrent validity for total test scores using the Scales of Communication Skills for Hearing-Impaired Children (Moog & Geers, 1975).

There is no published research on the validity of the CPVT with preschool children. However, Lederberg and Spencer (2002) assessed the vocabulary of 86

D/HH 4- to 5-year-olds using both the CPVT (with words presented either with simultaneous communication or speech only, depending on the children's language environment) and a teacher-completed English CDI. Percentile scores on the CPVT had a high, significant correlation with CDI word counts (r = .80). In addition, percentile scores for the CPVT were significantly correlated with percentile scores of a re-administered CPVT after an 8-month period (r = .65). Thus, the CPVT may have adequate test-retest reliability and predictive validity.

What do these assessment measures tell us? Because these standardized tests sample the child's vocabulary, unlike the CDI, they provide too little information for selecting intervention goals (Moeller, 1988). However, they offer an efficient means of providing an objective measure of lexicon size. Indeed, these tests are the only available standardized method of evaluation for older children, since it is unreasonable to attempt to compile a complete census of vocabulary for those who have lexicons above 560 words (Fenson et al., 1993). Blamey (in press) suggests that one of the best ways to document a language delay is to compute a language quotient (LQ), which is the ratio of the child's language age to chronological age. LQ is also an indication of the rate of the children's language learning at that particular point of development. For example, an LQ value of 1.0 reflects a normal average rate of learning. An LQ of 0.5 would indicate a rate of growth of half of what is the norm (e.g., when a 6-year-old has a raw score equal to that of an average 3-year-old).

To measure progress during a specified period of time, Blamey (in press) suggests computing the ratio of the *change* in age equivalency to the *change* in chronological age. The *rate* of growth, rather than the age equivalency, ascertains how effectively vocabulary was learned during a specific period of time (e.g., a school year) without penalizing children for previous slow vocabulary growth. Periodic direct testing provides the opportunity to ascertain if a child is benefiting from the curriculum in a particular classroom or program. In addition to being useful for the evaluation of individual children, rate of progress, or the slope of a regression line, has been especially useful in studying the effect of specific types of interventions on vocabulary growth (e.g., cochlear implantation, Blamey et al., 2001, or language method, Connor et al., 2000).

While these tests hold promise for assessing the vocabulary of D/HH children during later vocabulary development, their usefulness for very young children is limited. They can only be used with children who have developed the ability to respond to the testing situation. In addition, although the PPVT and EOWPVT are designed to be used with hearing children starting at 2;0 to 2;6 years of age, research suggests that D/HH children do not have comparable lexicons until they are 3;6 or 4;0 years of age (Lederberg, in press; Marion Downs National Center, n.d.). The CPVT also does not provide age equivalency scores for children below 4;0 years of age, and even the scores of 4-year-olds are based on only 20 children.

On the other hand, the GAEL-P is designed for assessing children at the earliest stages of word acquisition. Its use of realistic objects may allow assessment of children who do not respond to the picture items used in other vocabulary tests. In addition, the Single Words subtest was designed to be an assessment for children whose lexicons are fewer than 100 words. Unfortunately, the GAEL-P's normative data are for the whole test rather than the Single Words subtest.

Assessment of D/HH Children's Word-Learning Processes

Traditional vocabulary assessments measure the size of children's lexicons. Recent research suggests that vocabulary development also results in changes in the processes that are available to children when learning new words. Acceleration in vocabulary development (i.e., faster word learning) has been linked to the word-learning skills of hearing (Dromi, 1999) and D/HH children (Lederberg et al., 2000).

Two types of changes have been documented in hearing and D/HH children's development. First, children become capable of storing an initial representation of the form and meaning of a word after only a few exposures (called rapid word learning or fast mapping; Lederberg & Spencer, 2001). During initial word acquisition, children are in a slow word-learning phase characterized by their ability to learn words only after multiple exposures and only for referents or events that are

perceptually salient (Hollich, Hirsh-Pasek, & Golinkoff, 2000). Typically when their lexicons reach between 50 and 100 words, hearing toddlers become rapid word learners (i.e., they learn new words after only a few exposures when reference is made; Dromi, 1999).

The second change in word-learning processes occurs when children become capable of learning novel words in an increasingly broader variety of contexts. (See Lederberg and Spencer, 2001, and Golinkoff et al., 2000, for more extensive discussions of word-learning processes acquired.) Eventually, children can infer the meaning of new words even when the speaker gives no pragmatic cues for reference. In other words, the child can "guess" the meaning of the word, based on the way words are used in the world. One well-documented "internal" strategy is the novel mapping strategy; i.e., knowing that a novel word is more likely to refer to an unfamiliar than a familiar object. Hearing children aged 2;6 years consistently use the novel mapping strategy (Golinkoff et al.).

No commercial standardized measures exist to assess word-learning processes. Tasks that were used by Lederberg et al. (2000) can be adapted for clinical practice. Lederberg et al. tested D/HH children with two tasks to assess the word-learning skills that are described more fully in their article. The rapid word-learning task was designed to determine if children could learn and generalize a new label for an unfamiliar object when it is presented to them only three times. In this task, the reference for the novel words was made explicit by the researcher through multiple social-pragmatic cues (i.e., holding, manipulating and pointing to the referent or object while repeating the label). The novel mapping task was designed to assess if children would map a novel word onto a novel object because of internal strategies (i.e. by inferring that a novel word refers to a novel object rather than to three objects for which they already have labels). To be "credited" with learning a new word in both tasks, the children had to show that they knew the novel word referred to the labeled object (e.g., novel corkscrew) by selecting it from among four objects (e.g., ball, hat, girl, and corkscrew). In addition they had to generalize the word by selecting another example of the category of labeled objects (another set of toys including a new corkscrew, ball, hat, girl and another novel object).

For both tasks, the novel words (e.g., *dax, bipi*) were presented in the language used at the children's school (i.e., either spoken only, both spoken and signed, or signed only.) For children learning SC, novel signs accompanied the novel spoken words (e.g., Y-handshapes on both hands, produced with elbows bent so that forearms were upright in front of the signer's body with palms facing each other. The Y's were then tapped together twice). In each task, children were exposed to four novel words. A child was considered to have "passed" a task, demonstrating adequate use of a word-learning strategy, when she or he comprehended and generalized a minimum of two of the four words presented per task.

Informal observation can also be effective in assessing the word-learning processes available to a child. For example, a parent or teacher may introduce a toy for which the child does not know the name (e.g., gorilla) and refer to it explicitly three times within a short interval of time (e.g., 1–2 min). If, when presented several minutes later with a group of toys (for which the child knows the labels except "gorilla"), the child is able to select the gorilla, then he or she may no longer need extensive explicit exposure to a word before learning it. Similarly, testing for the presence of the novel mapping strategy is possible by using a label for a novel toy in conversation with the child while playing with the novel toy and several "known" toys. If the child is able to identify the novel toy from among the other toys in the group, he or she may have the novel mapping strategy.

Cautions

Conclusions about D/HH children's vocabulary development from their performance on the word-learning tasks must be considered tentative. Although experimental research of the development of word-learning strategies is well documented for hearing children, very few studies have been conducted with D/HH children (see next section). In addition, research on concurrent validity or reliability of these types of tasks for assessment of hearing or D/HH children's word learning in real world contexts is nonexistent. This is the newest and least well documented of the assessment techniques, and more research is needed.

Research assessing the word-learning skills available to children suggests that the more word-learning skills

they have, the more efficiently they learn new words. However, these word-learning processes, especially beyond a certain vocabulary level, may be necessary but not sufficient to continue age-appropriate gains in vocabulary. For example, Conner et al. (2000) noted that D/HH students' expressive and receptive vocabulary age stagnated at about the age equivalent of 7 years. Therefore, it is important to continue researching other areas that contribute to age-appropriate development of the lexicon.

Research with D/HH children

D/HH children's performances on rapid word-learning and novel mapping tasks are related to their vocabulary knowledge, thus suggesting the tasks assess vocabulary development (Lederberg, in press; Lederberg et al., 2000). Specifically, in our research program that included 91 D/HH children, children who did not learn new words in either task had, on average, the smallest lexicons (measured by the CDI.) Children who learned words only in the rapid word-learning task had moderately sized lexicons. Children who learned words in both tasks had the largest lexicons. There were no significant differences in the pattern of results for children learning language in oral or simultaneous communication environments. Longitudinal research (Lederberg et al., 2000) confirms that these word-learning abilities are acquired sequentially and are related to lexicon size. While all D/HH children acquired the word-learning skills, age of acquisition ranged from 3 to 5 years of age.

What do these assessment measures tell us?

Assessment of word-learning processes may be especially useful when planning educational interventions (Lederberg & Spencer, 2001). The assumption (though not proven) of word-learning tasks is that they are indicative of the type of contexts in which children will learn new words. Thus, the categorization of children into levels of word-learning abilities may provide therapists and teachers with information about the contexts and teaching strategies that will be most effective in promoting optimal word learning. Children who do not learn new words in either task do not learn words quickly even when reference is explicitly established. As a result, they will require multiple, explicit exposures to new words for acquisition. Children who learn words only in the rapid word-learning task will be able to acquire new words with fewer exposures, but only when the object-referent link is made explicitly. Finally, children who learn words in both tasks can infer the meaning of words and thus will acquire new words in more naturally occurring conversations.

This information may be especially important for language-delayed D/HH children. Adults naturally increase object-referent cues (e.g., slower speech, word repetition, pointing to an object while talking about it) when communicating with infants and young toddlers. However, older, language-delayed D/HH toddlers and preschoolers may also need these contextual supports if they are still in the earlier stages of word learning. Thus, an understanding of word-learning skills and the quantity and quality of cues necessary for a child to acquire vocabulary may help educators and parents to provide an appropriate enriching linguistic environment for D/HH children.

Conclusions

Hearing loss significantly affects vocabulary development as measured by vocabulary size, rate of word acquisition, and emergence of word-learning processes (Lederberg, in press). However, recent studies have demonstrated that, with early identification and timely implementation of intensive early intervention, many D/HH children are capable of acquiring vocabulary at rates closer to those of hearing children (Mayne et al., 2000a; Moeller, 2000). Accurate assessment of vocabulary for D/HH toddlers and preschoolers is essential to the development and enhancement of the early intervention programs that facilitate the realization of this potential.

Several assessment techniques, if administered by an informed examiner, can be informative. The recent creation of parent report measures, including several versions of the CDI, has provided a simple and reliable means of recording the lexicon of children in the earliest stages of vocabulary acquisition (regardless of their chronological age). The CDI correlates highly with tests of overall language development (Bornstein et al., 1999) and vocabulary knowledge (Lederberg et al., 2000). By completing the CDI at regular intervals, children's acquisition of individual words, as well as the rate of vo-

cabulary growth, can be tracked over time. This makes the CDI particularly useful for selecting appropriate intervention goals. Norms for vocabulary size and rate of growth of young D/HH children have recently become available for both the English (Mayne et al., 2000a) and ASL versions of the CDI (Anderson & Reilly, 2002). In addition, the many versions of the CDI allow for assessment of spoken languages other than English, which some D/HH children may be acquiring in the home.

Once D/HH children are beyond the initial stages of language learning and it is no longer possible to record the entire corpus of their vocabulary, it is appropriate to switch to assessment strategies that sample vocabulary knowledge through direct testing. The norms for the PPVT and the EPOWPT begin at age 30 months, which is the age when the CDI becomes inappropriate for use with typically developing hearing children. Most D/HH children are older than 30 months when their vocabulary is sufficient to begin direct testing. Research testing the validity of these tests for D/HH children is only available for children 5 years and older (Blamey et al., 2001; Moeller, 2000). Age equivalency scores of the PPVT–III and the EOWPVT also allow for the comparison of vocabulary knowledge across ages and individuals, which is instrumental in assessing both individual children and the effectiveness of intervention programs that aim to facilitate word acquisition. The CPVT and the Receptive ASL Vocabulary Test are designed to test receptive vocabulary for young D/HH children learning different sign languages and, thus, these may more accurately indicate some deaf children's lexical knowledge than English-based tests. However, only the CPVT has norms, and those are based on a relatively small sample size, making interpretation of performance tentative.

Vocabulary development not only consists of the acquisition of words but also the emergence of new learning processes for acquiring new words. Research suggests that the acquisition of two word-learning processes, rapid word learning and novel mapping, is associated with vocabulary knowledge (Lederberg et al., 2000; Lederberg et al., 2003). The tasks used to assess the presence of these word-learning processes may identify the learning contexts that are needed to acquire new words efficiently. Because of their potential for informing intervention strategies, research on the validity of these novel word-learning tasks would have important educational implications.

A combination of assessment techniques—a multidimensional assessment—may be especially useful for understanding children's strengths and weaknesses. Language samples can be used for describing children's functional communication. Norm-based assessment techniques can be used to document language delay and progress over time. Word-learning tasks can identify the word-learning processes available for learning new words. Assessments of all language systems (e.g., ASL, English) can identify the child's language-specific knowledge (Jamieson, in press). These broader assessments would provide key information for program planning. For example, a child's low performance may indeed reflect a limited vocabulary base and few word-learning processes available to facilitate word acquisition. In this case, the child may require more direct and repetitive instruction to learn novel words. Alternatively, a child may have difficulty assimilating information in the modality of instruction in the classroom (e.g., SEE) but may demonstrate a larger vocabulary base in another language (e.g., ASL). In this situation, a reassessment of the fit between the child and the learning environment, along with the educational goals (e.g., exposure to formal English to facilitate reading skills) may be necessary. This latter scenario may be particularly prevalent for children who have been exposed to more than one language system (any combination of spoken or signed languages) across home and school settings. A third group of children may exhibit specific language delays (e.g., scoring well on a test of receptive English vocabulary, but poorly on a test of expressive vocabulary) that reflect a language impairment unrelated to hearing loss. Finally, some children may perform poorly on tests due to factors such as poor communication between child and examiner.

In summary, hearing loss clearly affects children's vocabulary development (at least for those with hearing parents). D/HH children tend to have smaller lexicons, slower rates of new word acquisition, and a narrower range of contexts that foster word learning. Assessment measures described here, with the appropriate cautions observed by professionals and parents, should result in a better understanding of D/HH children's vocabulary development that can be used to improve early intervention programming.

Notes

1. Many studies of early vocabulary development include children who range in hearing loss from moderate to profound. In addition, early intervention programs frequently serve children with a range of hearing losses. Therefore, in general, we use the term *deaf and hard-of-hearing (D/HH) children* in this article. However, when a particular study only included children who had a profound hearing loss, the more restricted term *deaf* will be used.

References

Academic Therapy Publications, I. (2000a). *Expressive One-Word Picture Vocabulary Test* (3rd ed.). Novato, CA: Academy Therapy Publications.

Academic Therapy Publications, I. (2000b). *Receptive One-Word Picture Vocabulary Test*. Novata, CA: Academic Therapy Publications.

Anderson, D., & Reilly, J. S. (2002). The MacArthur Communicative Development Inventory: Normative data for American Sign Language. *Journal of Deaf Studies and Deaf Education, 7*(2), 83–106.

Bates, E., Bretherton, I., & Snyder, L. (1988). *From first words to grammar: Individual differences and dissociable mechanisms.* New York: Cambridge University Press.

Blamey, P. J. (in press). Development of spoken language by deaf children. In M. Marschark & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education*. New York: Oxford University Press.

Blamey, P. J., Sarant, J. Z., Paatsch, L. E., Barry, J. G., Bow, C. P., Wales, R. J., Wright, M., Psarros, C., Rattigan, K., & Tooher, R. (2001). Relationships among speech perception, production, language, hearing loss, and age in children with impaired hearing. *Journal of Speech, Language, and Hearing Research, 44,* 264–285.

Bornstein, M. H., Selmi, A. M., Haynes, O. M., Painter, K., M., & Marx, E. S. (1999). Representational abilities and the hearing status of child/mother dyads. *Child Development, 70*(4), 833–852.

Bradley-Johnson, S., & Evans, L. D. (1991). *Psychoeducational assessment of hearing impaired students: Infancy through high school*. Austin, TX: PRO-ED, Inc.

Calderon, R., & Naidu, S. (2000). Further support for the benefits of early identification and intervention for children with hearing loss. *The Volta Review, 100*(5), 53–84.

Capirci, O., Montanari, S., & Volterra, V. (1998). Gestures, signs, and words in early language development. In J. M. Iverson & S. Goldin-Meadow (Eds.), *The nature and functions of gesture in children's communication* (Vol. 79, pp. 45–49). San Francisco: Jossey-Bass Publishers.

Connor, C. M., Heiber, S., Arts, H. A., & Zwolan, T. A. (2000). Speech, vocabulary, and the education of children using cochlear implants: Oral or total communication? *Journal of Speech, Language, and Hearing Research, 43,* 1185–1204.

Coryell, J., & Holcomb, T. K. (1997). The use of sign language and sign systems in facilitating the language acquisition and communication of deaf students. *Language, Speech, and Hearing Services in Schools, 28,* 384–394.

Dodd, B., McIntosh, B., & Woodhouse, L. (1998). Early lipreading ability and speech and language development of hearing impaired preschoolers. In R. Campbell & B. Dodd & D. Burham (Eds.), *Hearing by eye II* (pp. 229–242). Hove, UK: Psychology Press.

Dromi, E. (1987). *Early lexical development*. New York: Cambridge University Press.

Dromi, E. (1999). Early lexical development. In M. Barrett (Ed.), *The development of language: Studies in developmental psychology* (pp. 99–131). Philadelphia, PA: Psychology Press.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary* (3rd ed.). Circle Pines: American Guidance Services.

Easterbrooks, S. R., & Baker, S. (2002). *Language learning in children who are deaf and hard of hearing.* Boston: Allyn and Bacon.

Ertmer, D. J., & Mellon, J. A. (2001). Beginning to talk at 20 months: Early vocal development in a young cochlear implant recipient. *Journal of Speech, Language, and Hearing Research, 44,* 192–206.

Everhart, V. (1993). *The development of sign language use in deaf preschoolers and their hearing mothers.* Dallas: University of Texas.

Everhart, V., & Lederberg, A. R. (1991, April). *The effect of mothers' visual communication use on deaf preschoolers' visual communication*. Paper presented at the biennial meeting of the Society for Research in Child Development, Seattle WA.

Fenson, L. (n.d.). *MacArthur Communicative Development Inventory*. Retrieved in 2002, from http://www.sci.sdsu.edu/cdi/

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*(5, Serial No. 242), 1–189.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., Pethick, S., & Reilly, J. S. (1993). *MacArthur Communicative Development Inventories: User's guide and technical manual.* San Diego, CA: Singular Publishing Group.

Gardner, M. E. (1979). *Expressive One-Word Picture Vocabulary Test*. Novato, CA: Academic Therapy Publication.

Goldfield, B., & Reznick, J. S. (1990). Early lexical acquisition: Rate, content, and the vocabulary spurt. *Journal of Child Language, 17,* 171–183.

Golinkoff, R. M., Hirsh-Pasek, K., Bloom, L., Smith, L. B., Woodward, A. L., Akhtar, N., Tomasello, M., & Hollich, G. J. (2000). *Becoming a word learner: A debate on lexical acquisition*. New York, NY: Oxford University Press.

Gregory, S., & Mogford, K. (Eds.). (1981). *Early language development in deaf children*. London: Croom Helm.

Griswold, E., & Commings, J. (1974). The expressive vocabulary of preschool deaf children. *American Annals of the Deaf, 119,* 16–29.

Harris, M. (1992). *Language experience and early language development: From input to uptake.* Hove, UK: Lawrence Erlbaum Associates.

Hollich, G. J., Hirsh-Pasek, K., & Golinkoff, R. M. (2000). Breaking the barrier: An emergentist coalition model for the origins of word learning. *Monographs for the Society for Research in Child Development, 65*(3).

Howell, R. F. (1984). Maternal reports of vocabulary development in four-year-old deaf children. *American Annals of the Deaf, 129*(6), 459–465.

Jamieson, J. R. (in press). Formal and informal approaches to the language assessment of deaf children. In M. Marschark & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education.* New York: Oxford University Press.

Layton, T. L., & Holmes, D. W. (1985). *Carolina Picture Vocabulary Test.* Austin, TX: PRO-ED.

Lederberg, A. R. (in press). Expressing meaning: From communicative intent to building a lexicon. In M. Marschark & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education.* New York: Oxford University Press.

Lederberg, A. R., & Everhart, V. S. (1998). Communication between deaf children and their hearing mothers: The role of language, gesture, and vocalizations. *Journal of Speech, Language, and Hearing Research, 41,* 887–899.

Lederberg, A. R., & Prezbindowski, A. K. (2000). Impact of child deafness on mother-toddler interaction: Strengths and weaknesses. In P. E. Spencer, C. J. Erting, & M. Marschark (Eds.), *The deaf child in the family and at school* (pp. 73–92). Mahwah, NJ: Lawrence Erlbaum Associates.

Lederberg, A. R., Prezbindowski, A., K., & Spencer, P. E. (2000). Word learning skills of deaf preschoolers: The development of novel mapping and rapid word learning strategies. *Child Development, 53,* 1055–1065.

Lederberg, A. R., & Spencer, P. E. (2001). Vocabulary development of deaf and hard of hearing children. In M. D. Clark, M. Marschark, & M. Karchmer (Eds.), *Context, Cognition and Deafness* (pp. 88–112). Washington, DC: Gallaudet University Press.

Lederberg, A. R. & Spencer, P. E. (2002). [Longitudinal study of vocabulary development of deaf and hard-of-hearing children]. Unpublished raw data.

Lederberg, A. R., Spencer, P. E., & Huston, S. (2003, April). *Development of fast-mapping in deaf and hard of hearing children: A longitudinal study.* Paper presented at the Society for Research in Child Development, Tampa, FL.

Leopold, W. F. (1949). *Speech development of a bilingual child: A linguist's record (Vol. 3).* Evanston, IL: Northwestern University Press.

Marion Downs National Center. (n.d.). *Developmental Norms for Infants/Toddlers/Children.* Retrieved in 2002, from http://www.colorado.edu/slhs/mdnc/research.html

Mayberry, R. I. (1992). The cognitive development of deaf children: Recent insights. In S. G. Segalowitz & I. Rapin (Eds.), *Handbook of Neuropsychology* (Vol. 7, pp. 51–68). New York: Elsevier.

Mayne, A. M., Yoshinaga-Itano, C., Sedey, A. L., & Carey, A. (2000a). Expressive vocabulary development of infants and toddlers who are deaf or hard of hearing. *Volta Review, 100*(5), 1–28.

Mayne, A. M., Yoshinaga-Itano, C., Sedey, A. L., & Carey, A. (2000b). Receptive vocabulary development of infants and toddlers who are deaf or hard of hearing. *Volta Review, 100*(5), 29–52.

Moeller, M. P. (1988). Combining formal and informal strategies for language assessment of hearing-impaired children. In R. R. Kretschmer & L. W. Kretschmer (Eds.), *Communicative assessment of hearing-impaired children: From conversation to classroom. Journal of Academy of Rehabilitative Audiology* (pp. 73–99): Monograph Supplement XXI.

Moeller, M. P. (2000). Early intervention and language development in children who are deaf and hard of hearing. *Pediatrics, 106*(3), e43.

Moeller, M. P., Osberger, M. J., & Eccarius, M. (1986). Receptive language skills. *Language and learning skills in hearing-impaired children, 23,* 41–53.

Moog, J., & Geers, A. (1975). *Scales of early communication skills for hearing impaired children.* St. Louis, MO: Central Institute for the Deaf.

Moog, J., Kozak, V., & Geers, A. (1983). *Grammatical Analysis of Elicited Language—Pre-Sentence Level.* St. Louis, MO: Central Institute for the Deaf.

Muma, J. R. (1998). *Effective speech-language pathology: A cognitive socialization approach.* Mahway, NJ: Lawrence Erlbaum.

Nicholas, J. G. (2000). Age differences in the use of informative/heuristic communicative functions in young children with and without hearing loss who are learning spoken language. *Journal of Speech, Language, and Hearing Research, 43,* 380–394.

Reynell, J., & Huntley, M. (1985). *Reynell developmental language scale* (2nd ed.). Windsor, UK: NFER-Nelson.

Schick, B. (2002). *Assessing ASL skills in children: Formal tests for elementary school-aged children.* Unpublished manuscript.

Semel, E., Wiig, E., & Secord, W. A. (1995). *Clinical evaluation of language fundamentals* (3rd ed.). San Antonio, TX: The Psychological Corporation, Harcourt Brace.

Shafer, D., & Lynch, J. (1981). Emergent language of six prelingually deaf children. *Journal of the British Association of Teachers of the Deaf, 5(*4), 94–111.

Spencer, P. E. (1993). The expressive communication of hearing mothers and deaf infants. *American Annals of the Deaf, 138*(3), 275–283.

Spencer, P. E. (2002, July). *Sensitive periods in language development: Evidence from deaf children with hearing parents.* Paper presented at The 22nd Annual Symposium on Research in Child Language Disorders and the 9th International Congress for the Study of Child Language, Madison, WI.

Stredler-Brown, A., & Yoshinaga-Itano, C. (1994). F.A.M.I.L.Y. assessment: A multidisciplinary evaluation tool. In J. Rousch & N. Matkin (Eds.), *Infants and toddlers with hearing loss* (pp. 133–161). New York: York Press.

Watkins, R. V., & Kelly, D. J. (1995). Measuring children's lexical diversity: Differentiating typical and impaired language learners. *Journal of Speech and Hearing Research, 38*(6), 133–143.

White, A., & Tischler, S. (1999). Receptive sign vocabulary tests: Tests of single-word vocabulary or iconicity. *American Annals of the Deaf, 144*(4), 334–338.

Zimmerman, I., Steiner, V., & Pond, R. (1992). *Preschool Language Scale–III.* San Antonio, TX: Psychological Corp.

Received February 2, 2002; revisions received November 5, 2002; accepted November 6, 2002