Objective: By 24 mo of age, most typically developing infants with normal hearing successfully transition to the production of words that can be understood about 50% of the time. This study compares early phonological development in children with and without hearing loss to gain a clearer understanding of the effects of hearing loss in early-identified children. A secondary goal was to identify measures of early phonetic development that are predictors of later speech production outcomes.

Design: The vocalizations and early words of 21 infants with normal hearing and 12 early-identified infants with hearing loss were followed longitudinally over a period of 14 mo (from 10 to 24 mo of age). Thirty-minute mother-child interaction samples were video recorded at 6- to 8-wk intervals in a laboratory playroom setting. Vocalizations produced at 16 and 24 mo were categorized according to communicative intent and recognizable words versus other types. Groups were compared on the structural complexity of words produced at 24 mo of age. Parent report measures of vocabulary development were collected from 10 to 30 mo of age, and Goldman-Fristoe Test of Articulation scores at 36 mo were used in regression analyses.

Results: Both groups increased the purposeful use of voice between 16 and 24 mo of age. However, at 24 mo of age, the toddlers with hearing loss produced significantly fewer words that could be recognized by their mothers. Their samples were dominated by unintelligible communicative attempts at this age. In contrast, the samples from normal hearing children were dominated by words and phrases. At 24 mo of age, toddlers with normal hearing were more advanced than those with hearing loss on seven measures of the structural complexity of words. The children with normal hearing attempted more complex words and productions were more accurate than those of children with hearing loss. At 10 to 16 mo of age, the groups did not differ significantly on parent-report measures of receptive vocabulary. However, the hearing loss group was much slower to develop expressive vocabulary and demonstrated larger individual differences than the normal hearing group. Six children identified as atypical differed from all other children in vowel accuracy and complexity of word attempts. However, both atypical infants and typical infants with hearing loss were significantly less accurate than normal hearing infants in consonant and word production. Early measures of syllable production predicted unique variance in later speech production and vocabulary outcomes.

Conclusions: The transition from babble to words in infants with hearing loss appears to be delayed but parallel to that of infants with normal hearing. These delays appear to exert significant influences on expressive vocabulary development. Parents may appreciate knowing that some children with hearing loss may develop early vocabulary at a slower rate than children with normal hearing. Clinicians should monitor landmarks from babble onset through transitions to words. Indicators of atypical development were delayed and/or limited use of syllables with consonants, vowel errors and limited production of recognizable words.

(Year & Hearing 2007;28:628–642)

During vocal play and babble, infants with normal hearing build a foundation in phonetic and motor abilities that facilitates the transition to word use (Stoel-Gammon, 1998a, 1998b; Vihman, 1996). Oller (2000) refers to the well-formed syllables produced in babble as “phonetic building blocks” for words. On average, early-identified infants with hearing loss (HL) have smaller consonant inventories and less complex syllables in babble than age-matched normal-hearing (NH) counterparts (see Moeller, Hoover, Putman, et al., 2007). Given such findings, it is reasonable to suspect that the transition to referential word use in infants with HL may be slower, and productions may be less accurate than those of infants with NH. Recent research has demonstrated a slower rate of word learning in infants with HL compared with infants with NH, despite early identification and intervention (Mayne, Yoshinaga-Itano, Sedey, et al., 2000; Mayne, Yoshinaga-Itano, & Sedey, 2000). Incomplete prelinguistic vocal development has been observed to contribute to early lexical delays in development.
deaf children (Ertmer & Stark, 1995). When children are slow to develop complex and consistent babble, they have fewer or less varied perceptual-motor experiences on which to build spoken words. Studies of the impact of phonetic delays on lexical development in early-identified infants with varied degrees of HL are rare. The current study compares the development of infants with NH and HL as they transition from vocal play and babble to referential use of words. The overall goal is to examine the impact of phonetic delays on expressive vocabulary growth in infants with varying degrees of HL.

Children with Normal Hearing

Although it was once thought that babble and meaningful use of speech were unrelated (Jakobson, 1968; originally 1941), there is considerable evidence supporting the influence of babbling on early word production (McCune & Vihman, 2001; Oller, Weiman, Doyle, et al., 1976; Stoel-Gammon, 1998a, 1998b; Vihman, 1996). First words generally include syllable types and consonants mastered during earlier vocal stages (Ferguson & Farwell, 1975). Several studies document overlap in the sounds of babble and children’s early words (Ferguson & Farwell, 1975; McCune & Vihman, 2001; Menn, 1976, Reference Note; Stoel-Gammon & Cooper, 1984; Stoel-Gammon, 1989). Stoel-Gammon (1998b) analyzed the developmental order of words on the MacArthur-Bates Communication Development Inventory (MCDI: Fenson, Dale, Reznick, et al., 1993) in relation to early consonant inventories. She found considerable correspondence between the typical sounds of babble and words that emerged earliest on the MCDI, with bilabials occurring most frequently in early words.

Another major contributor to the transition to words is the child’s stabilization of vocal-motor control (McCune & Vihman, 2001). Stable consonant production in the prelexical vocal period prepares the child for word production. McCune & Vihman (2001) analyzed the development of vocal motor schemes* in 10 children with NH from 9 to 16 mo of age. Results confirmed a close interaction between phonetic skills and early lexical development. They concluded that perceptual, cognitive, social and vocal-motor resources collaborate to support the transition from prelexical to lexical stages of development. A growing social understanding that words can convey meaning to others motivates infants to express ideas. An increasing representational knowledge (e.g., knowing that a word represents an object) helps infants map perceptual learning onto words.

Consonant use in prelexical vocalizations has been shown to be a consistent predictor of speech onset (Menyuk, Liebergott, & Schultz, 1986; Stoel-Gammon, 1998a) and of longer-term speech development (Vihman & Greenlee, 1987). Additional evidence of the contribution of consonant and vocal-motor development to word production comes from studies of late talkers with NH. Late talkers are delayed in the onset of CV syllable use, and are different from typically developing children in consonant inventory size and in the complexity of syllable structures (McCune & Vihman, 2001; Paul & Jennings, 1992; Pharr, Ratner, & Rescorla, 2000; Rescorla & Bernstein-Ratner, 1996; Stoel-Gammon, 1989; Stoel-Gammon, 1991; Whitehurst, Smith, Fischel, et al., 1991). Word learning studies provide further evidence. Schwartz & Leonard (1982) trained children to produce nonsense words over several sessions. Half of the trained words included consonants and syllable structures within each child’s inventories (IN words) and half were outside their inventories (OUT words). Although children produced a higher number of IN words, comprehension was equivalent for both IN and OUT words. These findings support the influence of phonological development on early expressive vocabulary.

During the single-word stage, children typically produce a mix of babble, jargon, unintelligible word attempts (called “possible words” by Otomo, 2001), and words (Elbers & Ton, 1985; Oller, 2000; Robb, Bauer, & Tyler, 1994, Stoel-Gammon, 1989; Vihman, Macken, Miller, et al., 1985). Words at this stage include simple syllable structures (CV, CVC, or CVCV), and are often most recognizable by family members (Stoel-Gammon, 1998a). From a research standpoint, it is of interest to identify which toddler vocalizations are true words and protocols have been developed to support this process in NH children (Otomo, 2001; Vihman & McCune, 1994). This is not a trivial matter when examining the development of toddlers with HL, whose word attempts may be poorly formed (Oller, 2000).

Robb et al. (1994) conducted a longitudinal analysis of the transition from prelexical vocalizations through the single word stage in six typically developing children. Results showed quantitative increases in the ratio of words to nonwords (e.g., babble, jargon, unintelligible word attempts) between 12 and 18 mo of age. Interestingly, ratios close to 1.00 were associated with the 10-word stage, and ratios >2.00 were linked to the 50-word stage. These findings point to a dynamic interaction between early phonological development and language learning. Although infant babble facilitates the produc-

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*Vocal motor schemes (VMS) were defined as 10 occurrences of a consonant in at least 3 out of 4 recorded sessions in a month. VMS is a measure of stability of consonant use.
tion of early words, at later stages the drive to learn and say new words also facilitates further phonological development (Stoel-Gammon, 1998a). For early-identified infants with HL, little is known about the influence of phonetic delays on the transition to phonological mastery. Examination of this transitional period also may be useful in identifying children with slower than expected developmental trajectories.

At 2 yr of age, children with NH are continuing to develop phonological skills, and intelligibility is typically limited. Stoel-Gammon (1998a) notes that typically-developing 24-mo olds do not have fully developed phonological systems, even though they have established the basic syllable shapes and sound classes. Coplan & Gleason (1988) found that children of this age can be understood about 50% of the time by strangers. Familial understanding is likely greater than this. It is important to note that intelligibility of words is affected not only by the child’s phonological skills but also by language abilities (Kent, 1993; Stoel-Gammon, 1998a). Stoel-Gammon (1998a) emphasizes that a child producing short utterances may appear more intelligible than one who is producing phrases at this age.

**Children with Hearing Loss**

Only recently have studies focused on the manner in which early-identified deaf infants who received early cochlear implants progressed from prelexical vocalizations to first words (Ertmer & Mellon, 2001; Ertmer, Strong, & Sadagopan, 2003; Warner-Czyz, Davis, & Morrison, 2005). Warner-Czyz et al. (2005) followed a child who received a cochlear implant at 24 mo over a 14-mo period to examine the influence of motor production and auditory skills on phonetic inventory and word production accuracy. Although consonant production increased markedly by 9 mo after implantation, the child’s phonetic inventory did not expand and was dominated by labials (e.g., [p], [w]) and stops (e.g., [t], [b]). Although labials dominated preimplant word productions, alveolars (e.g., /t/, /a/) and stops were most frequent in word productions at 7 and 9 mo after implant. Throughout the study, this child exhibited poor word-level accuracy (defined as a correct correspondence of all consonant and vowels with the target word). Vowel accuracy was greater than that of consonants. In general, degree of accuracy in word production for this child was markedly different than norms for children with NH at similar ages.

Ertmer & Mellon (2001) documented vocal and verbal changes in a single deaf female who received a cochlear implant at 20 mo of age. Results showed large increases in syllable production and complexity after 5 mo of cochlear implant use, with production of 90 different words after 1 yr of cochlear implant experience. In a follow-up study with the same child, Ertmer et al. (2003) documented typical or better rates of development in some aspects of speech and language learning (e.g., decreased production of nonwords, receptive language, use of word combinations). However, this child’s rate of development was considered below normal in speech intelligibility, variety of word types, and grammatical complexity. Taken together, these three case reports suggest that enhanced perceptual access provided by cochlear implants facilitates the expansion of phonetic inventories and syllable complexity. The transition to accurate and intelligible word production appears to progress more slowly in children with HL than in children with NH.

Further studies are needed to understand the ways in which limited phonetic inventories, limited motor practice, and reduced perceptual access may contribute to expressive vocabulary delays in children with HL. To date, studies of the transition from prelexical vocalizations to word production and then word accuracy have focused on a limited number of subjects and primarily those with cochlear implants. The current study was designed to compare this transition in early-identified infants with varying degrees of HL to a group of age-matched infants with NH. Overall goals were to address the following questions: 1) Are there relations between prelexical and early phonological behaviors and later vocabulary and speech production skills in children with NH and HL? 2) How do infants with HL compare with NH children in the ratio of words to other vocalizations (e.g., jargon, babble, unintelligible word attempts) at 16 and 24 mo of age? 3) How do the words produced at 24 mo of age by children with NH and HL compare in structural complexity and accuracy?

**Methods**

**Participants**

Twenty-one children with NH and 12 children with bilateral sensorineural HL participated in this longitudinal study. These are the same participants who were described in Moeller et al. (2007). The NH group included 11 girls and 10 boys who were enrolled in the study at 4 mo of age and followed longitudinally until at least 36 mo of age. All children were verified to have normal hearing and were from homes in which English was the primary spoken language.
The group with hearing loss included 12 children (six boys and six girls) who were identified before 12 mo of age ($M = 2.5$ mo). All children had bilateral sensorineural hearing loss; the mean better-ear, pure-tone average (PTA) was 67 dB HL (SD: 26 dB, range: 38–NR). Eight of the 12 children contributed data at each sampling point from 10 to 36 mo. Three children did not enter the study until 15, 17, and 19 mo of age and thus only contributed data in the latter half of the second year of life and at 36 mo. One child relocated before the end of the data collection period and then returned, contributing data from 10 to 16 mo and again at 36 mo. Audio- logical, amplification, and family characteristics were described in the first paper of this two-part series (Tables 1 and 2 in Moeller et al., 2007). Typical developmental status for children with HL was verified through Individual Family Service Plan assessment records. All children (NH, HL) received ongoing monitoring of play development. All infants with HL were enrolled in early intervention services through local public or private education programs. There were no significant between-group differences in socioeconomic status ($p = 0.08$) or level of maternal education ($p = 0.22$), measured using Nittrouer’s (1996) modification of the Hollingshead (1965) two-factor index. All children came from two-parent homes, except one child with HL who was being raised by his mother only. Across both groups, 32 mother/child dyads were white, one dyad was black; all participants were non-Hispanic.

Data Collection

Both groups of children were seen every 6 wk from 4 to 10 mo of age, every 2 mo from 12 to 36 mo of age, and at 6-mo intervals after 3 yr of age. The period from 10 to 30 mo and the Goldman-Fristoe articulation scores collected at 36 mo constituted the primary data set for the analyses of interest for the current paper. The children’s vocal and early verbal development was monitored by obtaining 30-minute video and audio recordings during parent-child interaction sessions conducted in a laboratory playroom setting. See Moeller et al. (2007) for additional details regarding data collection.

Transcript Preparation and Coding

Procedures for the transcription of the longitudinal vocal samples (ages 10–24 mo) were described in detail in Moeller et al. (2007). Fifty utterances from each session were analyzed using broad phonetic transcription (including diacritical marks) for all vocalizations and verbalizations, with exclusion of screams, cries, grunts, burps, laughs, or vegetative vocalizations. Transcription was conducted by six trained researchers, who used consensus transcription (Shriberg, Kwiatkowski, & Hoffman, 1984), in teams of two.

Analysis of Utterance Types

During the period of 10 to 24 mo, most of the infants transitioned from vocalizations to true word production. Between 16 and 24 mo, their spontaneous speech samples typically included a mix of vocal play, babble, jargon (complex variegated babbled sequences with the intonation contours of spoken phrases), unintelligible communicative utterances, and words or word attempts. Additional analyses were conducted to examine the communicative nature of vocalizations in the transitional period from preverbal to verbal development in both groups. Recorded samples from 16 and 24 mo of mother-child interactions were viewed by a team of two researchers, who examined the context and coded all utterances into the following mutually exclusive categories.

1. Noncommunicative. Although these vocalizations were speechlike, they served a function of vocal play rather than intentional communication. Vocal behaviors in this category included babble and jargon that was not directed to the adult and was not an attempt at conveying meaning.

2. Unintelligible communicative attempts. According to the rules of Wetherby & Prizant (1993), a vocal behavior is a communicative act if it is: a) directed toward an adult (e.g., looking and/or gesturing while vocalizing) and b) serves a communicative purpose (e.g., directing an adult to do something, calling attention to an object, seeking adult attention). This category included a range of vocalizations that met these criteria, some of which may have been word attempts but were not recognized as words by the mother or the transcription team.

3. Words. Infant word attempts are usually simplified versions of the adult form, and often parents will recognize phonetically-consistent forms as a meaningful word (e.g., /baba/ for bottle). The determination that a young child has produced a true word is challenging, at best, and requires consideration of phonetic details, as well as communicative and contextual issues (Otomo, 2001; Vihman & McCune, 1994). In the current study, children’s utterances were called words when: 1) the phonetic characteristics of the word attempt matched the target word for at least one consonant (by manner/place) and at least one vowel and/or syllable structure matched, 2) the utterance
was a communicative act, and 3) it was clear from the context that child was attempting a word (e.g., a clear referent was present or child was imitating the parent or responding to a parental comment) and the parent recognized the word and/or repeated it (determined from context).

A proportional score was calculated by dividing the number of utterances in each category by the total number of utterances in the sample (50).

Reliability
The reliability of coding decisions was assessed for 20% of the samples at 16 and 24 mo. Cohen’s $k$ for interjudge classifications of utterances as “noncommunicative,” “communicative but unintelligible,” and “words” were 0.85 at 16 mo and 0.87 at 24 mo. Because the original classifications were conducted by team consensus, intrajudge reliability was verified by asking team members to independently reclassify 20% of their previously scored samples. Kappa values for intrajudge reliability were 0.83 for 16 mo and 0.85 for 24 mo.

Structural Characteristics of Words at 24 Mo
Spontaneous words produced at 24 mo were analyzed further to determine if both groups of children were advancing to word production in similar ways. Because the children with HL had fewer phonetic resources (e.g., smaller consonant repertoires), it was hypothesized that this may play a role in the structural complexity and accuracy of their early word productions. All utterances determined to be words were entered phonetically into Profile of Phonology (PROPH), a software application of Computerized Profiling (Long, Fey, & Channell, 2004). Twenty-five words were selected randomly from each child’s transcripts for this analysis. The goal was to equalize the sample sizes across groups for purposes of comparison; and 25 words has been suggested as a minimum adequate sample size for this analysis (Ingram, 2002). However, some children did not produce 25 spontaneous words within the 50-utterance sample. In those cases, additional utterances from the half-hour session were examined by the transcription team to reach the target sample size. In spite of this procedural modification, 3 children (2 NH, 1 HL) had samples containing only 15 analyzable words. Three other children (1 NH, 2 HL) produced no words and were assigned scores of zero for the measures of interest. In the PROPH program, a phonetic transcription of a target word (e.g., the correct form of the word) is compared with a transcription of the child’s actual production to derive a variety of structural statistics. Measures included in the analysis were:

1. Mean Syllable Structure Level in Words (MSSL-W). This measure examines the structural complexity of syllable types in the words the child produced. Each word in the 25-word sample was examined for syllables at three levels from simple to complex (1 = vowels and glides; 2 = CV syllables with one consonant type; 3 = CVC or CVCV syllables with more than one consonant type). Levels 2 and 3 involve syllables with true consonants. The scores were then averaged by PROPH to derive the MSSL-words.

2. Percentage of Vowels Correct. This measure reflects the percentage of the time that the vowels in the child’s production matched the target word.

3. Percentage of Consonants Correct (PCC). This metric, originally described by Shriberg & Kwiatkowski (1982), is a measure of the number of consonants in the child’s utterance that matched the target word (/ʃu/ for shoe = 1/1 consonants correct; /tu/ for shoe = 0/1). In this study, the PCC measure was adapted for use with single words.

4. Phonological Mean Length of Utterance (PMLU). According to Ingram (2002), PMLU measures the word length of the child’s attempt and the number of consonants correct. This is useful in identifying children who attempt longer words, but vary in the correctness of the forms and those who attempt only short words, but do so accurately. Each consonant and vowel the child produces to form a word receives one point, with additional points given for each consonant that was produced correctly. Therefore, a higher PMLU reflects both length and accuracy of word productions. For example, cat produced correctly receives 5 points (one for each consonant and vowel plus 2 for the correctly produced /k/ and /t/); cat produced as /dae/ would receive only 2 points (one for the consonant and vowel, no extra points for consonant accuracy).

5. Proportion of Whole Word Proximity (PWWP). This score is derived by calculating the PMLU of the target word (5 for cat) and dividing it into the PMLU of the words actually produced (3 for substituting /dae/ for cat; 3/5 = .6). This is an overall reflection of how closely the child approximated the actual word as well as an indirect measure of word intelligibility (Ingram, 2002).
6. Word Shape Match. This measure compares the target form of the word (e.g., CVC or CVCV) to the actual production (/di/ for cookie substitutes a CV for a CVCV and is not a match).

7. Words with Final Consonants. Word attempts were examined to determine if final consonants were used in words (or syllables in two-syllable words) where they were expected (/got/ for goat). The child was credited for attempting to close the syllable with a consonant even if it was not fully accurate (i.e., consonant voicing changes).

Vocabulary Comprehension and Production:

At the 10-mo visit, parents were oriented to the MacArthur-Bates Communicative Development Inventory or MCDI (Fenson et al., 1993), a parent-report measure of early lexical development. They were asked to complete it at home after every laboratory visit (6- to 8-wk intervals). The MCDIs were to be returned within 1 wk of the visit and reminders were sent if forms were not returned promptly. A research coordinator regularly responded to parental questions about the MCDI, and provided assistance in completing the forms where needed. The MCDI Words and Gestures Form (Form 1) was used with most of the hearing children through 16 mo, after which, parents were asked to complete the Words and Sentences Form (Form 2). The Words and Gestures Form includes maternal estimates of children's vocabulary understanding and production, whereas the Words and Sentences Form measures only expressive vocabulary. In cases where children (HL or NH) had limited vocabularies, Form 2 was introduced only after more than half of the words (~198) on Form 1 were reported as produced. From these data, a measure of total words produced was calculated at each age. When a child was using both speech and sign, parents were asked to code the MCDI for expressive use in sign, speech or both. Two mothers reported sign only, and some analyses are adjusted by excluding these sign-based samples.

To determine the relations between early phonetic measures and later speech production in words, the Goldman-Fristoe Test of Articulation-2 (Goldman & Fristoe, 2000) was administered individually to each child in its standard format at 36 mo of age. Spontaneous productions elicited in the picture naming task were transcribed to yield Standard Scores for consonant production.

**RESULTS**

**Purposeful Communication and Early Vocabulary**

Changes over time in the purposeful use of voice were examined for both groups. Figure 1 illustrates the proportions of vocalizations within a 50-utterance sample that were classified into the three mutually exclusive categories at 16 and 24 mo of age: 1) noncommunicative vocalizations, 2) unintelligible communicative attempts, and 3) recognizable words or word attempts. At 16 mo, unintelligible communicative attempts were predominant for the NH children, but noncommunicative vocalizations were most common in the HL group. Two-way repeated-measures ANOVA, with group as the between subjects factor and age as the within subjects factor, revealed a significant decrease in noncommunicative vocalizations with age \[ F(1, 29) = 40.99, p = 0.001 \], a main effect for group \[ F(1, 29) = 6.44, p = 0.02 \], and no group × age interaction \[ F(1, 29) = 0.32, p = 0.58 \]. At 24 mo, the predominant category for the NH children was words, whereas unintelligible communicative attempts were most common in the HL group. Two-way repeated-measures ANOVA, with group as the between subjects factor and age as the within subjects factor, revealed a significant decrease in noncommunicative vocalizations with age \[ F(1, 29) = 40.99, p = 0.001 \], a main effect for group \[ F(1, 29) = 6.44, p = 0.02 \], and no group × age interaction \[ F(1, 29) = 0.32, p = 0.58 \]. At 24 mo, the predominant category for the NH children was words, whereas unintelligible communicative attempts were most frequent for the children with HL. Recognizable words increased with age \[ F(1, 29) = 68.6, p = 0.001 \] and there was a significant group effect \[ F(1, 29) = 20.87, p = 0.001 \]. However, the group × age in-
action was significant \(F(1, 29) = 20.64, p = 0.001\). Post hoc Bonferroni adjusted comparisons revealed that the NH children demonstrated significantly larger increases in the proportion of words used compared with the HL group at 16 (\(p = 0.02\)) and 24 (\(p = 0.001\)) mo of age. Delays in development of vocal milestones may contribute to the slower emergence of clear word attempts in the HL group. Interestingly, the pattern of production at 24 mo for the children with HL is similar to that of the NH children at 16 mo, suggesting a pattern of delayed but parallel performance. The extent to which all of the children were able to produce recognizable words at 24 mo was strongly and positively related (\(r = 0.83, p < 0.01\)) to Goldman-Fristoe articulation scores at 36 mo.

### Structural Characteristics of Words

Structural statistics for words produced at 24 mo are summarized in Table 1. One-way ANOVAs with hearing as the between subjects factor revealed that children in the NH group were significantly more advanced than children in the HL group on all the structural measures including: 1) Mean SSL for words \(F = 10.37, p = 0.003\), 2) Percent Vowels Correct \(F = 10.15, p = 0.004\), 3) Percent Consonants Correct \(F = 12.21, p = 0.002\), 4) PMLU, \(F = 10.46, p = 0.003\), 5) PWWP, \(F = 10.37, p = 0.003\), 6) Word Shape Match, \(F = 8.92, p = 0.006\), and 7) Final consonants in words, \(F = 11.47, p = 0.002\).

These findings suggest that the words attempted by NH children at 24 mo were structurally more complex, and more accurate in terms of consonant and vowel production and syllable shape than for age-matched children with HL. The effect sizes indicate that the groups differed by more than 1 standard deviation on PCC, Vowel accuracy, PMLU, Word Shape Match, and use of Words with Final Consonants.

Even though the children with NH were attempting to produce more complex forms, their accuracy was high relative to the children with HL. These findings are illustrated in Figure 2, where PCC is plotted as a function of the PMLU measure. Note that at 24 mo, the range of PMLU scores for NH children is 0 to 6.0 and percentage of consonants correct increases with PMLU. In contrast, the HL group falls at the lower range of normal for both PMLU and percent consonants correct. In an analysis of babble in these same children (Moeller et al., 2007), age-matched children with NH had larger consonant repertoires and greater syllable complexity than the children with HL. It is possible that the transition from babble to word representations was delayed in the HL group because of reduced consonant inventories and less experience in production of a variety of syllable forms.

### Receptive and Expressive Vocabulary Development

Repeated-measures ANOVA of the MCDI data (with age as the within-subjects variable and group as the between-subjects variable) revealed signifi-

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**TABLE 1. Comparison of NH and HL groups on six measures of structural complexity and accuracy of words produced at 24 mo of age**

<table>
<thead>
<tr>
<th>Word-level measure</th>
<th>NH (n = 21)*</th>
<th>HL (n = 11)*</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Syllable Structure Level</td>
<td>2.30 (0.62)†</td>
<td>1.65 (0.83)</td>
<td>0.89</td>
</tr>
<tr>
<td>Percent of Vowels Correct</td>
<td>73.42 (21.31)†</td>
<td>48.82 (27.2)</td>
<td>1.01</td>
</tr>
<tr>
<td>Percent Consonants Correct (PCC)</td>
<td>57.75 (21.12)†</td>
<td>32.00 (18.5)</td>
<td>1.3</td>
</tr>
<tr>
<td>Phonetic Mean Length of Utterance (PMLU)</td>
<td>4.11 (1.38)†</td>
<td>2.54 (1.35)</td>
<td>1.15</td>
</tr>
<tr>
<td>Proportion of Whole Word Proximity (PWWP)</td>
<td>75.08 (19.76)†</td>
<td>54.56 (27.88)</td>
<td>0.85</td>
</tr>
<tr>
<td>Word Shape Match</td>
<td>71.19 (21.23)†</td>
<td>46.97 (27.11)</td>
<td>1.0</td>
</tr>
<tr>
<td>Percent Words with Final Consonants</td>
<td>39.45 (25.7)†</td>
<td>12.18 (8.84)</td>
<td>1.4</td>
</tr>
</tbody>
</table>

* Two children with HL and one with NH produced no words at 24 mo; they were assigned scores of zero for these analyses. S9 from the HL group is not included because she did not participate in the 24-mo sampling session.

† \(p < 0.01\).
significant changes in receptive vocabulary with age from 10 to 16 mo \( F (3, 78) = 52.13, p = 0.001 \), but no significant effect of group \( F (1, 26) = .16, p = 0.69 \) and no age \( \times \) group interaction \( F (3, 78) = 1.95, p = 0.16 \). The MCDI measures comprehension only through 16 mo of age, because it is challenging for parents to report children’s understanding once language skills begin to advance rapidly. As illustrated in Figure 3, both groups showed changes in receptive vocabulary over this time period. For selected children with HL, the mothers reported word comprehension based on signs rather than spoken words. However, if the two sign-dominant children (S7, S5) are removed from the analysis, the results are unchanged. Nonetheless, a few other children had exposure to some signing at early ages, which may have contributed to these findings. Although receptive vocabulary for the NH group appears to accelerate and diverge from the HL group by 16 mo, these differences were nonsignificant.

Repeated-measures ANOVA revealed that expressive vocabulary (MCDI) increased significantly with age from 16 to 24 mo \( F (4, 88) = 24.28, p = 0.001 \). Two subjects with HL were excluded from this analysis because their scores were based on sign language rather than spoken language. For a third subject with HL, the interventionist’s scores on the MCDI were used due to poor correspondence between the maternal report and the child’s expressive behaviors in the laboratory or during parent-infant sessions. There was a main effect for group \( F (1, 22) = 5.02, p = 0.02 \) and no age \( \times \) group interaction \( F (8, 88) = 4.6, p = 0.001 \). Results indicate that, on average, vocabulary grew at a slower rate in the HL group than in the NH group. Figure 4 shows longi-

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![Figure 3](image1.png)

**Fig. 3.** Means and standard deviations for receptive vocabulary (MCDI) as a function of age for the NH and HL groups.

![Figure 4](image2.png)

**Fig. 4.** Expressive vocabulary data from the current study (upper panels) are compared with data from Mayne, Yoshinaga-Itano, Sedey, & Carey (2000) on children with HL and from the MacArthur-Bates CDI norms for NH children. Filled circles on the upper left figure (HL) signify children with cochlear implants; these are longitudinal vocabulary scores for 10 children with HL (2 of 12 children with HL were omitted because their CDI data were based on signs).
tudinal MCDI expressive vocabulary data for children with HL and NH in the current study (top panels) in relation to primarily cross-sectional data for children with HL from Mayne, Yoshinaga-Itano, Sedey, et al. (2000) and the MacArthur-Bates norms for NH children (lower panels). Specifically, longitudinal trajectories for the children with HL in the current study (top left panel) are compared with the 25th to 90th percentiles from the other two primarily cross-sectional data sets. The pattern of results for the HL group in the current study bears close resemblance to the data from Mayne, Yoshinaga-Itano, Sedey, et al. (2000). Specifically, there is considerable variability in performance, but both the average (50th percentile) data from Mayne, Yoshinaga-Itano, Sedey, et al. (2000) and the individual data in the current study suggest a much slower rate of early vocabulary development compared with NH children.

**Atypical Performers in the Data Set**

In Moeller et al. (2007), 6 children (2 NH, 4 HL) were described as atypical because they differed from their respective groups’ performance by >1.5 to 2.0 standard deviations on selected phonetic measures. The goal of this analysis was to identify early markers that might signal greater than expected delays in performance. Further analysis of atypical performance was pursued in the current paper, with a focus on the transition to word production and word accuracy. Mean data for young children with HL can be difficult to interpret due to large individual differences in performance that are even more extreme than noted in typical development. Greater understanding of atypical performers may assist with the interpretation of outcomes.

Figure 5 illustrates a comparison of three groups (typical children with NH or NH-typical; typical children with HL or HL-typical; and children with NH or HL with atypical findings or NH+HL-atypical) on measures of vowel accuracy, PCC, PWWP, and Word Shape Match. One-way ANOVAs with group as the between-subjects variable revealed significant main effects for all measures. Bonferroni-adjusted post hoc comparisons revealed that the percent scores of children in the atypical group were significantly lower than both other groups for vowel accuracy \(p < 0.02\) and PWWP \(p < 0.001\). Atypical group performance on PCC \(M = 20.16\) was significantly different from the NH children \(M = 61.82; p = 0.001\) but not from the typical children with HL \(M = 38.44; p = 0.184\). Word shape match showed a similar pattern of results, with significant differences between NH \(M = 75.7\) and atypical groups \(M = 34.5; p < 0.001\), but the atypical group was not significantly different than the typical HL group \(M = 52.18; p = 0.384\). Children in the atypical group also performed significantly below both other groups on measures of syllable structure level (SSL) in words \(NH M = 2.43, HL M = 2.07, atypical M = .98; p < 0.003\) and PMLU \(NH M = 4.36, HL M = 3.3, atypical = 1.34; p < 0.007\). The findings provide some insight into measures that might be sensitive to greater than expected delays in development.

In interpreting results, it is important to consider that when the atypical performers were excluded from the analysis, the typical children with HL did not differ significantly from the NH group on several measures, including Vowel accuracy \(p = 0.065\), SSL of words \(p = 0.435\), PMLU \(p = 0.089\) or PWWP \(p = 0.301\). However, their performance was comparable to the atypical group on measures of PCC \(p = 0.184\) and Word Shape Match \(p = 0.384\).

Receptive vocabulary data from the MCDI were examined for the same three groups from 10 to 16 mo. A repeated-measures ANOVA with age as the within subjects variable and group as the between subjects variable revealed significant improvements with age, \(F(3, 75) = 46.77, p = 0.001\) and no age × group interaction \(F(6, 75) = 1.20, p = 0.322\). Between group effects did not achieve significance \(F(2, 25) = .013, p = 0.988\) for this measure.

Figure 6 illustrates the developmental trajectories for MCDI expressive vocabulary scores for the three groups as a function of age (at 16, 18, 20, 22, and 24 mo). Repeated-measures ANOVA revealed a
at 10 to 12 mo (scores at 36 mo included 1) proportion of SSL2 forms were found to be significantly related to speech 14 to 16 mo at Step 2. Early vocal measures that of regressions entered proportion of SSL1 forms at 10 to 12 mo entered at Step 2. A second set forms at 14 to 16 mo were entered at Step 1, with proportion of SSL2 * MCDI expressive vocabulary scores at 22 to 24 lary.* MCDI expressive vocabulary scores at 22 to 24 individual developmental differences in vocabu-

scores at 36 mo, after controlling for the influence of outcomes. This section describes a series of hierar-
chical multiple regression analyses were con-
ducted to determine if selected early vocal measures would predict unique variance in Goldman-Fristoe Scores at 36 mo, after controlling for the influence of individual developmental differences in vocabulary.8 MCDI expressive vocabulary scores at 22 to 24 mo were entered at Step 1, with proportion of SSL2 forms at 10 to 12 mo entered at Step 2. A second set of regressions entered proportion of SSL1 forms at 14 to 16 mo at Step 2. Early vocal measures that were found to be significantly related to speech scores at 36 mo included 1) proportion of SSL2 forms at 10 to 12 mo (t = 3.55, p = 0.002), accounting for 25.7% of the variance; the full model explained 53.1% of the variance; and 2) proportion of SSL1 forms at 14 to 16 mo (t = −3.27, p = 0.003), accounting for 21.7% of the variance; the full model explained 51.3% of the variance.

Hierarchical multiple regression procedures were used to determine if an early measure of consonant accuracy (PCC at 24 mo) was related to expressive vocabulary development at 30 mo. It was reasoned that such a relationship would provide further insight into contributions of consonant mastery to lexical development. Before testing the relationship between consonant accuracy and vocabulary, variance explained by the complexity of the word attempt and its match to the target word shape was partialed out in an effort to test the independent contribution of consonant accuracy. Four measures (SSL, PMLU, PWWP, and Word Shape Match) were significantly and positively correlated with each other at levels >0.70. Therefore, principal components analysis was used to create a single standardized score reflecting word complexity/accuracy. The goal of this procedure was to derive one economical variable that was representative of the two separate variables (and in this case, two early time points). This analysis forms a summary score by producing a weighted linear combination of the original variables. This derived factor score represented a majority of the variance in the independent scores (0.978, 0.953, 0.974, 0.959, respectively). The word factor score was entered at Step 1 with MCDI expressive vocabulary at 30 mo as the dependent variable. This model was significant, explaining 47.1% of the variance in vocabulary (p = 0.001). PCC was entered at Step 2, and it explained an additional 18.7% of the variance, after controlling for the other word level speech measures. This finding was significant (t = 3.553, p = 0.002), and the full model explained 65.8% of the variance (R2 = 0.658).

Previous research has demonstrated that late onset of canonical babble can predict a delay in the onset of speech production and vocabulary (Oller, Eilers, Neal, et al., 1999). A third set of regressions explored the relationships between onset of consistent babble (see Moeller et al., 2007) and MCDI. With the word factor score entered at Step 1, the model was significant (F = 21.37, p = 0.001) and 47.1% of the variance in MCDI expressive scores was explained. Age of consistent babble was entered at Step 2, and an additional 12.7% of significant variance was explained (Full model $R^2 = .598; t = −2.70, p = 0.013$).

**DISCUSSION**

**Proportion of Words Versus Other Vocalizations**

Consistent with the finding of early phonetic delays (Moeller et al., 2007), the children with HL

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**Fig. 6. Means and SDs for MCDI expressive vocabulary scores for three groups (NH-typical, HL-typical, NH/HL-atypical) as a function of age.**

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*The original goal was to partial out background variables, such as maternal education and socioeconomic status. However, in this population, the variables did not contribute significant variance to the model.
were slower than NH peers to produce words that were recognized as such by their mothers during observational sessions. Robb et al. (1994) demonstrated systematic increases in the ratio of words to nonwords as a function of age in NH children, with rapid advances in word use once children achieved a W:NW ratio of 1.0. The current study used a similar but expanded analysis to examine this transitional stage in development. It was hypothesized that, during this period, both groups of children would attempt words that may not be clear to their mothers. However, by virtue of their phonetic delays, children with HL would exhibit this behavior more frequently. At 16 mo, the infants with HL produced a large proportion of vocalizations judged to be non communicative. It is important to clarify that these children with HL often engaged in communicative exchanges with their mothers at this age point. However, they often did so using gesture, eye gaze, or for some children, formal signs. They were less likely than their NH age-mates to use vocal communicative means. Their non communicative utterances reflect development at earlier vocal stages (i.e., vocal play not directed at an adult). Both groups of children reduced the proportion of non-communicative vocalizations between 16 and 24 mo, with concomitant increases in communicative vocalizations and word attempts.

As hypothesized, the children with HL produced fewer recognizable words at 24 mo than NH children. The largest proportion of utterances for the HL group was in the unintelligible communicative attempts category. Although the children with HL made numerous attempts at communication, they were delayed in their ability to form syllables that were close enough approximations to adult forms to be recognized. This may affect the degree to which the caregiver can respond to the child in a contingent manner (Otomo, 2001). Further research is needed to determine the extent to which children’s reduced clarity of word attempts influences the quality of maternal responses. If a child with HL is slower to develop the consonantal repertoire, then production experience may be less varied, resulting in a smaller pool of syllables that become segments in word attempts. A history of limited auditory experience appears to influence the developmental time course of clear representations of target words in the lexicon.

Over time, children’s word attempts come closer to the target form, allowing them to be recognized in context-supported situations. Increasing accuracy in word attempts may provide the child with maternal feedback that supports continued phonological development (Otomo, 2001). In the current study, the extent to which children were able to produce recognizable words at 24 mo was strongly and positively related ($r = 0.83, p < 0.01$) to Goldman-Fristoe scores at 36 mo for both groups; children who produced more clear words at 24 mo had better Standard Scores in articulation at 3 yr of age. Further longitudinal study over a longer time period is needed to determine which children recover from early phonetic delays and which demonstrate continued problems. Greater understanding of the ways in which mothers may support this learning is needed. Studies of development from 24 to 48 mo will provide additional insight into individual differences in word accuracy and maternal support for speech development. For example, two of the three children with Cochlear Implants in the current study made rapid gains toward intelligible spoken word production in the period from 24 to 36 mo, supporting work reported by Ertmer et al. (2003) and Nicholas & Geers (2006).

**Structural Complexity and Accuracy**

On average, by 24 mo of age, the NH children were more advanced in phonetic, phonological, and language skills than the children with HL. It is not surprising, then, that the children with NH demonstrated greater accuracy in word production at this age. The children with NH produced word attempts that were more structurally complex and segmentally accurate (higher scores for consonant and vowel accuracy) than the children with HL. Consistent with data from Stoel-Gammon and Herrington (1990), the NH children achieved a high degree of vowel accuracy. Although the children with HL were nearly comparable to the NH children in vowel inventory size (Moeller et al., 2007), they were less accurate, on average, in using vowels in words. These differences, however, were no longer statistically significant when the children with atypical development were excluded. The findings indicate that typically developing children with HL were comparable to NH infants in vowel accuracy in early words. Ertmer & Mellon (2001) reported improvements in vowel accuracy in a deaf child after cochlear implantation, which he attributed to the greater perceptual salience of vowels.

The perceptual salience of consonants may be differentially affected by noise, reverberation and distance in everyday situations. The results of the current study indicate that, at 24 mo, the NH children achieved greater accuracy in their use of consonants in words than children with HL. It might be reasoned that this difference can be accounted for by the overall delays in expressive development exhibited by children in the HL group. However, the typical children with HL performed more like the
atyypical group than the NH group on percentage of consonants correct and word shape match (with many final consonant deletions). This may suggest that consonant development is more challenging for children with HL than other phonetic-phonological transitions. The results of the regression analysis provide additional support for this impression. Both consonant accuracy at 24 mo and age of onset of consistent canonical babble predicted unique variance in MCDI scores at a later age (30 mo). Although causality cannot be assumed based on correlational findings, it may be that earlier, accurate and flexible consonant use facilitates word learning. These findings provide further support for the continuity theory of early speech development (Vihman, 1996).

Children with HL produced fewer final consonants in their word attempts than NH peers. It is possible that the effects of noise and reverberation may make it difficult for children with HL to perceive ending sounds in their own speech or the speech of others. This explanation may be supported by the fact that final consonants are typically less intense in words and therefore less audible to children with HL. However, similar deficits in word closure have been observed in late talkers (Pharr et al., 2000), which suggests an alternative explanation; it is possible that this measure is sensitive to general delays in phonetic development. When interpreting the results of the current study, it is important to consider that the children in the two groups were at different language stages when compared for word production at the same age (24 mo). The children with NH had been producing words for a longer developmental period, which would provide a greater experience base for the production of closed syllables. Further, consonant closure has also been found to be later-emerging in typically developing infants by Nathani, Ertem & Stark (2006). Thus, reduced use of final consonants by the children with HL may be a reflection of phonetic delays. Further research is needed to understand the contributions of devices (cochlear implants, hearing aids) and behavioral interventions to development of consonant closure in words.

**Relationships Between Early Skills and Later Vocabulary**

The NH and HL groups did not differ in receptive vocabulary on the MCDI. This finding could be interpreted in a number of ways. It may be that early identification and amplification support typical rates of receptive vocabulary development for early words. If this is the case, the overall results suggest that hearing loss has a greater impact on vocal/expressive language learning than word comprehension. However, given the wide ranges in vocabulary performance at early ages, it is important to exercise caution until later ages are examined. It is possible that receptive vocabulary measures at early ages are less sensitive to between group differences than other measures (e.g., syllable complexity, accuracy in consonant use). Interestingly, the receptive vocabulary results for the children with HL in the current study are comparable to 75th percentile scores for 118 children with HL reported in Mayne, Yoshinaga-Itano, & Sedey (2000). Because a child’s comprehension can be difficult to judge, it is possible that some mothers in the current study overestimated their children’s understanding, and with small sample sizes, this could result in inflated average scores. This possibility has been reported elsewhere (Tomasello & Mervis, 1994). Some mothers may have judged comprehension based on sign understanding, although the overall pattern of results was the same when two children who were dominant signers were removed from the analysis.

Results for spoken vocabulary development (MCDI) confirm earlier reports documenting delays with wide individual differences in outcomes for infants with HL (Mayne, Yoshinaga-Itano, Sedey, et al., 2000; Nicholas, 2000). There are close parallels between the data from the current study and that of Mayne, Yoshinaga-Itano, Sedey, et al., (2000), who included cross-sectional and limited longitudinal data on 113 infants with HL. Both studies demonstrate that the average child with HL adds words to the lexicon at a slower rate than NH children. The current study provides additional support for the concept that early phonetic delays may contribute to variance in first word acquisition among infants with HL. The NH infants in the present study performed in a manner that is highly consistent with norms from the MacArthur-Bates CDI.

**Individual Differences: Identifying At-Risk Children**

A unique outcome of this longitudinal study was the identification of two NH infants who demonstrated characteristics of specific language impairment (SLI). Leonard (1998) describes SLI in reference to “children who show a significant limitation in language ability, yet the factors usually accompanying language learning problems—such as hearing impairment, low nonverbal intelligence test scores, and neurological damage—are not present” (p. 3). This provided a prospective opportunity to characterize the natural history of their vocal development and determine if there were early indicators that signaled their difficulties. Another goal was to ascertain if similar indicators would apply to those
infants with HL who demonstrated delays greater than typically developing infants with HL. Such information may aid the differential diagnosis for infants with hearing loss who have additional developmental challenges that influence the development of spoken language.

The 6 children (2 NH, 4 HL) judged as atypical in rate of development shared a number of characteristics, which could be helpful in identifying children who may be at risk for speech and language problems. Vocal and verbal characteristics of these children are combined from Moeller et al. (2007) and the current study. They included the following: 1) persistent high proportions (>0.60) of simple syllables without consonants (i.e., SSL1) across the age range 10 to 24 mo; 2) slow emergence of syllables with consonants (<0.4 at 22 to 24 mo); 3) absent or limited production of recognizable words at 24 mo (2 of 6 children produced no words at 24 mo); 4) limited use of fricatives. When these children attempted words, vowel accuracy and the complexity and accuracy of attempted syllables were significantly lower than that achieved by all of the other children.

The limited use of consonants (both in babble and early words) has been demonstrated as a long-term predictor of speech development in previous studies of NH children (Menyuk, et al., 1986; Stoel-Gammon, 1989; Vihman & Greenlee, 1987). McCune & Vihman (2001) stressed that children’s “specific vocal capacities play a facilitative role in capturing the representations of adult words to attempt.” (p. 680). They reasoned that when children have stable control of different consonant types, then they can more easily attend to and recall adult word forms and meanings across situations. In other words, consistent control over phonetic forms supports the transition toward representational use. The children in the atypical group were notably lacking in consistent production of a range of CV forms, as indexed by their prolonged use of simple syllable shapes. Furthermore, they made a significantly higher number of vowel errors when attempting to produce words at 24 mo. The characteristics of the atypical group are quite similar to reports on children with expressive specific language impairments (SLI-E). Children with SLI-E, when compared with typically developing peers, demonstrate smaller consonant inventories, less complex syllable shapes, less accurate word forms, and frequent final consonant deletions (Paul & Jennings, 1992; Pharr et al., 2000). The performance of two NH-atypical children in the current study was similar to that of children with HL who were judged to be atypical performers. This lends support to use of these characteristics as signals for clinical concern, regardless of hearing status.

The importance of consonant and syllable development for word learning was underscored by the regression analyses. Early significant predictors of articulation skill at 36 mo were the proportion of canonical syllables (SSL2) at 10 to 12 mo and the limited use of canonical syllables at 14 to 16 mo (indexed by high use of SSL1 forms at that age). These two measures will not necessarily apply to children who subsequently undergo cochlear implantation and may demonstrate rapid phonetic advances (Schauwers, Gillis, Daemers, et al., 2004). However, they may be useful as observational benchmarks for early-identified children who use hearing aids. This study has emphasized that it is important to monitor for changes in syllable complexity, but also to ensure that children make the transition toward using these skills for recognizable word formation. Regression analyses further supported the notion that the onset of consistent use of canonical syllables is an important benchmark. This measure predicted significant variance in MCDI scores at 30 mo. Consonant accuracy in word attempts at 24 mo also was associated with vocabulary abilities at 30 mo. These findings suggest several benchmarks along the developmental continuum that can be monitored in young children. They also suggest the importance of the child’s advances in syllable production and consonant use.

**Study Limitations and Additional Clinical Implications**

Longitudinal research with young infants is a labor-intensive and challenging enterprise that is not without difficulties. This two-part study was limited to a small, heterogeneous group of infants with hearing loss. All the children with HL were enrolled in early intervention services, but these services ranged in the degree to which specialists (e.g., oral teachers of the deaf, speech pathologists experienced with infants with hearing loss) were implementing the program. As such, this was not a study of an “ideal” intervention. Although the focus of the study was on spoken language, three infants also used sign language and one child had deaf parents. There are not sufficient numbers in the study to sort out the influence of these variables on outcomes; however ongoing longitudinal work may address them. A limitation of the study is missing data points, related to late study entrants (N = 3), and the relocation of one subject. Although there were not significant differences between groups in socioeconomic status or maternal education histories, it should be recognized that families who commit to a 5-year longitudinal study may be advantaged in ways that are not representative of the...
typical population. Age-matched analyses have limitations in that they sometimes result in comparisons of children at qualitatively different language stages. In clinical settings, the reality is that parents and early interventionists frequently rely on age-based comparisons to monitor progress.

There are additional clinical implications of this work. Parents may benefit from knowing that it is not unusual for some children with sensorineural hearing loss to develop first words at a slower rate than the average NH child. Although some infants with HL achieve at a rate similar to NH peers, the average child with HL does not. As clinicians evaluate outcomes in infants with HL, it is essential to examine behaviors along the continuum from vocalization to babble to clear word attempts. The current work suggests that consonant use in increasingly complex syllables is a feature that may promote speech and vocabulary learning. However, clinicians need to ensure that the child with HL makes the transition from syllabic babble to meaningful, recognizable words. Caregivers can be coached to make educated guesses about the meaning of their children’s unclear communicative attempts, so that contingent responses will include clear exemplars of the target word (e.g., Child says /pedo/ and parents respond, “Yes, potato. Your potato is hot.”).

Summary

This longitudinal study compared aspects of early phonological and lexical development in infants with NH and HL to understand how children transition from vocal to verbal development. By 24 mo of age, children with HL made communicative attempts as often as children with NH. However, the word approximations of children with HL were less complex, less accurate in consonantal elements, and were recognized less often by mothers than those of the NH children. Ability to produce recognizable words at 24 mo was associated with higher Goldman-Fristoe scores at 36 mo and greater consonant accuracy in early words was associated with improved expressive vocabulary. The results suggested that early-identified children with HL were similar to NH children in receptive vocabulary (MCDI) at 10 to 16 mo. Overall, the findings indicate that the transition from preverbal stages to recognizable word productions may be slower in children with hearing loss, resulting in delayed development of early words. However, the majority of the children with HL demonstrated delayed but parallel developmental patterns. If it is the case that developing accurate word use takes more time in children with hearing loss, early intervention has a key role to play in facilitating this process. Children described as atypical shared several characteristics, which may be useful indices for determining which children are at risk and require supplemental intervention. Ongoing longitudinal studies will provide additional insights into individual differences that contribute to variables outcomes for children with HL.

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