From Screening to Early Identification and Intervention: Discovering Predictors to Successful Outcomes for Children With Significant Hearing Loss

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This article summarizes the research findings from a longitudinal study of the language, speech, and social-emotional development of children who are deaf and hard of hearing, all of whom have hearing parents. This series of studies, from 1994 to the present, investigated predictors of successful developmental outcomes. The article provides information about how the findings of these studies relate to the existing literature. A description of the Colorado Home Intervention Program (CHIP) in which the participants were enrolled is also provided. During the course of these investigations, universal newborn hearing screening programs were established in Colorado, changing the age of identification of hearing loss and initiation into intervention in this program geared to families with infants and toddlers, birth through three years of age, from an average of 20 months of age to 2 months of age. Language development is positively and significantly affected by the age of identification of the hearing loss and age of initiation into intervention services. Both speech development and social-emotional variables are highly related to language development.

As of this writing, at least 41 states in the United States have passed legislation to implement universal newborn hearing screening (UNHS) programs. Five states have achieved UNHS without legislation and others have legislation pending (www.professional.asha.org). In the remaining states, significant progress toward the implementation of universal newborn hearing screening has been made. Many countries are also instituting UNHS programs in Europe, Australia, Asia, Africa, and South America. As these programs develop, there are significant and rapid changes in the early-identified (EID) populations served by professionals who provide intervention follow-through services. As the age of identification of hearing loss is lowered and more newborns and their families enter EID programs, both exciting opportunities and new challenges are emerging.

This article is a summary of the presentation at the International Congress on the Education of the Deaf in Sydney, Australia, 2000. The Colorado studies were supported by the National Institutes of Health (N01-DC-4–2141), Maternal and Child Health, the Colorado Department of Education, the Colorado Department of Public Health and Environment, and the University of Colorado-Boulder. Correspondence should be sent to Christine Yoshinago-Itano, Department of Speech, Language & Hearing Sciences, Campus Box 409, University of Colorado, Boulder, CO 80309-0409 (e-mail: Christie.Yoshi@colorado.edu).

Evidence for the Efficacy of Early Identification and Intervention

Bess and Paradise (1994) reviewed the existing literature on the efficacy of early identification and early intervention of hearing loss and found equivocal evidence. Early identification at that time was predominantly defined as "prior to 18 months" or "prior to 30 months" of age, and no studies of developmental outcomes of infants identified in the newborn period had been published. White and White (1987) reported significantly better oral language outcomes of EID children in a group of 46 deaf infants up to 36 months of age; 14 of the 46 infants were EID (prior to 12 months). The EID group began intervention services by 12 months of age, but the average age of obtaining hearing aids in this EID group was 20.5 months for those with deaf parents and 28 months for those with hearing parents. The study lacked a comparison with either a control group or norms from children

with typical development. Apuzzo and Yoshinaga-Itano (1995) and Robinshaw (1997) reported significantly better language outcomes of infants identified with hearing loss within the first 6 months of life. The sample sizes of EID children ($n = 14$; Apuzzo & Yoshinaga-Itano, 1995) and ($n = 5$; Robinshaw, 1997) were small. Because UNHS programs were established in a few large Colorado hospitals in 1992, an opportunity to drastically increase the number of EID children emerged. The purpose of this article is to present the results of a series of developmental studies conducted for the most part at the University of Colorado on the language, speech, and social-emotional development of deaf and hard-of-hearing (D/HH) children in Colorado.

An unexpected outcome of these investigations was the emergence of age of identification of hearing loss and the initiation of early intervention within the first few months of life as a primary predictor variable. Colorado began UNHS programs in 1992 with two birthing hospitals, and by 1994, when the study began, approximately 40% of the birthing hospitals were involved in UNHS, resulting in an increased number of EID children and a change in the demographics of the population. The studies represent a variety of different statistical designs to investigate the predictor variables: matched designs, multivariate analyses of variance, multiple regression, and logistic regression techniques. The first published study in 1995 had 68 children. Although each new study either doubles the number of participants or studies new populations of children and families (those identified through the high-risk register vs. those identified through UNHS programs), the impact of early identification and earlier intervention remains constant.

Prior to newborn hearing screening, the EID newborns had severe and profound hearing loss and were predominantly multiply disabled (66%) (Apuzzo & Yoshinaga-Itano, 1995; Yoshinaga-Itano & Apuzzo, 1998a, 1998b), while two-thirds of those identified through UNHS are children with hearing loss only (Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). The difference in number of participants in each of the Colorado studies depends on the age level of the children studied, whether the study is cross-sectional or longitudinal, and the number of participants assessed with a particular developmental instrument. All available participants in the database fulfilling the criteria for participant eligibility are included in each study.

Over 90% of the Colorado children in these studies received intervention services through the Colorado Home Intervention Program (CHIP). Over 90% of the total population of Colorado children with significant hearing loss between birth and 3 years of age receive services through the CHIP. Children with unilateral hearing losses and those with borderline mild losses whose losses are typically not amplified and their families often do not choose service delivery from CHIP. A description of CHIP is provided for the purposes of determining generalizability of the results. The demographic characteristics of the Colorado population are similar to the national statistics reported by the Office of Demographic Studies at Gallaudet University, with the exception of the ethnic distribution. Colorado statistics include about 25% of the population of children with hearing loss from ethnic minority families, the majority from Hispanic/Mexican American or Mexican families. Ethnicity varies widely throughout the United States. The national statistics include a larger representation of children from African American and Asian/Asian American backgrounds. Colorado has a birthing population of about 65,000 infants per year. The research studies are Colorado population studies rather than random samples.

Colorado Home Intervention Program

The Colorado Home Intervention Program began in Colorado in 1970, when it was established through an Office of Education demonstration grant at the University of Denver. In 1973, the parent-infant program was moved to the Colorado Department of Public Health, where it has continued until 2001, and it is now administered through the Colorado Department of Education. The program offers intervention services provided within the home for Colorado families with children identified with significant hearing loss.

The early intervention providers are trained professionals, deaf educators, speech/language pathologists, audiologists, early childhood special educators, bilingual educators, and social workers/psychologists who typically have earned graduate degrees in their field of expertise. These individuals receive ongoing in-service

training in counseling, developmental assessment, auditory skill and speech development, sign language development, language, and cognitive and social-emotional development. Only a few existing preprofessional training programs throughout the United States provide extensive training in intervention for families and children from birth through the early childhood period. Colorado has an increasing number of D/HH providers who fulfill a variety of positions as early-intervention providers, sign language instructors, and mentors for families who want ongoing communication with adults who are similar to their own children.

Information (e.g., resources, strategies, development, methods of communication) is provided to the parents through 1- or 1.5-hour sessions each week. Direct services are not provided to the child. Initiation of intervention begins immediately upon diagnosis of the hearing loss (often the same day), and coordinators contact the families to help them acquire the information they need to make choices about type of intervention. The individual who provides the initial contact is specially trained to offer support to families during this particularly difficult time, but most do not remain as the long-term intervention provider. Colorado has instituted a Co-Hear Coordinator system, with an individual designated in one of eight regions throughout Colorado. As the first contact, this Co-Hear coordinator provides initial counseling, guidance, and education necessary for the parents to feel comfortable in making a decision about which intervention service they will choose for their family.

Developmental progress is monitored through 6-month assessments that consist of parent questionnaires about child development and videotaped parent/child interaction. Parents make decisions about the success of intervention strategies based on their individual child's progress and sometimes by comparing this development with that of other groups: children with normal hearing, children with similar hearing losses, and children with or without additional disabilities. The developmental assessments help families use objective data to make decisions about mode of communication and other intervention strategies. All language aspects measured in the Colorado studies included language understood or produced in either sign or speech or with both sign and speech. The language development in the early years, for those children who use sign language, tended to be different in each modality, if the child used both modalities. Only measures that could be used with English or American Sign Language (ASL) are reported here. Studies including measures of the total number of different words and the total number of words in a spontaneous language sample involved transcription of the language sample by both a deaf (native or fluent signer) research assistant and a hearing research assistant.

Age of Identification/Intervention of the Hearing Loss and Language Development Outcomes

Age of Identification/Intervention and General Receptive/Expressive Language Development

Apuzzo and Yoshinaga-Itano (1995) compared the development of 14 EID children, in the first 2 months of life identified through high-risk register to 11 children identified between 3 and 12 months, 30 participants identified between 13 and 24 months, and 14 children identified 25 months or greater on eight subtests (General Development, Self-Help, Situation Comprehension, Conceptual Comprehension, Expressive Language, Gross Motor, Fine Motor, and Personal Social) of the Minnesota Child Development Inventory (MCDI). The four age-of-identification groups were balanced by age at time of testing, hearing loss category, and self-help developmental quotient. The self-help subscale measures the ability of the child to care for himself or herself such as the ability to feed oneself or dress oneself. Children in the first age group who were early-identified/intervened within the first 2 months of age had significantly higher language quotients (LQ = 87) than those identified in the 3- to 12-month group (LQ = 58), the 13- to 24-month group (LQ = 68), and the 25+ group (LQ = 58). Language quotients are derived by dividing language age by chronological age and multiplying by 100. A language quotient of 87 is within the low average range of development, whereas a language quotient of 58 is significantly delayed from the average range of development.

Yoshinaga-Itano et al. (1998) in a study of 150 deaf and hard-of-hearing infants and toddlers (72 EID, 78 later identified/intervened [LID]) found significantly higher language development on the MCDI among

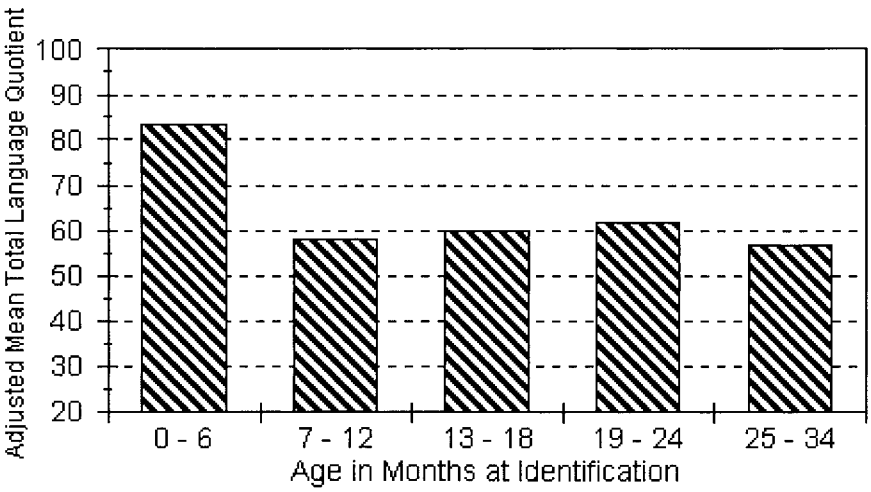

Figure 1 Adjusted mean total language quotients by groups based on age of identification. (Reprinted with permission from Yoshinaga-Itano, Sedey, Coulter, & Mehl [1998], *Pediatrics, 102*[5], 1161–1171.)

children identified with hearing loss and placed into intervention by 6 months of age (see Figure 1). The EID population were matched as closely as possible to an existing LID group of 78 children from a sample of 300 possible participants by degree of hearing loss, gender, ethnicity, socioeconomic status (SES), mode of communication, age at testing, and nonverbal symbolic play development. The 72 EID children included 18 children from the Apuzzo and Yoshinaga-Itano 1995 study and 54 children identified through UNHS. These EID children represented 70% of the eligible participants identified in Colorado through UNHS programs from 1992 to 1996. This study artificially balanced these variables, although they are not balanced in the naturally occurring population; that is, there are fewer children with profound hearing loss than those in any other hearing loss category between mild through severe hearing loss. This balancing ensured that none of the variables historically believed to influence language development of children with significant hearing loss would affect the results significantly. Thus, the relationship of age of identification/intervention and language development could be investigated without undue influence of other demographic variables. As we later learned, when all of these variables are left to occur naturally and multiple regression techniques are used, the impact of age of identification/intervention remained (Snyder & Yoshinaga-Itano, 1999; Yoshinaga-Itano & Snyder, 1999).

The impact of age of identification/intervention strengthens when the studies include children with hearing loss only, rather than including children with hearing loss and other disabilities. Some of the children with hearing loss and other disabilities included in the 1998 study had developmental quotients of 20 on the MCDI on the self-help subscale (developmental age divided by chronological age multiplied by 100). Including children with significant additional disabilities reduces the probability of measuring the impact of age of identification/intervention but increases the generalizability of the results of the research.

The results of these studies indicated that the first 6 months of life represents a particularly sensitive period in early language development, a window of opportunity for initiation of intervention services. Access to language during this period provides an opportunity for children with significant hearing loss to develop language skills that are slightly depressed from the mean language of children with normal hearing (low average) but within the normal developmental continuum.

Language Development and Identification/Intervention of Hearing Loss in the First 2 to 6 Months

Children with hearing loss identified in the first 2 months, 3rd and 4th months, and 5th and 6th months of life had

similar language development quotients, language development proportionate to chronological age (Yoshinaga-Itano et al., 1998). In the Apuzzo and Yoshinaga-Itano (1995) study, the children whose losses were identified in the first 2 months of life had significantly better language development than children identified between 3 and 12 months of life. However, the smaller number of children in the study prevented an examination of other demographic variables that could have influenced the outcome. In the 1998 study, there were almost 4 times more children (72 compared to 18) with EID hearing loss within the first 6 months. Regardless of the month of identification in the first 6 months, these children had developmental profiles at the low average range of the development of children with normal hearing.

No other published studies have outcome data of children identified within the first 2 months of age, the 3rd and 4th months of life, and the 5th and 6th months of life. Until UNHS is established in other states and follow-through data management systems are established, replication of these results is not available. Both the Moeller (2000) and Calderon and Naidu (2000) studies included children in the earliest intervention group whose intervention began within the first 12 months of life and reported that they had language development within the normal range at 5 years of age (Moeller, 2000) or significantly better langauge development than children with later intervention (Calderon & Naidu, 2000). The Calderon and Naidu study did not include data about children with normal hearing.

Language Development Comparisons of Children Identified in the First 6 to 30 Months of Age and Language Outcomes

EID Colorado children had significantly higher language quotients on the MCDI than LID children when compared with children identified between 7–12 months of age, 13–18 months, 19–24 months, or 25–30 months of age (Yoshinaga-Itano et al., 1998). On average, language quotients of LID children, with intervention initiated after 6 months of age, remain significantly below 80 at a mean of 60, indicating that they had significant language delays when compared to children with normal hearing. At the ages tested, the LID children had language development at 60% the level of children with normal hearing and typical development, while EID children had language development at 80% of typical development.

Moeller (2000) in her study of 112 participants with hearing loss only and no additional disabilities, tested at 5 years of age, found that the age of initiation of intervention predicted 55.5% of the variance in language outcome. The participants were enrolled in the Diagnostic Early Intervention Program (DEIP) between 1981 and 1994. The language measures were clinically administered standardized assessments, the Peabody Picture Vocabulary Test (Dunn & Dunn, 1981), the Preschool Language Assessment Inventory (Blank, Rose, & Berlin, 1978), and the Reynell Test of Language Development (Reynell, 1977). Information about SES or ethnicity was not available. The Nebraska DEIP and CHIP share many similarities in expertise of the providers and philosophy of the parent-infant program. The age of initiation of intervention (11.4%), level of parental involvement (35.2%), and nonverbal intelligence (2.5%) made significant predictions of language outcome at 5 years of age. Age of initiation of intervention was a continuous variable so that statistical significance of language within specific age groups was not tested. In addition to the multiple regression analysis, Moeller made mean comparisons of results by four categories of age of initiation of intervention and found that children in the first category (birth through 11 months) had means that were within a low normal range of development. No statistical comparisons of the means of groups 1 through 4 were made.

Calderon and Naidu (2000) conducted a longitudinal study of 80 children, 9 who entered intervention prior to 12 months of age, 39 between 13 and 24 months of age, and 32 between 25 and 36 months of age. Age at entry into intervention significantly predicted receptive language posttest score, expressive language posttest score, auditory discrimination posttest score, and speech production posttest score. These children were enrolled in the early intervention program from 1989 to 1994 and had no additional disabilities. Calderon and Naidu also compared 5 children who entered into intervention prior to 13 months to 23 children who entered later at a mean of 26 months. Language development was measured between the ages of 9 months and 52 months postgraduation from early intervention, and the chil-

dren were between 45 and 88 months of age. The children who entered into early intervention earlier had significantly higher receptive and expressive scores on the Language Development Scale (Tonelson & Watkins, 1979) and marginally significant differences on the Preschool Language Scale (Zimmerman, Steiner, & Pond, 1992). Calderon (2000) reported that teachers rated the mothers in the early intervention group as more involved than those with later age of intervention. The Washington early intervention program is also similar to CHIP, with the exception that all the children and families in the Washington program used simultaneous communication (sign plus speech).

Yoshinaga-Itano et al. (1998) also reported no significant differences in the language development of children identified at 7–12 months, 13–18 months, 19–24 months, or 25–30 months of age, indicating that with this sample of children, age of identification of hearing loss between 7 and 30 months of age did not significantly affect language quotients. Time at intervention was not significantly correlated with language quotients (r = .08) (Yoshinaga-Itano et al., 1998). These results were similar to those reported by Apuzzo and Yoshinaga-Itano (1995) and Moeller (2000). All four late-identified groups, however, differed significantly from the EID group (Yoshinaga-Itano et al., 1998). These findings may indicate that early intervention for LID children can keep language delays from increasing, but closing developmental delays at the time of diagnosis of hearing loss is much harder, for it would require children to make language gains greater than the development of typically developing hearing children.

Relationship Between Language, Speech, Social-Emotional, and Cognitive Development and Age of Identification/Intervention of the Hearing Loss

Yoshinaga-Itano et al. (1998) found that EID children with no additional disabilities maintained language development similar to their nonverbal cognitive symbolic play development from the Play Assessment Questionnaire (Calhoun, 1987), while LID children evidenced greater than a 20-point discrepancy between nonverbal cognitive development and language development. Cognitive symbolic play quotients and language quotients were similar for EID children with normal cognitive quotients. Cognitive quotients of 80 or greater were considered within the normal range by the test authors.

Discrepancies between nonverbal intelligence quotients and verbal intelligence quotients among the school-age D/HH population have been reported, even among the most educationally successful students. Twenty-point discrepancies are commonly found even among children with significant hearing loss who have the most successful language development, while discrepancies as great as 40 points are characteristic of children whose language development is difficult to ascertain and measure after the age of 12 years (Geers & Moog, 1989; Levitt, McGarr, & Geffner, 1987). Nonverbal cognitive development has not been highly predictive of language or academic achievement within the school-age period and accounted for only about 9% of the variance in academic achievement (Geers & Moog, 1989; Levitt et al., 1987).

Children with additional disabilities who were identified early and provided with immediate early intervention services also had symbolic play quotients similar to their language quotients. Children with additional disabilities who were identified later had significant discrepancies between their cognitive and language quotients. Thus, both children with hearing loss only and those with additional disabilities have language development very similar to their nonverbal developmental skills but only when their hearing losses are identified early and the families receive earlier intervention services.

Snyder and Yoshinaga-Itano (1999) conducted a study of 170 children between the ages of 8 and 36 months of age (n = 117 EID); autosymbolic play, age of identification, and symbolic substitution accounted for 41.8 % of the variance in expressive vocabulary of infants and toddlers who are deaf or hard of hearing on the MacArthur Communicative Development Inventory (CDI). The numbers increased because EID children who reached the age of 8 or 9 months when developmental assessments were administered were added to the participant sample. When the Play Assessment Questionnaire (Calhoun, 1987) was used as an index of symbolic play, the Symbolic Play Quotient accounted for 44% of the variance in productive vocabulary, with an additional 3 % of the variance accounted for by

age of identification (Yoshinaga-Itano & Snyder, 1999). These studies also addressed the issue of early-identification/intervention using a different language measure from the MCDI, a measure of expressive vocabulary, the MacArthur Communicative Development Inventory. Mayne, Yoshinaga-Itano, and Sedey (2000) reported that 56% of the variance in expressive vocabulary scores of 113 children, 24 through 37 months of age, was accounted for by child's age and age of identification (23%), Situation-Comprehension quotient of the MCDI (30%), and whether the child had additional medical conditions (3%).

Three nonverbal developmental outcome areas were significantly and strongly related to all language and all social-emotional variables, whether measured through the development of symbolic play, situation comprehension or self-help, or based on the presence/absence of secondary disabilities (Pipp-Siegel, Sedey, & Yoshinaga-Itano, 2001; Yoshinaga-Itano & Abdala de Uzcategui, 2001).

In a study of 200 participants between the ages of 6 and 72 months of age (Pipp-Siegel, Sedey, VanLeeuwen, & Yoshinaga-Itano, in press), 63% of the variance in expressive language on the MCDI was predicted when including mastery motivation, a measure of temperament, demographic variables of age of intervention initiation, general competence, gender, age at testing, degree of hearing loss, mode of communication, maternal level of education, presence of a disability in addition to hearing loss, and ethnicity, in the multiple regression analysis. Ninety of the participants were identified prior to 6 months of age (45%), 94 participants were identified between 6.1 and 30 months of age, and 17 were identified between 31 to 60 months of age. There were twice as many children with profound hearing loss as any other hearing loss category. General competence (from parent report) explained 32% of the variance, chronological age and gender explained 21% of the variance, age of identification and degree of hearing loss explained 4% of the variance and two mastery motivation subscales, social symbolic persistence with object-oriented persistence, which was only marginally significant, accounted for an additional 7% of the variance in language development.

No other studies of children with hearing loss have investigated the relationship between mastery motivation and language development. MacTurk (1993), however, found no differences in mastery motivation of children who were 8 and 12 months of age when comparing children with hearing loss to those with normal hearing. Stinson (1974) found significantly lower mastery motivation for school-age 8- to 12-year-old boys with significant hearing loss when compared to boys with normal hearing. The Pipp-Siegel et al. (in press) study differs from these previous studies, because it looks at the relationship of mastery motivation as a predictor of language development in a group of children with hearing loss. No comparisons are made with children who have normal hearing.

Yoshinaga-Itano, Coulter, and Thomson (2000) conducted a study of 294 children with hearing loss, born in hospitals with UNHS programs (54 children born in UNHS hospitals from 1992, 77 children born in Colorado hospitals without UNHS programs during the same time period, and 163 children born before 1992). The children had an 80% probability of having language development on the MCDI within the low normal range. The study was conducted to respond to the medical community's question regarding the relationship of newborn screening to outcome. A goal of the study was to determine whether the newborn hearing screening resulted in EID and early intervention and better language outcomes. Children with hearing loss born in UNHS hospitals had significantly better expressive vocabulary on the MacArthur CDI, significantly better speech intelligibility, significantly higher number of different consonant types, as well as initial and final blends in their phonetic repertoire, and significantly higher total number of intelligible words and number of different words on a spontaneous videotape of parent-child interaction.

Age of Identification/Intervention and Vocabulary Development

Mayne, Yoshinaga-Itano, and Sedey (2000) found that EID children (n = 54) had significantly more words in their expressive vocabulary than LID children (n = 59) in a study of 113 children with significant hearing loss between the ages of 24 and 37 months. Children with hearing loss who had normal nonverbal development on

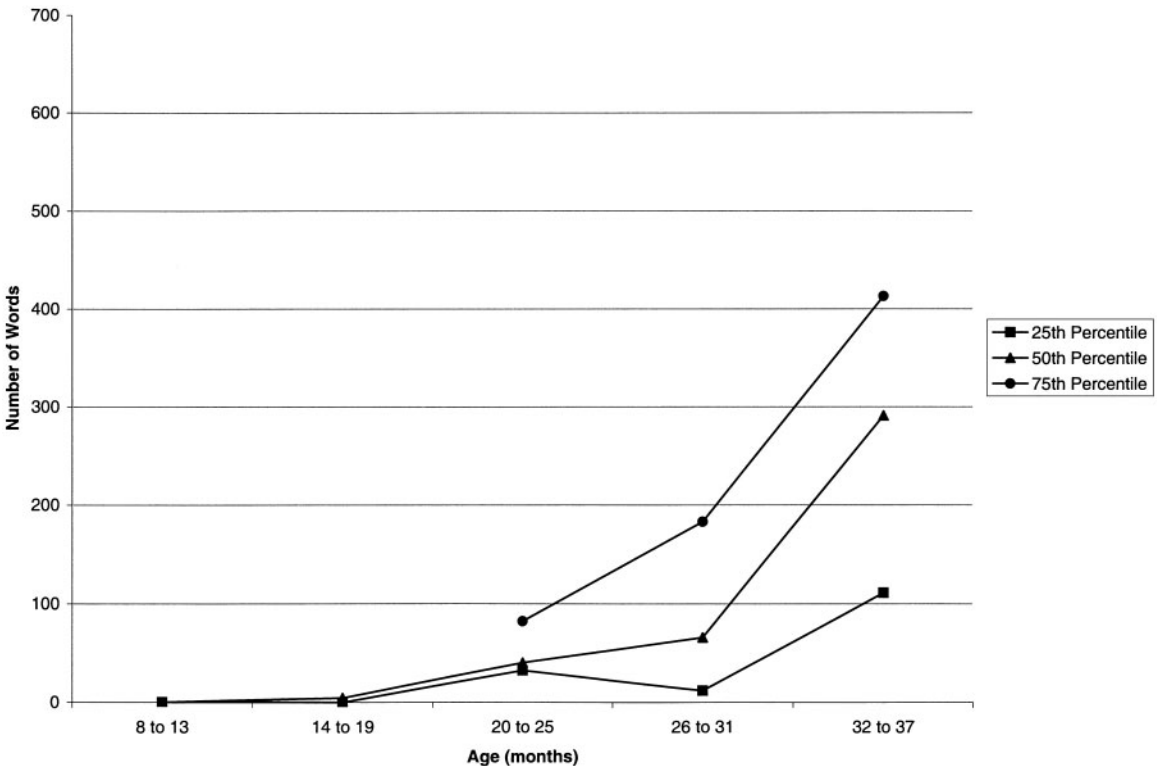

Figure 2 Expressive vocabulary scores of children who are deaf or hard of hearing with Situation Comprehension quotients of 80 or higher and identified with hearing loss after 6 months of age. (Reprinted with permission from Yoshinaga-Itano, C., & Sedey, A. [Eds.] [2000]. *Language, speech, and social-emotional development of children who are deaf or hard of hearing: The early years.* Washington, DC: Alexander Graham Bell Association.)

the Situation Comprehension subscale of the MCDI had expressive vocabulary development on the CDI that was approximately 25% lower than that of hearing children with typical development. Children with EID hearing loss and early intervention had a distribution of vocabulary scores from the 10th through the 90th percentile on the distribution derived from children with normal hearing.

LID children with significant hearing loss and no additional disabilities had vocabulary development that was 50% lower than that for children without hearing loss during the first 36 months of life. Thus, the top 25th percentile of the LID children (those above the 75th percentile) fell at the bottom 25th percentile of the distribution for children with normal hearing. Children with vocabulary scores between the first and 75th percentile of the LID distribution fell below the 10th percentile of the distribution for normally hearing children.

Figure 2 depicts Colorado norms on the CDI of 172 children between the ages of 8 and 37 months with hearing loss and cognitive quotients on the situation comprehension subtest of 80 and greater who were identified with hearing loss after 6 months of age. Figure 3 depicts Colorado norms on the CDI of 154 children between the ages of 8 and 37 months with hearing loss and cognitive quotients on the situation comprehension subtest lower than 80 and who were identified with hearing loss prior to 6 months of age. Comparison of the two distributions (Figures 2 and 3) clearly shows the significant expressive vocabulary advantage of children who were EID with early intervention.

Age of Identification/Intervention and Speech Development

Several studies (Apuzzo & Yoshinaga-Itano, 1995; Yoshinaga-Itano et al., 2000; Yoshinaga-Itano & Sedey, 2000) found that EID children had significantly more consonants, as well as initial and final blends in their spontaneous phonetic repertoire and significantly better speech intelligibility than LID children. Analysis of

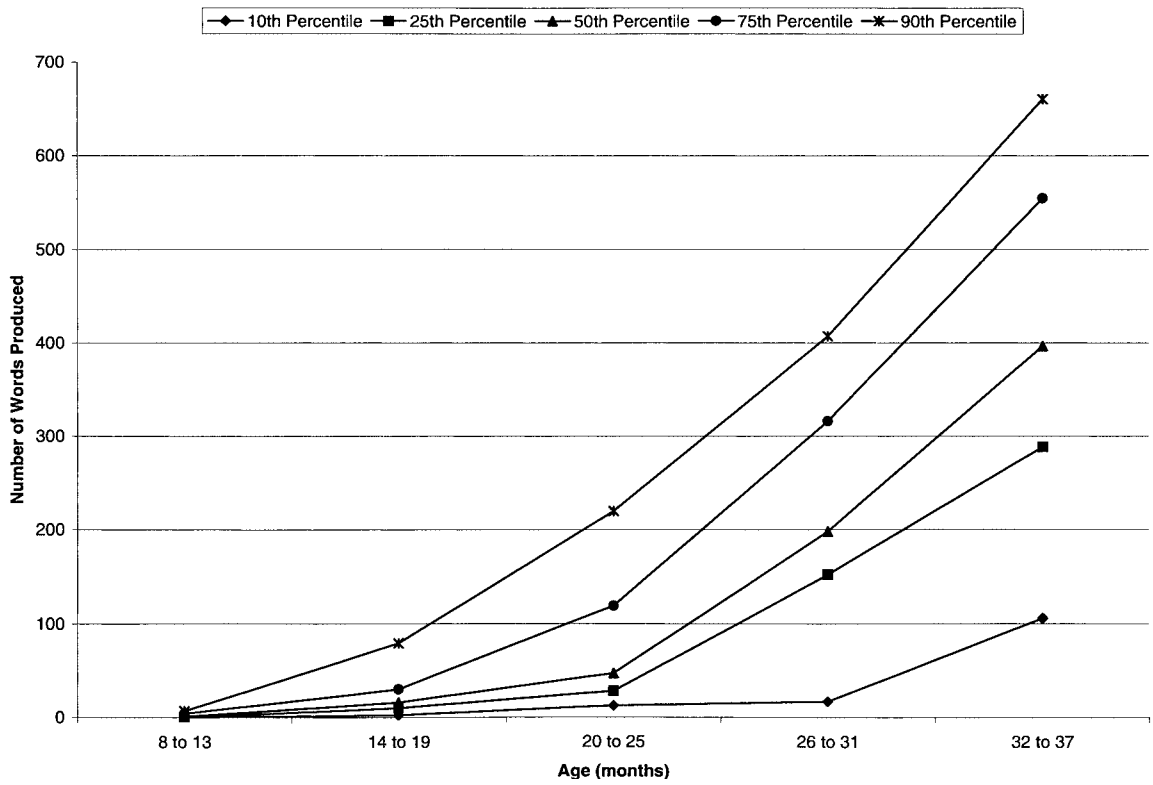

Figure 3 Expressive language quotients of children who are deaf or hard of hearing with Situation Comprehension Quotients 80 or higher and identified with hearing loss prior to 6 months of age. (Reprinted with permission from Yoshinaga-Itano, C., & Sedey, A. [Eds.] [2000]. *Language, speech, and social-emotional development of children who are deaf or hard of hearing: The early years.* Washington, DC: Alexander Graham Bell Association.)

vocal production was done by an experienced phonetician. Speech intelligibility was rated by the phonetician, the parent, and the parent-infant provider.

Early identification and intervention do not directly predict outcomes in speech development. Early identification/intervention predicts better language development. Better language development predicts better speech intelligibility. In a study of 147 children between the ages of 14 and 60 months, Yoshinaga-Itano and Sedey (2000) found that the primary predictors of speech development of D/HH children in order of influence are chronological age, expressive language development, degree of hearing loss, and mode of communication. The total model accounted for 58% of the variance for number of vowels, 70% of the variance for number of consonants, 84% of the variance for presence/absence of initial blends, 88% of the variance for presence/absence of final blends, and 86% of the variance of overall speech intelligibility. Expressive language is predicted by nonverbal cognitive development and age of identification of hearing loss. The expressive language ability, whether measured in speech only, speech plus sign, or sign only, significantly predicted speech intelligibility. Most children (75%) with mild through severe hearing loss in the CHIP developed intelligible speech by 5 years of age. Only 20% of the children with profound hearing loss, using conventional amplification, were judged to have intelligible speech by 5 years of age. Children with profound hearing loss who used conventional amplification had speech that was significantly different from children with mild through severe hearing loss. Thus, degree of hearing loss differences were reduced to two categories, hard of hearing (mild through severe) versus profound, rather than a continuum by degree of hearing loss. Speech development variables were the number of vowels, number of consonants, number of initial blends, number of final blends, and speech intelligibility coded from a spontaneous speech sample of parent-child interaction.

Children with expressive language quotients within

the normal range of development had a mean of 17 different consonant types at 2 to 2.5 years of age. However, they were nevertheless rated as only "25% intelligible," meaning that although good progress in consonant production was being made, these children were not intelligible to the adults in their environment. Between 31 and 42 months of age, the children with a language quotient that was 80 or greater had increased their consonant repertoire to 21 different consonant types, and these children were also rated as "almost always intelligible with careful listening." Those children who could communicate their thoughts, needs, and desires only through speech production had difficulty getting their conversational partners to understand what they were saying until they were 2.5 years to 3.5 years of age.

Because children with mild through severe hearing loss have only a small variance in speech production and they represent the largest proportion of the population, degree of hearing loss did not account for as much variance in speech production as language ability. Presumably, the more language a child has to communicate, the more speech combinations the child will attempt.

Speech intelligibility by hearing loss. In summary, even children with mild hearing loss were rated as only "25% intelligible" at 25 to 30 months of age (Yoshinaga-Itano & Sedey, 2000). However, their speech intelligibility rose to "almost always understandable" with careful listening between 31 to 42 months of age. Combining information about vocabulary inventories, the range of vocabulary scores from the 25th to 90th percentile ranged from approximately 300 to 700 words for EID children with no additional disabilities at this same age level. Recall that although there is wide variation in speech intelligibility for children with mild to profound hearing losses, there was no significant difference in language development among EID children by degree of hearing loss at these ages (Yoshinaga-Itano et al., 1998). All other categories of hearing loss, moderate, moderately severe, severe, and profound hearing losses, were still rated, at 31 to 42 months of age, as having "unintelligible speech 50% of the time" for moderate hearing loss and "almost always unintelligible" for severe and profound hearing loss. Thus, there is a significant discrepancy between vocabulary production and speech intelligibility at this age. Many children who had not yet developed intelligible speech had a significant amount of vocabulary in sign language.

Age of Identification/Intervention of the Hearing Loss and Social-Emotional Outcomes

Age of Identification/Intervention and Personal-Social Development

In addition to the impact of age of identification/intervention on language and speech development, the relationship to social development, emotional development, and self-concept was investigated. In a study of the same 150 children in the Yoshinaga-Itano et al. (1998) study, EID children had significantly higher personal-social skill development on the MCDI than children whose hearing losses were later identified. The scores on the personal-social subscale of the MCDI were highly related to the scores of the participants on the Meadow-Kendall Social Emotional Inventory. In general, children with strong language development also had strong personal-social development, indicating a strong relationship between language and social-emotional skills development. Surprisingly, children with mild hearing loss evidenced the greatest discrepancy between EID and LID children, despite the fact that they typically had strong language development. The LID children with mild hearing loss had poorer personal-social skills than LID children with moderate to profound hearing loss (Yoshinaga-Itano & Abdala de Uzcategui, 2001).

Age of Identification/Intervention and Self-Development

Pressman (2000) examined the self-recognition and self-description/evaluation in a group of 53 14- to 40-month-old children who were deaf or hard of hearing using the Stipek, Gralinski, and Kopp (1990) Self-Concept Questionnaire, which includes the following aspects: self-recognition, self-description, and self evaluation. Self-recognition of children who are deaf or hard of hearing was similar for children of the same ages who had normal hearing. Self-recognition development increases significantly with age from 14 to 40 months, and the majority of self-recognition items were passed before the majority of self-description/evaluation. The devel-

opment of self-recognition of children with hearing loss was similar to the development of children with normal hearing. Expressive language development, as measured by the MCDI, completely accounted for the relationship between self-recognition and age. As children age, their language development improves, thus allowing the child to develop beyond the ability to recognize the self to the ability to describe and evaluate the self. Self-description/evaluation increased significantly with age. However, the later the age of identification, the lower the self-description/evaluation scores, even when child and family characteristics were controlled. The relationship among self-description/evaluation, age, and age of identification was partially accounted for by expressive language, but age of identification contributed to the development of self-description/evaluation over and above expressive language ability.

Even at very early ages in development, expressive language is highly related to self-concept development. While some aspects of self-concept development are not highly related to language development (e.g., the ability to recognize the self, such as an image in the mirror), a significant component of self-development at this age appears to depend on language, that is, the ability to describe the self and evaluate the self.

Age of Identification/Intervention and Parental Stress

Pipp-Siegel, Sedey, and Yoshinaga-Itano (2002) measured the parental stress of 184 hearing mothers of D/HH children between 6 and 67 months of age (n = 86, 46.7%, EID 0–6 mo.) (n = 22, 12%, LID 6.1–12 mo.). All families enrolled in the Colorado developmental studies begun in 1994 are sent the parental stress questionnaire at 6-month intervals. The participant pool represents all families who chose to fill out the questionnaires. The Parental Stress Index/Short Form (PSI: Abidin, 1997) consists of 36 items taken from the full-length PSI. Mothers rate the items on a 1 to 5 scale from strongly agree to strongly disagree. There are three major subscales of 12 items each: (1) Parental Distress, (2) Parent-Child Dysfunctional Interaction, and (3) Difficult Child. Parental distress is derived from items from subscales of depression, role restriction, isolation, and spouse and indicates the amount of stress an individual feels in the role of parenting due to personal factors, such as feelings of poor competence in parenting, conflict with the other parent, depression, or lack of social support. Parent-child dysfunctional interaction indicates whether the child is seen as reinforcing to the parent or is a negative element in the parent's life and indicates parental feelings of rejection or alienation by the child. These items come from subscales of acceptability and reinforce parent and attachment subscales. The difficult child subscale assesses behavioral characteristics of the child that reflect whether the child is difficult to manage due to temperamental factors or learned patterns of defiance and noncompliance. Items are derived from the temperament, adaptability, demandingness, mood, and distractibility/hyperactivity subscales.

In addition, the relationship between the mothers' perception of the intensity and frequency of daily hassles and their perception of social support were included in the multiple regression analysis. The Parenting Events/Daily Hassles scale (Crnic & Greenberg, 1990) consists of 20 statements about daily routines. Parents rate whether each item is a "big hassle" or "no hassle" on a 5-point scale and the frequency of occurrence of the hassle on a 4-point scale from "rarely" to "constantly." The Family Support scale (Dunst, Jenkins, & Trivette, 1984) consists of 18 sources of family support, including parents, friends, spouse, church, and so on. Parents indicate whether each source of support is available and whether the source is helpful.

Stress levels were measured in three domains using the short-form of the PSI (Abidin, 1997). Mothers in this study demonstrated significantly less parental distress on the PSI than a normative, hearing group, although this difference was quite small. No significant differences between the mothers of children who are D/HH and mothers of hearing children were found for the Dysfunctional Parent-Child Interactions or the Difficult Child subscales. Mothers who perceived their daily hassles as more intense also obtained higher stress ratings on all three subscales. Additional predictors of the Parental Distress subscale were frequency of hassles, social support, and annual family income. Increased stress on the Dysfunctional Parent-Child Interaction subscale was predicted by children who had disabilities in addition to hearing loss, more delayed language relative to their chronological age, and less severe degrees of hearing loss. No additional significant predictors were

obtained for the Difficult Child subscale. When all measured variables were controlled for, characteristics that did not predict maternal stress on any of the three subscales included the child's gender, ethnicity, age of identification, mode of communication used, months between age of identification and child age at time of observation, and maternal education.

Contrary to some objections to UNHS, the findings of this study indicate that early identification and intervention does not result in increased parental stress leading to problems with maternal attachment and bonding.

Age of Identification/Intervention and Emotional Availability

Pressman, Pipp-Siegel, Yoshinaga-Itano, and Deas (2000) observed the emotional availability of mother to child and child to mother and the reciprocity of the interaction. One purpose of the study was to identify variables that predicted language gain other than age of identification/intervention of the hearing loss. The Emotional Availability scales (Biringen, Robinson, & Emde, 1988) measure the emotional connection between mother and child, the maternal bonding as observed on videotaped interactions. The enjoyment of mother and child in their interactions with one another, sensitivity to each other's emotions, ability to structure, scaffold interactions in a supportive, nonintrusive fashion are all aspects of emotional availability.

Pressman, Pipp-Siegel, and Yoshinaga-Itano (1999) analyzed emotional availability from spontaneous videotaped parent-infant interactions according to scales developed by Biringen et al. (1988) and reported that emotional availability (e.g., maternal sensitivity to infants and infant responsivity to mothers) when infants were 2 years of age predicted gain in expressive language when the infants were 3 years old. Pressman et al. (2000) reported that emotional availability made significantly greater positive predictions of child language gain for children who are D/HH than for children with normal hearing. The language of children who are deaf or hard of hearing seems to be more responsive to greater maternal sensitivity. Greenstein, Greenstein, McConville, and Stellini (1975), in a study of children who are deaf or hard of hearing, also found significant relationships between maternal sensitivity and language development. Most studies comparing mothers of children who are deaf or hard of hearing with mothers of children who are hearing, however, have found less optimal interactions for dyads with children who have significant hearing loss (MacTurk, Meadow-Orlans, Koester, & Spencer, 1993; Meadow-Orlans, 1990, 1997; Spencer & Gutfreund, 1990). Lederberg and Mobley (1990) also found no significant differences between dyads with hearing children and dyads with children who have significant hearing loss. The differences in these results may be due to differences in intervention services and social supports.

Poorer emotional availability of mothers to their children was related to the number of times hearing mothers touched their hearing children, with more touches related to higher maternal intrusiveness scores. No relationship, however, was seen between touch and emotional availability in hearing mothers of D/HH children (Pipp-Siegel et al., 2000). The authors concluded that touch was used as a means of communication for dyads with a D/HH infant and so was unrelated to emotional availability, but was seen as intrusive for dyads with hearing infants.

Family Involvement and Age of Enrollment in Intervention

Moeller (2000) found that age of enrollment made significant predictions about vocabulary outcomes of 112 5-year-old children with significant hearing loss and no additional disabilities. However, 97 of the 112 children were enrolled after the age of 11 months. Mean comparisons of groups by age of enrollment indicated that even when family involvement was rated at the lowest level, those early-enrolled families had children with significantly higher vocabulary scores than the other three groups. When focusing on the earliest enrolled group, although a vocabulary score difference still existed between those children with the highest family involvement (standard score = 100) versus the lowest family involvement (standard score = 80), the scores were within the low average range even for those with the lowest family involvement. Future research will hopefully investigate the variables that predict family involvement.

Early-Identification/Intervention, Developmental Outcomes, and Demographic Variables

Relationship Between Early-Identification/ Intervention, Language Outcomes, and Age at Testing

Yoshinaga-Itano et al. (1998) reported that the language advantage that characterized the EID group was present at all test ages. EID children had significantly higher language development than LID children when tested at 12 months, 18 months, 24 months, 30 months, and 36 months. Thus, the impact of early identification and intervention can be observed at 12 months of age and throughout the first 3 years of life.

Analysis of approximately 60 children between 3 and 4 years of age with longitudinal language scores indicates that language development of both EID and LID children remains very stable over this period of time (Stevens, 2002). Moeller (2000) found a language advantage of children with early intervention prior to 12 months of age at a test age of 5 years of age. Calderon (2000) found a language advantage of children who enrolled earlier into intervention services when children were tested between 45 and 88 months of age.

Relationship Between Early-Identification/ Intervention, Developmental Outcome, and Mode of Communication

The studies discussed in this section indicate that early identification of hearing loss with early intervention was associated with better language development for all families regardless of method of communication. Families with early identification and early intervention who chose oral methods of communication, as well as those whose families chose communication with sign language, had children with significantly higher language quotients than children who were later-identified. No significant difference in the language quotients of the children by mode of communication selected by the families was found.

Expressive and receptive language. Apuzzo and Yoshinaga-Itano (1995), Yoshinaga-Itano et al. (1998), and Yoshinaga-Itano and Apuzzo (1998a, 1998b) found no significant differences between the language outcomes, based on the MCDI Expressive Language, and Comprehension Conceptual subscales, of children whose families chose an oral-aural method of communication as compared to families who chose a method of communication that included the use of sign language. Mayne (2000) and Mayne, Yoshinaga-Itano, and Sedey (2000) reported that mode of communication was not a significant predictor of receptive or expressive vocabulary production based on the MacArthur CDI. Moeller (2000) similarly found that language development of the 112 5-year-old children was not significantly different by mode of communication.

Speech production: Number of vowels, number of consonants, number of initial and final blends, and overall speech intelligibility. Yoshinaga-Itano and Sedey (2000) reported that mode of communication accounted for a very small amount of the variance (4% of 86%) in speech production from 12 to 60 months of age, after the variance accounted for by age, expressive language development, and degree of hearing loss. The participants in that study included children with mild to profound hearing loss. For only the children with severe and profound hearing loss who developed intelligible speech, 50% of the severe hearing loss group had families who had chosen sign language, and 50% were in families who had chosen oral speech only. Only 2 children of 34 children with profound loss developed intelligible speech by 5 years of age and had families who had chosen an oral-aural approach.

Social-emotional development. Yoshinaga-Itano and Abdala de Uzcategui (2001) found no significant differences by mode of communication for the personal-social development of D/HH children as measured by the MCDI. Pipp-Siegel, Sedey, and Yoshinaga-Itano (2001) reported that no significant differences by mode of communication were found for the subscales on the Parental Stress Inventory. Additionally, we have found no significant differences by mode of communication in measures of emotional availability of the parent to the child and the child to the parent (Pressman, Pipp-Siegel, Yoshinaga-Itano, & Deas, 1999), the child temperament trait of mastery motivation (Pipp-Siegel, 1999b), and the development of self (Pipp-Siegel, 1999a).

The Relationship Between Degree of Hearing Loss, Age of Identification/Intervention and Developmental Outcomes

Language. Little research has specifically addressed the relationship between the degree of hearing loss and language outcome among children with mild to profound hearing loss at all ages or even for preschool-age children. The most comprehensive study of the language development of preschool-age children was conducted by Musselman, Wilson, and Lindsay (1988) on a population of children from Ontario, Canada. This study included 118 children with bilateral severe to profound sensori-neural hearing loss (better pure tone average ≥65 decibels). Significant relationships between hearing threshold level and receptive and expressive language measures were found. This study population differed from the Colorado studies because only children educated through oral-aural means of communication were included.

A majority of studies in the literature found students with a less than severe hearing loss (ranging from 15 to 70 dB HL) performed better on measures of reading and language than those students with both severe and profound degrees of hearing loss (Allen, 1986; Brannon, 1968; Brannon, & Murry, 1966; Davis, 1974; Davis, Shepard, Stelmachowicz, & Gorga, 1981; Elliot, Hirsch, & Simmons, 1967, Holt, 1993; Karchmer, Milone, & Wolk, 1979; Yoshinaga-Itano & Downey, 1996). Significant differences in language and academic achievement have been reported by some researchers based on degree of hearing loss for those students with severe to profound sensori-neural hearing loss (Holt, 1993; Karchmer et al., 1979; Musselman et al., 1988; Yoshinaga-Itano & Downey, 1996).

Other studies with subgroups of participants with mild to profound hearing loss failed to find differences by degree of hearing loss (Davis, Elfenbein, Schum, & Bentler, 1986; Moeller, 2000). Based on the findings from other studies that primarily included children with LID hearing loss, degree of hearing loss has previously been found to have a variable relationship with language outcome. It is possible that early identification and early intervention mediate the relationship between language development and degree of hearing loss within the first few years of life. However, as children age, even with earlier identification, degree of hearing loss may have a greater influence on language development.

Yoshinaga-Itano et al. (1998) found that EID children with mild, moderate, moderately severe, severe, and profound hearing loss had similar language development in the first 3 years of life. EID children, regardless of degree of hearing loss, had language development that was 90% of their chronological age if they had no additional disabilities. When children with hearing loss only were identified later, their language development was significantly better with better hearing, and, on average, the LID children had language development that was 70% of their chronological age.

Moeller (2000) also found that degree of hearing loss did not predict language outcome in her study of 112 5-year-old children. Several studies also found that degree of hearing loss did not predict general language ability as measured by the MCDI (Apuzzo & Yoshinaga-Itano, 1995; Yoshinaga-Itano & Apuzzo, 1998a, 1998b; Pipp-Siegel et al., in press; Pipp-Siegel, Blair, Deas, Pressman, & Yoshinago-Itano, 2000; Pressman et al. 1999, 2000). Degree of hearing loss did not predict receptive vocabulary nor expressive vocabulary (Mayne et al., 2000).

Social-emotional outcomes. Degree of hearing loss was not found to predict parental stress (Pipp-Siegel et al., 2002), the development of self (Pipp-Siegel, 1999a), or emotional availability (Pressman et al., 1999). Degree of hearing loss was not a significant variable in the pilot study of grief resolution (Pipp-Siegel, 1999).

Speech production. Degree of hearing loss was a significant predictor of the variance in number of vowel types, number of consonant types, number of initial blends, number of final blends, and overall speech intelligibility (Yoshinaga-Itano & Sedey, 2000). Age of the child and expressive language accounted for a greater proportion of the variance in speech production than degree of hearing loss. Calderon (2000) reported that degree of hearing loss was a significant predictor of speech production at 36 months of age. Yoshinaga-Itano and Apuzzo (1998a) in a study that included children with mild to profound hearing loss, reported that vowel

production and consonant production were better for children with more hearing.

The Relationship Between Ethnicity, Age of Identification/Intervention, and Developmental Outcomes

The historical literature in deafness contains developmental data indicating that children from ethnic minority backgrounds have significantly lower academic and language achievement than those children from ethnic majority backgrounds (Holt, 1993; Schildroth & Hotto, 1993a, 1993b). The Colorado population of D/HH children is approximately 75% Caucasian or non-Hispanic, 20%–25% Hispanic, and 1%–5% other (Asian, Native American, African American). As mentioned, the Colorado population has proportionately fewer children in African American and Asian/Asian American families than represented in the national statistics.

Quite a few studies have found strong relationships between educational performances and ethnicity. However, the confounding relationship between ethnicity and SES has rarely, if ever, been studied (Allen, 1986; Allen & Osborn, 1984; Kluwin, 1994; Kluwin & Stinson, 1993; Powers, 1996). Deaf learners from ethnic backgrounds are less likely to be mainstreamed and attain overall poorer performance in education (Mertens, 1990).

EID children from Caucasian non-Latino (predominantly Hispanic, Mexican, or Mexican-American) ethnic backgrounds, as compared with EID children from Caucasian-Latino and non-Caucasian ethnic backgrounds, evidenced significantly better language development than their LID counterparts (Yoshinaga-Itano et al., 1998).

There was no significant difference between the language outcomes by ethnicity group (Apuzzo & Yoshinaga-Itano, 1995; Pipp-Siegel et al., in press; Pressman et al., 1999; Yoshinaga-Itano et al., 1998). Ethnicity did not predict receptive or expressive vocabulary on the MacArthur Communicative Inventory (Mayne, Yoshinago-Itano, Sedey, & Carey, 2000; Mayne et al., 2000). Ethnicity did not significantly predict parental stress (Pipp-Siegel et al., 2001). Ethnicity did not significantly predict speech intelligibility or number of consonants produced in a spontaneous parent-child conversation (Yoshinaga-Itano & Sedey, 2000).

The Relationship Between Gender, Age of Identification/Intervention, and Developmental Outcomes

Girls in the Yoshinaga-Itano et al. (1998) study had significantly lower language quotients than boys. Because this finding is the reverse of what would normally be anticipated in a typically developing sample of children at these ages, further investigation was warranted. The MCDI provides different language ages for the same raw score, adapting the test to the gender difference typically found. The raw scores of the boys and girls were not significantly different. Thus, the unusual finding was due to the separate gender norms of the test itself. The early identification effect was found for both girls and boys.

Gender did not significantly predict parental stress (Pipp-Siegel et al., 2001), speech intelligibility and number of consonants (Yoshinaga-Itano & Sedey, 2000), receptive vocabulary (Mayne et al., 2000), expressive vocabulary (Mayne et al., 2000), or general language development (Pressman et al., 1999, 2000), Pipp-Siegel et al., in press).

Gender differences for deaf students generally reflect those found for hearing pupils, with girls scoring more highly on reading in two studies (Allen, 1986; Allen & Osborn, 1984). However, a number of studies of D/HH children did not find significant gender differences (Kluwin, 1994; Wood et al., 1986).

The Relationship Between Socioeconomic Status, Age of Identification of the Hearing Loss, And Developmental Outcome

Socioeconomic variables have been associated with better language development of typically developing hearing children (Hart & Risley, 1995). In the first 3 years of life, higher SES does not appear to be associated with better language development in this sample of D/HH children.

Yoshinaga-Itano et al. (1998) found that EID children from families with low, middle, or high SES, as

measured by maternal level of education and qualification for Medicaid (Medicaid qualification is determined by family income), had better language development than children who were LID, regardless of socioeconomic level. These findings differ somewhat from the language development of children with normal hearing. These findings may indicate that intervention techniques that characterize the home intervention program (when children are between birth and 3 years of age) provide an equalizing effect to the normal advantages associated with greater income and higher education. This sample contained a significant number of families with very low incomes and low educational levels.

Calderon (2000) reported a significant relationship between maternal communication skills and SES in a study of 80 children enrolled in an early intervention program and tested between 45 and 88 months of age. All but nine of these children were enrolled in intervention after 12 months of age. Teacher-rated maternal involvement was also significantly related to maternal education and SES.

The Relationship Between Age of Identification, Presence of Additional Disabilities, and Developmental Outcome

A significant number of D/HH children have secondary disabilities. The language advantage associated with early identification/intervention was found for both children with hearing loss only and children with secondary disabilities. As mentioned previously, when identified early, children with secondary disabilities had nonverbal symbolic play development similar to their language development, while LID children with secondary disabilities had more than a 10-point discrepancy between their nonverbal cognitive development and their language development. These differences are smaller than those for children without additional disabilities because the range of development is considerably smaller for this group of children.

Yoshinaga-Itano et al. (1998) found that EID children with secondary disabilities had remarkable similarities in language quotients to LID children with hearing loss only. Both groups were significantly different from EID children with hearing loss only, but not from one another (see Figure 4). The LID children with additional disabilities had the lowest language development. Later identification of hearing loss with later onset of intervention services results in language development more similar to that of multiply disabled children who are identified early than that of children with no other disabilities.

Presence or absence of additional disabilities is a significant predictor of general language ability (Pipp-Siegel et al., in press; Pressman et al., 2000,); receptive vocabulary (Mayne et al., 2000); expressive vocabulary (Mayne et al., 2000); number of vowel types, consonant types, initial and final blends, and overall speech intelligibility (Yoshinaga-Itano & Sedey, 2000); and parental stress (Pipp-Siegel et al., 2002).

Conclusions

Studies involving children in CHIP indicate that diagnosis of hearing loss within the first few months of life allows the opportunity to begin early intervention services for families with infants and that this early identification and early intervention results in significantly better language, speech, and social-emotional development. These results have been replicated by Moeller (2000) in a sample of children from Nebraska and by Calderon and Naidu (2000) and Calderon (2000) in a sample of children from western Washington state. In previous generations, children with hearing loss were identified at average ages of 2 and 2.5 years of age, after significant opportunities for the development of age-appropriate language had passed. Earlier diagnosis allows the families to obtain information and receive counseling support over a longer period of time. The children are not yet delayed in their language development, and families have the opportunity to provide their children with access to language that could prevent significant delay.

Parent-infant facilitators/providers in the CHIP program have had an average of 10 to 15 years of experience with parent-infant intervention and participate in ongoing regular in-service training workshops, and initiation of intervention services is provided almost immediately after the diagnosis of the hearing loss. Extensive emphasis has been placed on teaching counseling strategies such as theories of family systems, maternal bonding theories, social-emotional development, and

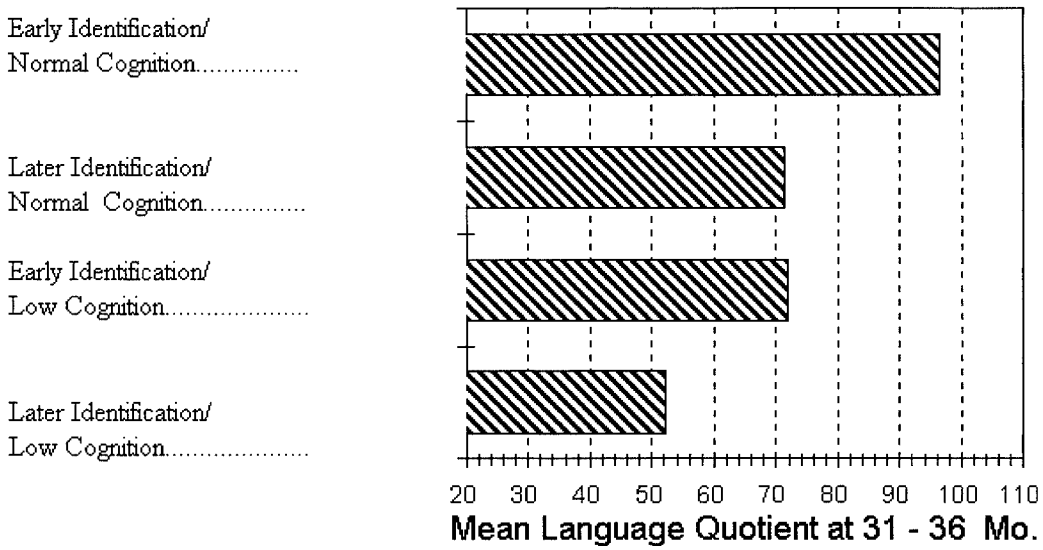

Figure 4 Mean total language quotient scores at ages 31 to 36 months by age of identification of hearing loss and cognition. (Reprinted with permission from Yoshinaga-Itano, Sedey, Coulter, & Mehl [1998], *Pediatrics, 102*[5], 1161–1171.)

grief resolution strategies. Additionally, the parent-infant providers have received intensive training in teaching parents about auditory skills development, particularly within the first few months and years of life, early speech development and appropriate language stimulation methods. Parents have the opportunity of receiving sign language instruction from native or fluent users of ASL who are deaf or hard of hearing. They may also receive their primary parent-infant intervention from a provider who is deaf or hard of hearing or a hearing professional certified as an auditory-verbal therapist or an auditory-oral therapist. A cadre of approximately 60 community members who are deaf or hard of hearing is available to families as role models and supports. Additionally, a statewide network of parents with D/HH children is available to families for support, advice, and advocacy. Families may combine services in ASL with services from providers who describe their intervention strategies as traditionally auditory-oral or auditory-verbal. This service provision differs from the traditional total communication services where speech and sign language may be combined but through the services provided by a single professional. This familiar type of intervention, a simultaneous communication program, is also available as an option for parents. Intervention services utilizing Cued Speech are also available to families, although not many families have chosen this method in Colorado.

Several outcomes have been observed for EID children with significant hearing loss in Colorado. A significantly higher number of children have developed and maintained age-appropriate language skills, both orally and in sign language. There is a significantly more competent sign language level of children entering kindergarten. Most children with all degrees of hearing loss except profound (when using traditional amplification) have developed intelligible speech by entrance to kindergarten, regardless of their mode of communication and even when they have additional disabilities. In general, the research indicates that more children are linguistically competent in two modalities, visual and auditory.

The method of coding families by mode of communication needs to be further explored. Regardless of whether the family received services from deaf or hearing providers, very few of the families actually used ASL as the primary mode of communication in the home. The intensity of service delivery, however, is very low, only 1 to 1.5 hours per week, insufficient to rapidly develop fluency. The families tended to use sign support to speech in English word order. Initially, family skill levels in sign language are at very beginning ability levels,

some families become more proficient as their child prepares to enter preschool (3 to 5 years) programs. Some families who have chosen oral methods of communication use very small amounts of oral conversation, while some families who have chosen sign language communication use small amounts of sign language and large amounts of speech. Measures of parent sign language skill have also been collected, as well as the amount of sign language used in spontaneous conversation and the accuracy of the sign language. Analysis of these measures has not yet been accomplished. The skill of the family in the use of the method of communication must play a significant role in the development of language.

The predictor variables for successful outcomes of EID children appear to differ from those of LID children. Future research should focus on the separation of these two groups to provide information about the unique intervention needs of each.

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Received July 9, 2001; revisions received April 26, 2002; accepted May 6, 2002