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Developmental Outcomes of Early-Identified Children who are Hard of Hearing at 12 to 18 Months of Age

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1. Introduction

Over the past decade, universal newborn hearing screening (UNHS), improved screening techniques, and the committed efforts of Early Hearing Detection and Intervention (EHDI) programs have helped to lower the age at which children with congenital hearing loss are identified. Before the implementation of UNHS, the average age of identification of congenital childhood hearing loss in the United States was 2 to 3 years [1]. However, children with mild to moderate hearing loss frequently were not identified until they entered school [2]. As a result of the widespread adoption of EHDI programs across the country, children with hearing loss of varying degrees are now being identified, on average, by 3 months of age [3].

Although it is well documented that children with congenital hearing loss are at risk for speech-language delays, poor academic achievement, literacy delays, and psychosocial difficulties in comparison to their peers with normal hearing [4], a substantial body of research evidence indicates that early detection and intervention can help reduce negative outcomes for these children [5]. Much of the outcomes research on children with hearing loss, however, has focused on children with severe and profound hearing loss (> 70 dB HL) and, more recently, children with cochlear implants. Significantly less attention has been given to developmental outcomes for children who are hard of hearing (i.e., those children with better-ear pure-tone averages between 25 and 79 dB HL, who typically receive benefit

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from hearing aids and do not use cochlear implants). Of the few studies that have investigated outcomes for children who are hard of hearing, most have involved school-aged children whose hearing losses were identified after 2 years of age with hearing aids fitted later [6,7]. Consequently, we know relatively little about the developmental outcomes and intervention needs for very young children who are hard of hearing, especially those identified within the first few months of age.

Prior to the implementation of EHDI programs, most studies reported adverse language outcomes for children who are hard of hearing, especially in the areas of phonology, morphology, vocabulary, and syntax [8]. Though relatively limited in scope, more recent research suggests that young children with mild to moderate hearing loss, who are identified early, amplified by 3 months of age, and enrolled early in early intervention by 6 months of age, may not show language delays to the same extent as do children who are later identified (> 6 months of age) [9].

Given the well documented associations between language delays and behavioral, social, and emotional difficulties in the general population of hearing children [10], it is not surprising that children with hearing loss have been found to evidence in general more behavioral and social problems than typical hearing peers. In particular, children with severe and profound hearing loss have been noted to exhibit problems with externalizing and internalizing behaviors, attention, emotional regulation, and social understanding [11]. Although there is some evidence that school-aged children with mild and unilateral hearing loss also are prone to elevated rates of emotional and behavior difficulties [6], we do not know whether younger children who have been identified through EDHI programs and provided early intervention services exhibit similar types and frequencies of psychosocial problems.

Over the years, research has linked a variety of child and parent factors with developmental outcomes of children with severe and profound hearing loss. These factors include severity of hearing loss, gender, presence of additional disabilities, maternal education, ethnicity, and family socioeconomic status (SES). Whether these particular variables contribute significantly to early developmental outcomes of children who are hard of hearing is not well known. Further, the extent to which early intervention services may help moderate developmental risks associated with certain child and parent factors (e.g., severity of hearing loss, low SES) has not been adequately examined for children who are hard of hearing.

Recently there has been an increased interest in examining the influences of parenting factors for children with hearing loss [12, 13]. This new line of investigation is not surprising, as an extensive body of literature has shown strong relationships between maternal self-efficacy, parenting stress, and developmental outcomes for children with normal hearing. Specifically, higher maternal self-efficacy and lower parenting stress have been linked with more positive child outcomes, including age-appropriate language development, better academic achievement, and healthier social-emotional adjustment [14].

Surprisingly few studies have examined the relationship between self-efficacy of mothers of young children with hearing loss and children’s developmental outcomes. In a study by

DesJardin and Eisenberg [13], mothers of preschool children with cochlear implants who felt more knowledgeable and efficacious in developing their children's language skills provided their children with higher-level language strategies, including parallel talk and open-ending questioning. Moreover, these facilitative language techniques were positively associated with children's spoken language skills. In a follow-up study, DesJardin [15] found mothers of children with severe to profound hearing loss who used hearing aids to have lower self-ratings of self-efficacy and involvement in their child's sensory device use and speech-language development than mothers of children with cochlear implants. Neither of these studies, however, included children with milder degrees of hearing loss.

Although parenting stress among mothers of children with hearing loss has received considerable attention, research findings have been inconsistent. Some studies report significantly higher levels of stress for parents of children who are deaf or hard of hearing than for parents of children with normal hearing [16], and other studies reporting no differences between groups [17]. These contradictory findings have been attributed to a variety of factors, including differences in study sample size, child age, degree of hearing loss, and assessment instruments used to measure parenting stress. However, Meinzen-Derr, Yim, Choo, Buyniski, and Willey [18] suggested that the types of parenting stressors experienced by parents of children with hearing loss may be different than those experienced by parents of children with normal hearing and, importantly, that these parental stressors evolve over time. Moreover, they asserted that in order to provide appropriate support services to promote optimal child development, it is imperative we have a better understanding of the specific concerns that burden parents of children with hearing loss across the lifespan. Currently, we have limited knowledge regarding the parenting stress that may be experienced by mothers of very young, early-identified children who are hard of hearing.

The primary aim of this study was to examine the early developmental outcomes, including language skills, social-emotional functioning, and adaptive behavior, for very young children who are hard of hearing compared with those for children of similar age with normal hearing. A secondary aim was to explore the associations between child, maternal, and parenting factors, and developmental outcomes for children 12 to 18 months of age who are hard of hearing.

2. Methods

2.1. Study Population

As part of a longitudinal prospective outcome study, a culturally diverse cohort of 28 children ages 12 to 18 months with bilateral mild to severe hearing loss and their parents were identified for inclusion in our investigation. Forty-two children of similar age with normal hearing and their parents were enrolled for comparison purposes. All children and their parents were recruited through two prominent pediatric audiology clinics located in Los Angeles and Indianapolis. Research procedures were approved by each center's Institutional Review Board, and written informed consent was obtained from parents.

Children with hearing loss were eligible to participate if they had: (a) confirmed permanent hearing loss bilaterally, with a 4-frequency pure-tone average of 20 to 89 dB HL in the better ear (PTA-BE); (b) at least one parent or primary caregiver at home who spoke English; and (c) no other known significant physical, neurological, cognitive, or visual impairments. Children with normal hearing were eligible for participation if they met the same criteria except that they demonstrated PTAs of < 20 dB HL for both ears.

Two children with hearing loss and three children with normal hearing were excluded due to medical issues and observable developmental delays. Four children with normal hearing were evaluated by the research team but judged inappropriate for inclusion in the final analyses due to apparent neurological impairments or off-task behaviors during testing that deemed test results invalid.

2.2. Procedures

Each child participated in a comprehensive assessment administered by the project's research team comprised of certified speech-language pathologists, audiologists, and a clinical psychologist experienced in working with children with hearing loss. Testing was conducted over a 1 to 2 day period. The child's cognitive, language, and social-emotional skills and adaptive behavior were assessed through standardized, clinician-administered measures, questionnaires, and a semi-structured parent interview. Parents provided sociodemographic information and, when applicable, details about the child's hearing loss, diagnostic history, use of amplification, and participation in early intervention services. In addition, parents completed self-report measures of parenting stress and maternal self-efficacy. All measures employed demonstrate excellent psychometric properties and are routinely used in both research and clinical practice with young children.

Audiological evaluations were completed on the children either at the time of their assessment or shortly before at pediatric audiology centers connected to the research sites. Assessments included pure tone audiometry, speech detection thresholds, and speech recognition measures. Tympanometry and acoustic reflex threshold testing were conducted when middle ear disorder was suspected. The average of air-conduction pure tone thresholds at 500, 1000, 2000, and 4000 Hz (PTA_4) was calculated for each ear. The pure-tone average in the better hearing ear was used for the purpose of quantifying and classifying degree of hearing loss. For the children who are hard of hearing, the interval between age of confirmation of hearing impairment and age at initial hearing aid fitting was obtained from parent reports and audiologic records.

2.3. Measures

2.3.1. Demographic information and early intervention services—Family and child demographic information was obtained by a parent-completed questionnaire. Family variables included parents' ages, race/ethnicity, marital status, levels of education, primary language spoken in the home, and household annual income level. Child variables included age, gender, race/ethnicity, health status, and audiologic history if applicable. The questionnaire also included questions for the parents of children with hearing loss regarding their experiences with early intervention services. Specifically, parents were asked whether

their child received early intervention services and, if so, the types of services received, when they began, where the services were provided (i.e., home or outside the home), who provided the services, and the frequency of services provided. In addition, parents were asked to rate the quality of early intervention services received and indicate to what extent early intervention professionals helped them understand their child's special needs and development.

2.3.2. The Mullen Scales of Early Learning (MSEL)—The MSEL [19] is an individually administered measure of early developmental abilities for young children from birth to 68 months. The MSEL assesses developmental abilities across 5 skill domains: Visual Reception, Receptive Language, Expressive Language, Fine Motor, and Gross Motor (mean *T* score = 50, *SD* = 10). The Early Learning Composite, derived from 4 mental scales, measures global development abilities and is reported as a standard score (mean = 100, *SD* = 15). Higher scores reflect better development. The MSEL was standardized on a nationally representative sample and has a strong theoretical base in information processing and neurodevelopmental theories. The MSEL shows good test retest reliability coefficients (.82 to .85), internal consistency coefficients (.83 to .93), and interscorer reliability (.91 to .99).

2.3.3. Preschool Language Scale-Fourth Edition (PLS-4)—The PLS-4 [20] is a clinician-administered standardized test that assesses language skills of children from birth to 6 years, 11 months of age. The PLS-4 yields standardized scores, percentile ranks, and age-equivalent scores for Total Language, Auditory Comprehension, and Expressive Communication scales. The PLS-4 evaluates communication skills that are important precursors for language development (e.g., attention to the speaker, appropriate object play, vocal development), as well as more advanced receptive and expressive language skills (e.g., understanding and using basic vocabulary and concepts, naming objects, grammatical markers, social communication). The PLS-4 was standardized on a representative sample of American children collected in 2001. Test-retest reliability coefficients range from .82 to .95 for the subscale scores and .90 to .97 for the Total Language score. Internal consistency reliability coefficients range from .66 to .99.

2.3.4. MacArthur – Bates Communicative Development Inventories (CDI)—The CDI [21] is a standardized caregiver-report questionnaire of emerging and early receptive and expressive communication skills. The CDI has two age-related forms. For children younger than 16 months, parents completed the Words and Gestures (W&G) form; for children between the ages of 16 and 30 months, the Words and Sentences (W&S) form was completed. The CDI uses a recognition format, whereby parents check the words that their child produces. Percentile scores were computed for number of words produced in comparison to the norm population. Scores below the 10th percentile reflect delayed productive vocabulary. The CDI has excellent internal consistency (alpha = .96) and good to excellent test-retest reliability (r = .60 to .95), with lower coefficients shown for children assessed at ages 12 months and younger.

2.3.5. The Infant-Toddler Social and Emotional Assessment (ITSEA)—The ITSEA [22] is a 166-item parent-report questionnaire that assesses social-emotional/

behavior problems and competencies of children ages 12 to 36 months. Using a 3-point scale, parents rate the degree to which their child exhibited certain behaviors during the past month. A “no opportunity” code allows parents to indicate that they have not had the opportunity to observe certain behaviors (e.g., behavior with peers). Age-specific *T* scores (mean = 50, *SD* = 10) are calculated for four domains: Externalizing (activity/impulsivity, aggression/defiance, peer aggression); Internalizing (depression/withdrawal, general anxiety, separation distress, inhibition to novelty); Dysregulation (negative emotionality, sleeping, eating, sensory sensitivity); and Competence (mastery motivation, imitation/play, empathy, prosocial/peer relations). Higher scores on the problem domains (Externalizing, Internalizing, Dysregulation) represent increased behavioral and emotional problems, whereas higher scores on the social-emotional competence domain (Competence) indicate greater competence. For the problem domains, a *T* score of 65 and higher is considered significant for adjustment difficulties. For the Competence domain, a *T* score of 35 or lower reflects substantial deficit or delay. The ITSEA has acceptable internal consistency reliability, with coefficients for the 4 domains ranging from .85 to .90, and for the 17 scales ranging from .52 to .83. Test retest reliability of the ITSEA is good to excellent (alpha = .76 to .91).

2.3.6. Vineland Adaptive Behavior Scales, Second Edition (Vineland-II)—The Vineland II [23] measures adaptive functioning of individuals from birth to adulthood. The authors define adaptive behavior as the performance of age-appropriate daily activities required for personal and social sufficiency. Adaptive behaviors involve real life skills such as grooming, dressing, eating, following school rules, and making friends. Using a semi-structured interview, the parent or caregiver is asked to describe the child’s typical performance in everyday activities, including Communication, Daily Living Skills, Socialization, and Motor Skills. Standard scores (*M* = 100, *SD* = 15), percentile ranks, adaptive levels, and age equivalent scores are generated for 4 global domains and the Adaptive Behavior Composite; the 11 subdomains yield *v*-scale scores (*M* = 15, *SD* = 3), adaptive levels, and age equivalents. Reliability and validity information on the Vineland-II is quite extensive, and outlined within the manual. For the age groups under 3 years, internal consistency coefficients ranged from .79 to .95 for the 4 global domains and from .95 to .98 for the Adaptive Behavior Composite. Retest reliability coefficients for children younger than 3 years ranged from .75 to .96.

2.3.7. The Parenting Stress Index-Short Form (PSI-SF)—The PSI-SF [24] is a 36-item parent self-report questionnaire designed to measure perceived parenting stress in response to the parenting role. It yields 3 scales: Parental Distress (i.e., stress related to personal factors, such as limited parenting skills, lack of social support, presence of depression); Parent-Child Dysfunctional Interaction (i.e., stress related to how the parent perceives the interaction with the child and whether the child meets the expectations of the parent and is seen as reinforcing); and Difficult Child (i.e., stress related to the behavioral characteristics of the child that makes that particular child either difficult or easy to manage). Parents rate each item on a 5-point Likert type scale, ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). A PSI-SF Total Stress score is calculated by combining scores on all 36 items, with a higher total score indicating greater parenting stress. Parents

who obtain scores at or above the 85th percentile are considered to be experiencing clinically significant levels of stress. The PSI-SF scales show high internal consistency, with alphas of .80 to .91, and good to excellent test–retest reliability, ranging from .68 to .85 over a 6-month period.

2.3.8. Maternal Self-Efficacy Scale—The Maternal Self-Efficacy Scale (MSE) [25] consists of 10 items that are rated by the mother on a 4-point scale (1 = *not good at all*, 2 = *not good enough*, 3 = *good enough*, and 4 = *very good*). Nine of the 10 items assess the mother's perceived efficacy in relation to specific domains of child care (e.g., understanding what the child wants, soothing the child when the child is upset). A final item evaluates the mother's global feeling of efficacy in mothering. Item scores are summed to yield a total maternal self-efficacy score; higher scores indicate greater maternal self-efficacy. The authors of the MSE report a Cronbach's standardized item alpha of .79 to .86 for the scale. Significant negative correlations between scores obtained on the MSE and the Parental Stress Index Sense of Competence Scale (r = .75, p = .001) are presented as evidence of reliability and concurrent validity.

3. Statistical Analysis

Descriptive statistics were used to characterize the study sample and performance on the developmental and functional outcome measures. Bivariate analysis, chi-square (χ^2), Mann-Whitney *U* test, and analysis of variance (ANOVA) were used to examine differences between groups. Relationships between child, parent, and parenting variables and outcome measures were examined using either Pearson's *r* or Spearman's correlation (rho), as appropriate.

4. Results

4.1. Child and Parent Characteristics

The two groups of children were similar on age, gender, race, and ethnicity (Table 1). Although the study sample was predominantly Caucasian (hard of hearing = 79%; normal hearing = 81%), the sample was diversified relative to ethnicity with 32% of the children with hearing loss and 22% of the children with normal hearing identified as Hispanic. All of the mothers indicated that they spoke primarily English with their child. However, parent questionnaires revealed that all the Hispanic children, except one child with normal hearing, were exposed to Spanish within the home on a daily basis (for example, when interacting with their father, grandparents, or caregiver whose primary language was Spanish). Except for one Asian child with hearing loss whose parents spoke Mandarin approximately 50% of the time at home, all non-Hispanic children in the study had minimal exposure to languages other than English.

Audiologic information for the children who are hard of hearing is presented in Table 1. The PTA_4 for the better ear ranged from 28.8 dB HL to 76.0 dB HL across children; the overall group mean was 46.9 dB HL. For the majority of children, the better ear PTA_4 fell within the mild and moderate hearing loss ranges. This is consistent with the study goal of investigating developmental outcomes of children with hearing losses less severe in degree

than those typically studied in the past. Of the 28 children who are hard of hearing in the present sample, 10 had mild hearing loss (20–39 dB HL), 9 had moderate hearing loss (40–54 dB HL), 7 had moderately severe hearing loss (55–69 dB HL), and 2 had severe hearing loss (70–89 dB HL). All of the children had failed newborn hearing screening. The majority of parents (64%) reported that they did not know the cause of their child's hearing loss, whereas 36% indicated genetics as the etiology. All of the children received amplification soon after their hearing loss was confirmed (mean age of amplification = 5.1 months, *SD* = 2.9; mean time lapse between diagnosis and amplification = 3.4 months, *SD* = 2.7), and used amplification consistently throughout the day. Spoken language, rather than sign language, was reported by all parents as the primary mode of communication used at home with the children.

The two groups were comparable with respect to maternal demographic characteristics (Table 2). Most of the mothers were married (hard of hearing = 75%; normal hearing = 76%) and employed either fulltime or part-time outside the home (hard of hearing = 52%; normal hearing = 64%). A slightly larger percentage of mothers of children with normal hearing had obtained either a college or postgraduate degree than had mothers of children with hearing loss (64% versus 48%), but the difference between the two groups on maternal education was not statistically significant, χ^2 (4) = 3.85. p = .287. Family income for the sample was broadly distributed. A roughly equal proportion of parents in each group reported annual incomes of more than $100,000 (hard of hearing = 26%; normal hearing = 31%). However, 37% of the mothers of children with hearing loss and 31% of the mothers of children with normal hearing reported a household annual income of less than $50,000. Further, 15% of the parents of children with hearing loss (n = 4) and 12% of the parents of children with normal hearing (n = 5) reported incomes that placed their households below the US Census Bureau poverty thresholds [26].

4.2. Early Intervention Services

At the time of their initial assessment for this study, the children with hearing loss had been receiving early intervention services on average for 8 months, with the majority of parents (89%) reporting that services were provided through home visits. Approximately half of the parents identified speech-language therapy as the type of early intervention service received. Other services noted included "deaf and hard of hearing early intervention", Early Head Start for deaf and hard of hearing children, and occupational therapy. Slightly more than two-thirds of the families (68%) received services from one provider, 21% of the parents indicated two providers came to their home, and the remaining parents reported that three 3 or more individuals provided services to their child and family. Services were provided either once or twice a month, with the study sample divided equally on frequency of service delivery. The majority of parents (80%) rated the quality of services received as either "good" or "excellent". Almost all of the parents (88%) indicated that they felt the early intervention professionals helped them understand their child's needs and development, and taught techniques that they could use to promote their child's developmental progress. Although the majority of parents (67%) indicted that they were satisfied with their level of involvement in the decisions about their child's services, 22% of the parents reported that they wanted to be more involved.

4.3. Early Developmental Skills

Early developmental skills for both groups of children, as measured by the MSEL, are displayed in Table 3. The two groups differed significantly on the Early Learning Composite, $F(1,68) = 8.44$, $p = .01$, $\eta^2 = 0.11$, with the group of children with normal hearing demonstrating more advanced skills overall than the group of children who are hard of hearing. Despite this group difference, mean standard scores for both study samples fell in the average range relative to the test's normative sample (normal hearing: $M = 103.4$, $SD = 12.0$; hard of hearing: $M = 94.8$, $SD = 12.1$). A closer look at the individual domain scores revealed no significant differences between groups on nonverbal skills as measured by the MSEL Visual Reception, Fine Motor, or Gross Motor scales. However, the children with hearing loss obtained significantly lower scores than did the children with normal hearing on both the Receptive Language scale, $F(1,68) = 5.38$, $p = .02$, $\eta^2 = 0.07$, and the Expressive Language scale, $F(1,68) = 6.58$, $p = .01$, $\eta^2 = 0.09$. Although mean *T* scores for Receptive Language scale were within normal limits for both groups, 29% of the children with hearing loss ($n = 8$) and 14% of the children with normal hearing ($n = 2$) earned *T* scores that were 1.5 or more standard deviations below the normative mean. On the MSEL Expressive Language scale, 21% of the children with hearing loss ($n = 6$) compared with 7% of children with normal hearing ($n = 3$) scored at or below 1.5 standard deviations from the normative mean.

4.4. Language Skills

An analysis of variance (ANOVA) was used to assess differences between the two groups on the PLS-4 scales and the CDI for percentile for number of words the child says (see Table 2). No significant differences were found between groups on the PLS-4 Auditory Comprehension, Expressive Communication, or Total Language scales. In addition, based on results of the CDI, children with hearing loss were reported by parents as producing, on average, a similar number of words (percentile score) as those produced by children with normal hearing. Moreover, both groups of children achieved mean scores on the PLS-4 scales and the MCDI that fell solidly within normal limits relative to the respective test's normative sample. In fact, none of the children, either with or without hearing loss, obtained a PLS-4 Total Language standard score of 77 or below (1.5 standard deviation below the normative mean), which is the conservative cutoff score used by some school districts as indication of a significant language delay [45]. In addition, no child scored below the 10^{th} percentile on the MCDI, which also would have indicated developmental delay.

4.5. Social-Emotional Skills

As shown in Table 3, the two groups of children did not differ overall on the ITSEA problem behavior domains (i.e., Externalizing, Internalizing, and Dysregulation) or on the social-emotional competence domain (i.e., Competence). Moreover, group mean *T* scores on each primary ITSEA domain fell within normal limits in comparison with the test's normative sample. However, closer inspection of the ITSEA subscales revealed one significant group difference: Inhibition to Novelty scale within the Internalizing domain, $F(1,63) = 6.42$, $p = .01$, $\eta^2 = 0.09$. Interestingly, in this case, the group of children with normal hearing was rated by parents as demonstrating more behavioral difficulty (i.e., shy

with new adults and/or children) than was the group of children who are hard of hearing (normal hearing: $M = .74$, $SD = .43$; hard of hearing: $M = .48$, $SD = .37$). Further, whereas 12% of the children with normal hearing ($n = 5$) obtained scores on the Novelty scale that fell in the "at risk" range (i.e., ≤ 10th percentile rank), none of the children with hearing loss obtained scores in this range.

4.6. Adaptive Behavior Skills

When the two groups of children were compared relative to mean standard scores on the Adaptive Behavior Composite and individual domains, no significant group differences were found. In addition, none of the children's standard scores on the four Vineland II domains fell below 70, which is equivalent to 2 *SD* below the normative sample mean and represents the upper cutoff for significant impairment.

4.7. Parenting Stress and Maternal Self-Efficacy

As shown in Table 4, no significant group differences were found on self-reported levels of maternal self-efficacy (MSE) or indices of parenting stress (PSI-SF). Somewhat surprisingly, mothers of children with normal hearing reported significantly higher ratings on the Difficult-Child scale than did mothers of children who are hard of hearing (mean normal hearing = 22.1; mean hard of hearing = 18.6; $F(1,65) = 5.47$, $p = .02$, $\eta^2 = 0.08$). However, categorical analysis of scores on the Difficult-Child scale indicated that the children with normal hearing were no more likely to have scores in the clinical range (≥ 85th percentile) than were the children with hearing loss (hard of hearing = 7%; normal hearing = 5%; $p = .68$). Furthermore, although both groups included several subjects whose scores fell in the clinical range on the Parental Distress scale (hard of hearing = 11%; normal hearing = 10%), a significant group difference was not found.

4.7. Severity of Hearing Loss in Relation to Developmental Skills

A series of Pearson's product-moment correlations were conducted to examine associations between severity of hearing loss, based on PTA_4 in the better ear, and scores on developmental outcome measures. None of the correlation coefficients reached significance ($r = .02$ to $-.35$, $p > .05$), indicating that degree of hearing loss was not associated strongly with children's language skills, social-emotional functioning, or adaptive behavior outcomes at this very young age. In addition, severity of hearing loss was not significantly associated with early learning skills as measured by the MSEL Early Learning Composite ($r = -.07$, $p = .72$). Given the small effect sizes, the lack of association does not appear to be due to small sample size.

4.8. Child and Maternal Characteristics in Relation to Children's Developmental Skills

Univariate analyses were run to examine the effects of child's gender, race, and ethnicity, mother's education, and household annual income on children's scores on select measures of early developmental skills. These particular independent variables were chosen because of their known potential contribution to child developmental outcomes. No significant differences were found for either group of children based on child's gender, race, or mother's educational level. However, for the children with hearing loss, ethnicity showed a

significant effect on expressive language skills as measured by the MSEL, with Hispanic children performing lower than non-Hispanic children ($p < .001$). Ethnicity was not associated with children's scores on other measures of language skills (i.e., PLS-4 and CDI) or other targeted outcomes. In addition, for the children with hearing loss, family income was associated with child externalizing behaviors ($p < .001$), such that parents of lower economic status tended to report higher frequencies of externalizing behavior problems for their child.

4.10. Parenting Characteristics in Relation to Child's Development Skills

Bivariate associations between total perceived parenting stress, perceived maternal self-efficacy, and scores on outcome measures are reported in Table 5. Perceived parenting stress was negatively correlated with maternal self-efficacy for both groups. For the group of children who are hard of hearing, overall perceived parenting stress was negatively correlated with children's early learning skills and psychosocial competence, and positively correlated with children's behavior problems, including externalizing and dysregulation behaviors ($r = .41$ to .51). In contrast, perceived maternal self-efficacy showed significant positive correlations with children's early developmental abilities, language skills, and adaptive behavior, and significant negative correlations with children's problem behaviors, including externalizing, internalizing, and dysregulation behaviors ($r = .40$ to .55). For the group of children with normal hearing, significant positive correlations emerged between perceived parenting stress and child externalizing and dysregulation behaviors ($r = .32$ and .52, respectively), such that mothers reporting higher parenting stress endorsed more behavior problems for their child.

5. Discussion

With the implementation of UNHS, infants with milder degrees of hearing loss are being identified soon after birth in greater numbers than in the past. As a result, professionals are now faced with the challenge of providing appropriate and effective intervention to a population of children and their families about which relatively little is known. The present study represents one of the first comprehensive investigations of developmental outcomes specifically targeting young children who are hard of hearing (as opposed to deaf), who were early identified, and for whom intervention services (including amplification) were initiated soon after hearing loss was officially confirmed. The majority of children in our study are Caucasian. Nevertheless, our study sample includes an ethnically diverse group of children with approximately one-third of the children who are hard of hearing being Hispanic. Although mothers of the Hispanic children regularly used English when talking with their child, all the Hispanic children, except one child with normal hearing, were exposed to Spanish on a daily basis.

The results of our study indicate that overall the children who are hard of hearing demonstrate age-appropriate language skills. Although the children with hearing loss performed lower on the MSEL language scales than the children with normal hearing, the two groups did not differ significantly when scores obtained on more commonly used language assessment instruments were examined (PLS-4 and CDI). Moreover, all the children who are hard of hearing, except for two, achieved scores on the PLS-4 and CDI that

fell solidly in the average range. Because published literature relative to language outcomes for early identified children who are hard of hearing at 12 to 18 months of age is limited, it is difficult to make comparisons between our findings and previous research. However, our results are generally consistent with results of the study by Vohr et al. [27] that found that 12 to 16-month old children with mild or minimal hearing loss, who were identified early and enrolled in intervention at or before 3 months of age, exhibited expressive and receptive language skills that were comparable to skills demonstrated by their peers with normal hearing. Our results are also similar to those of Yoshinaga-Itano et al. [28] who reported finding no differences in language outcomes based on degree of hearing loss for very young children early identified (< 6 months of age). Collectively, these research findings provide strong indication that children with milder degrees of hearing loss, who are identified early and provided intervention services, are indeed able to acquire developmentally-appropriate language skills at ages 12 to 18 months. The results of our study expand on previous research by providing evidence that suggests that young children from ethnically diverse home environments, in which another language in addition to English is spoken, are able to acquire a solid foundation of early language skills. Of course, prospective studies are needed to verify whether these children's language skills remain stable.

We are not certain why group differences emerged in our study for children's scores on the MSEL language scales, when no differences were shown between group scores on the PLS-4, the MCDI, or the Vineland II Communication domain. We know that for the children who are hard of hearing, ethnicity had a main effect on their MSEL Receptive Language scores. However, a significant difference between the hard of hearing and normal hearing groups remained for scores on this scale even after controlling for the effect of ethnicity ($p = .02$). One possibility is that the discrepancies reflect subtle differences in test formats and task demands. The PLS-4 includes more items than the MSEL, which may provide smaller developmental increments between skills tested, especially at early ages. In addition, the PLS-4 includes many more items that assess nonverbal communication skills than does the MSEL. Closer examination of group differences on individual MSEL test items revealed several language skills that proved challenging for the children with hearing loss. For example, whereas 17% of the children with normal hearing ($n = 7$) pointed correctly to 1 to 3 body parts when named, only 1 child with hearing loss was able to complete this task successfully. In addition, in comparison to the children with normal hearing, proportionately fewer children with hearing loss demonstrated the ability to vocalize with inflection (36% versus 67%, $p = .01$) or communicate intentions by using jargon combined with gestures (29% versus 62%; $p = .01$). It is possible that a combination of factors, such as auditory perceptual deficits, the processing of speech via hearing aids, and/or developmental delays, explain these results. More in-depth analyses at subsequent assessments (i.e., when the children are 24 or 36 months) might better clarify this issue.

Topol et al. [29] reported internalizing behaviors and especially withdrawn behaviors to be more prevalent amongst children with mild and unilateral hearing loss than children with moderate to profound hearing loss. However, the results of our study showed no elevation in level of internalizing problem behaviors for the children who are hard of hearing, irrespective of degree of hearing loss. In fact, based on parent ratings on the ITSEA, the

children with normal hearing in our study were noted as demonstrating *more* inhibition and shy behavior in everyday situations than the children who are hard of hearing, though both groups scored overall within normal limits. Topol et al. suggested that the increased withdrawn behavior of the children with mild and unilateral hearing loss in their study may be related to the fact that the majority of the children with milder degrees of hearing loss were still not amplified by 18–24 months. In contrast, all of the children with hearing loss in our study were amplified, on average, by 5 months of age. We would propose another possible explanation for this group difference – that the children who hard of hearing in our study may be less shy in novel situations as a result of having been around many early intervention professionals at a very young age, whereas the children with normal hearing have not.

Consistent with previous research [4], the present study did not find a significant association between severity of hearing loss and early psychosocial outcomes, possibly suggesting that amplification provided adequate access to the sounds of speech at an early age.

Results of the present study indicated that mothers of very young children who are hard of hearing report similar levels of maternal stress as mothers of children with normal hearing. These findings are consistent with those reported by Pipp-Siegel et al. [17], Topol et al. [29], and Vohr et al. [27]. However, Quittner et al. [30] recently reported that mothers of young deaf children with cochlear implants did not indicate experiencing parenting stress when responding to a general measure of parenting stress, but did endorse elevated levels of stress when completing a rating scale designed to address issues specific to parenting a child with hearing loss. Lederberg and Golbach [16] noted a similar discrepancy between results obtained when first using a disability-specific measure of parenting stress, followed by a general measure. Our study used a measure of general parenting stress: the PSI-SF. Had a more disability-specific measure been employed, possibly greater parenting stress would have been indicated. On the other hand, the PSI-SF has been used successfully in numerous studies for differentiating rates of parenting stress among parents of children with various disabilities, cultural backgrounds, and socioeconomic levels [24]. As such, it may be the case, as Vohr et al. [27] speculated, that if a child's hearing loss is diagnosed early and intervention services are provided in a timely fashion, parents may be less likely to experience elevated levels of parenting stress.

In our study, mothers of children who are hard of hearing reported comparable levels of maternal self-efficacy as mothers of children with normal hearing. Of particular significance was the finding that, for the group of children who are hard of hearing, greater maternal self-efficacy was positively associated with children's better language skills, overall adaptive behavior, and social-emotional competence. Conversely, lower maternal self-efficacy was associated with a greater number of parent-reported child problem behaviors, including externalizing, internalizing, and dysregulation. Future research is needed to identify the specific maternal behaviors that influence optimal developmental outcomes for children who are hard of hearing.

Early intervention program models for children with hearing loss emphasize the importance of family-centered care that promotes partnership with families and self-efficacy in parents

(31). Previous research has shown that, in addition to age of enrollment in early intervention services, level of family involvement is a significant predictor of positive outcomes for children who are deaf or hard of hearing [5]. Although examining relationships between level of parent involvement and early developmental outcomes was not a direct focus of our study, information shared by the parents allows for at least a preliminary evaluation of their experiences and feelings regarding services delivered.

The majority of mothers enrolled in this study, in general, felt good about the quality of services delivered and satisfied with their level of involvement in decisions about their child's services. However, almost one-quarter of the mothers reported that they wanted to be more involved. Recognizing the value of parent involvement relative to child developmental outcomes, it is important for early intervention programs to find ways to actively engage parents as partners in their child's early intervention.

This study had several limitations. First, this study represented cross-sectional findings from the first assessment point of a 4-year longitudinal investigation. Because results reflect the developmental status of very young children at one point in time, predictive and causal relationships cannot be confirmed. It is not known whether these children's skills will continue to remain at age-appropriate levels, decline, or begin to show greater within group variability as the children grow older. Second, this study included a relatively small sample size of children who are hard of hearing, with a significant proportion of parents being college-educated and English speaking. As such, it is not certain whether these results can be generalized to the broader population.

On the other hand, these results provide new information regarding multiple domains of early development for a very young population of children who are hard of hearing. We obtained these data using a comprehensive diagnostic protocol that included a combination of direct testing, observation, and parent-report measures. A similar cohort of children with normal hearing was assessed for comparison purposes. This comprehensive assessment allowed for between group comparisons across developmental domains, as well as the opportunity to begin to identify profiles for very young children who are hard of hearing who may be at risk for future developmental delays. We anticipate that future analyses of longitudinal data collected for this study will add key information and significantly enhance our efforts to better understand developmental outcomes for early-identified children who are hard of hearing and the specific factors that influence those outcomes.

6. Summary and Conclusions

This study indicates that very young children with mild to severe hearing loss, who are identified early and provided prompt intervention that includes amplification, can demonstrate age-appropriate development in multiple domains. Results also underscore the significance of parent-related factors, especially perceived maternal self-efficacy, in influencing positive developmental outcomes for these children early in life. Although our findings offer a more optimistic picture with respect to developmental outcomes for children who are hard of hearing than did earlier studies of this population, caution should be used when interpreting these findings, as other recent studies involving slightly older children

who are hard of hearing have found that a significant percentage of the children displayed delayed language skills [32]. Although those findings are specific to language outcomes, they may suggest that differences in other developmental domains begin to emerge for children who are hard of hearing at later ages. We anticipate that as we continue to track the development of these children, factors that contribute to both positive and negative developmental outcomes will be better understood.

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Abbreviations

HL	hearing loss
UNHS	universal newborn hearing screening
EHDI	Early Hearing Detection and Intervention
PTA	pure-tone average
BE-PTA	better-ear pure-tone average
MSEL	Mullen Scales of Early Learning
PLS-4	Preschool Language Scale-Fourth Edition
MCDI	MacArthur-Bates Communicative Development Inventory
ITSEA	Infant-Toddler Social and Emotional Assessment; Vineland-II Vineland Adaptive Behavior Scales Second Edition
PSI-SF	Parenting Stress index-Short Form
ANOVA	analysis of variance
NIDCD	National Institute on Deafness and Other Communication Disorders

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Highlights

- We examine the developmental outcomes of children who are hard of hearing at ages 12–18 months.
- Children with hearing loss were comparable to children with normal hearing on select outcomes.
- Greater maternal self-efficacy was associated with children's positive development.

Table 1

Demographic characteristics of children in the study sample.

	Hard of Hearing (*n* = 28)	Normal Hearing (*n* = 42)	*p*-value
Age in months, *M* (*SD*)	13.2 (1.4)	13.0 (1.5)	0.62
Female gender, *n* (%)	16 (57)	23 (55)	0.84
Race, *n* (%)			0.21
White	19 (68)	34 (81)	
Black	2 (7)	5 (12)	
Asian	3 (11)	1 (2)	
Mixed	4 (14)	2 (5)	
Ethnicity, Hispanic, *n* (%)	9 (32)	9 (21)	0.41
Exposure to Spanish at home on a daily basis	9 (32)	8 (19)	0.21
Unaided PTA_4 in better ear (dB HL), *M* (*SD*)	46.9 (13.0)	NA	
Severity of hearing loss in better ear, *n* (%)			
Mild (PTA_4 = 20–39 dB HL)	10 (36)	NA	
Moderate (PTA_4 = 40–54 dB HL)	9 (32)	NA	
Moderately Severe (PTA_4 = 55–69 dB HL)	7 (25)	NA	
Severe (PTA_4 = 70–89 dB HL)	2 (7)	NA	
Age at confirmation of hearing loss in months, *M* (*SD*)	1.8 (1.2)	NA	
Age received first hearing aids in months, *M* (*SD*)	5.1 (2.9)	NA	
Duration from diagnosis to amplification in months,	3.5 (2.8)	NA	
Duration receiving early intervention in months, *M* (*SD*)	8.1 (3.4)	NA	
Cause of hearing loss, *n* (%)			
Unknown	18 (64)	NA	
Genetic	10 (36)	NA	

Note: PTA_4 = Pure-tone average threshold at 500, 1000, 2000, and 4000 Hz; NA = Not applicable.

Table 2

Demographic characteristics of mothers in the study sample.

	Hard of Hearing (n = 27)[a]	Normal Hearing (n = 42)	p-value
Age in years, *M* (*SD*)	31.8 (6.1)	32.4 (5.4)	0.67
Marital Status, *n* (%)			0.21
Married	20 (74)	32 (76)	
"Living with" partner but not married	2 (7)	7 (17)	
Divorced	2 (7)	0 (0)	
Single, never married	3 (11)	3 (7)	
Education, *n* (%)			0.43
Less than high school	1 (4)	0 (0)	
High school graduate	3 (11)	4 (10)	
Some college/AA/Trade school	10 (37)	11 (26)	
College graduate	11 (41)	19 (45)	
Graduate/Professional degree	2 (7)	8 (19)	
Household annual income, *n* (%)			
Less than $15,000	2 (7)	3 (7)	0.62
$15,000 – $29,000	4 (15)	2 (15)	
$30,000 – $49,000	4 (15)	8 (20)	
$50,000 – $74,999	6 (22)	12 (29)	
$75,000 – $100,000	4 (15)	3 (7)	
More than $100,000	7 (26)	13 (32)	
Employment, *n* (%)			0.29
Fulltime outside home	11 (41)	16 (38)	
Part-time outside home	3 (11)	11 (26)	
Not currently working	13 (48)	15 (36)	

Note: Demographic information was not provided by the mother of 1 child with hearing loss; Percentages may not total to 100% due to rounding.

[a] One mother did not return the parent background questionnaire; information not included.

Table 3

Summary scores on outcome measures for the two study groups.

	Hard of Hearing (n = 28)	Normal Hearing (n = 42)			
Measure	**Mean (*SD*)**	**Mean (*SD*)**	***F* scores**	***p*-value**	**Effect Size (η^2)**
MSEL Composite	94.8 (12.1)	103.4 (12.0)	8.44	**0.01**	0.11
MSEL Visual Reception	52.6 (9.7)	55.4 (9.3)	1.50	0.23	0.02
MSEL Receptive Language[b]	41.0 (7.8)	45.8 (8.9)	5.38	**0.02**	0.07
MSEL Expressive Language[b]	42.4 (10.8)	49.0 (10.4)	6.58	**0.01**	0.09
MSEL Fine Motor[b]	53.4 (8.2)	56.3 (7.6)	2.23	0.14	0.03
MSEL Gross Motor[b]	46.9 (14.2)	50.8 (10.2)	1.84	0.18	0.03
PLS-4 Total Language[a]	99.1 (12.2)	102.0 (10.1)	1.22	0.27	0.02
PLS-4 Auditory Comprehension[b]	94.5 (9.2)	96.3 (10.0)	.57	0.45	0.01
PLS-4 Expressive Communication[b]	103.8 (14.1)	107.3 (9.5)	1.55	0.22	0.02
CDI words produced[c]	46.0 (14.3)	53.9 (20.3)	2.87	0.10	0.04
ITSEA					
Externalizing[b]	49.4 (9.1)	45.8 (7.6)	2.99	0.09	0.05
Internalizing[b]	42.4 (8.5)	46.1 (9.4)	2.53	0.12	0.04
Dysregulation[b]	40.8 (10.7)	42.6 (14.2)	.31	0.58	0.01
Competencies[b]	41.3 (8.9)	44.7 (8.6)	2.27	0.14	0.04
Vineland II Composite[a]	94.3 (8.7)	97.5 (6.5)	3.20	0.08	0.05
Communication[a]	96.8 (10.1)	100.5 (10.2)	2.25	0.14	0.03
Daily Living Skills[a]	91.8 (10.0)	93.5 (8.7)	.60	0.44	0.01
Socialization[a]	95.5 (8.8)	97.5 (6.5)	.64	0.43	0.01
Motor Skills[a]	98.0 (10.8)	102.0 (8.8)	2.94	0.09	0.04

Note: MSEL = Mullen Scales of Early Learning; PLS-4 = Preschool Language Scales-Fourth Edition; CDI = MacArthur Communicative Development Inventory; ITSEA = Infant-Toddler Social and Emotional Assessment; Vineland II = Vineland Adaptive Behavior Scales, Second Edition.

[a] Standard scores.

[b] *T*-scores.

[c] Percentile scores.

Table 4

Parenting stress and maternal self-efficacy for mothers of the study groups.

	Hard of Hearing (*n* = 27)	Normal Hearing (*n* = 40)	*p*-value	Effect Size
Total Parenting Stress, *M* (*SD*)	57.2 (16.2)	63.4 (12.9)	0.08	0.05[a]
≥ 85th percentile, *n* (%)	2 (7)	2 (5)	0.68	0.05[b]
Parental Distress, *M* (*SD*)	23.4 (8.7)	24.8 (5.9)	0.44	0.01[a]
≥ 85th percentile, *n* (%)	3 (11)	4 (10)	0.88	0.02[b]
Parent-Child DI, *M* (*SD*)	15.6 (4.2)	16.2 (3.9)	0.54	0.01[a]
≥ 85th percentile, *n* (%)	1 (4)	0 (0)	0.22	0.15[b]
Difficult Child, *M* (*SD*)	18.6 (6.3)	22.1 (5.7)	**0.02**	0.08[a]
≥ 85th percentile, *n* (%)	2 (7)	2 (5)	0.68	0.05[b]
Maternal Self-Efficacy, *M* (*SD*)	35.0 (3.3)	34.8 (2.8)	0.78	0.001[a]

Note: Parent-Child DI = Parent-Child Dysfunctional Interaction.

[a] η^2.

[b] Φ.

Table 5

Bivariate associations for parenting factors and child developmental outcomes.

Variable	Hard of Hearing (*n* = 27)		Normal Hearing (*n* = 40)	
	PSI-SF Total Stress	MSE	PSI-SF Total Stress	MSE
PSI-SF Total Stress	---	**−.61****	---	**.37***
MSE	−.61**	---	**−.37***	---
MSEL Early Learning Composite	**−.41***	**.49***	.10	.06
PLS-4 Total Language	−.31	**.41***	−.18	.04
CDI words produced percentile	−.09	.01	−.03	.11
Vineland II Composite	−.31	**.42***	−.01	.18
ITSEA Externalizing	**.47***	**−.48***	**.32***	.01
ITSEA Internalizing	.33	**−.48***	.28	.06
ITSEA Dysregulation	**.51***	**−.41***	**.52****	−.08
ITSEA Competencies	−.58	**.55****	−.07	.11

Note: PSI-SF = Parent Stress Index – Short Form; MSE = Maternal Self-Efficacy; MSEL = Mullen Scales of Early Learning; PLS-4 = Preschool Language Scales-Fourth Edition; CDI = MacArthur Communicative Development Inventory; Vineland II = Vineland Adaptive Behavior Scales, Second Edition; ITSEA = Infant-Toddler Social and Emotional Assessment.

* $p < .05$,

** $p < .01$.