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Social Competence in Children with Cochlear Implants and Normal Hearing: Longitudinal Trajectories and Interrater Differences

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UNIVERSITY OF MIAMI

SOCIAL COMPETENCE IN CHILDREN WITH COCHLEAR IMPLANTS AND NORMAL HEARING: LONGITUDINAL TRAJECTORIES AND INTERRATER DIFFERENCES

By

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Children with hearing loss, who have substantial delays in language development, are likely to experience deficits in various aspects of social competence, such as social skills, emotional awareness, and interpersonal problem-solving. To date, few studies have measured and compared social competence in children with cochlear implants (CIs) and their hearing peers, and no studies have compared their longitudinal outcomes. Using parent, teacher, and child reports from two standardized measures, this study compared social competence in children with CIs and their hearing peers, followed by an analysis of discrepancies among these respondents over five years. Further, a latent variable of social competence was created and then modeled over time using data from parents. Several hypotheses were tested: 1) Children with CIs would have significant delays in social competence compared to their hearing peers on all measures and across all raters; 2) Fewer deficits in social competence would be observed in children implanted before vs. after age two; 3) A greater magnitude of rater discrepancies would be found between parents and teachers in the CI vs. hearing groups; 4) A greater magnitude of rater discrepancies would be found between parents and children in the CI vs. hearing groups; and 5) Using longitudinal modeling, children with CIs would display worse social competence at 48 months, but exhibit more improvement in social skills than their hearing peers over time. Results showed that children with CIs were rated as significantly delayed compared to hearing peers at all time points, according to both parent and child report. However, teachers reported no differences between the CI and hearing groups. Longitudinal modeling of the parent data revealed that children with CIs were significantly delayed compared to their hearing peers at 48, 72, and 96 months post-implantation and demonstrated minimal evidence of catch-up over a 5-year period. The magnitude of interrater discrepancies did not vary as a function of hearing status, but correlations among raters were low. These results indicated that children with CIs continue to experience delays in social competence even 8 years following implantation and, to date, no interventions exist to address these deficits.

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CHAPTER 1

Introduction

Social competence is a broad construct that reflects a child's ability to interact effectively with those in the environment, such as peers, family members and other adults (Waters & Sroufe, 1983). It includes the ability to spontaneously utilize social skills in interactions in a flexible and adaptive manner (Lillvist, Sandberg, Björck-Äkesson, & Granlund, 2009). These social skills consist of reciprocity, perspective taking, complying with directions and rules, problem-solving, and responding to the actions of others (Cook & Oliver, 2011; Spence, 2003; Waters & Sroufe, 1983). It also encompasses the ability to express emotions appropriately and exhibit self-control (Gresham & Elliot, 1990; Hogan, Scott, & Bauer, 1992). Thus, social competence is fundamental to the establishment and maintenance of positive relationships.

Social competence has a profound effect on several aspects of child development, facilitating family and peer relationships, emotion regulation, and academic achievement (Semrud-Clikeman, 2007; Spinrad et al., 2006). It is also a strong predictor of important developmental outcomes, such as social anxiety, antisocial behavior, and later psychopathology (Hymel, Rubin, Rowden, & LeMare, 1990; Ladd & Troop-Gordon, 2003). Children with hearing loss, who have delays in language and deficits in attention (Barker et al., 2009; Mitchell & Quittner, 1996; Quittner, Smith, Osberger, Mitchell, & Katz, 1994; Smith, Quittner, Osberger, & Miyamoto, 1998), may be at increased risk for delays in social competence and related sequalae. The purpose of this study was to compare social competence over time in children with cochlear implants (CIs) and their hearing peers, and evaluate the extent of rater discrepancies in these two samples. A cochlear implant (CI) is a surgically implanted, electronic device that provides sound to individuals with hearing loss. These devices have been shown to improve oral language skills in these children (Niparko, et al., 2010). However, children with CIs still display delays in oral language and other areas of development in comparison to hearing peers (Svirsky, Robbins, Kirk, Pisoni & Miyamoto, 2000).

Using a dynamical systems approach, psychologists have demonstrated that there are interconnections among different areas of development, and that deficits in one area can lead to cascading effects in others (Rubin, Burgess, Kennedy, & Stewart, 2003; Smith & Thelen, 1993; Thelen & Smith, 1994). Thus, children with hearing loss, who have substantial delays in language development, are likely to experience deficits in several aspects of social competence, such as social skills, emotional awareness, and interpersonal problem-solving (Arnold & Tremblay, 1979; Barker et al., 2009; Kennedy et al., 2006).

To date, few studies have measured and compared social competence in children with CIs and their hearing peers, and no studies have compared their longitudinal trajectories over time (Moog, Geers, Gustus, & Brenner, 2011; Percy-Smith, Caye-Thomasen, Gudman, Jensen, & Thomsen, 2008). Further, the assessment of social competence relies on the ratings of parents, teachers, and children themselves, which may yield discrepancies across these raters (De Los Reyes & Kazdin, 2004). Additionally, no studies have evaluated the magnitude of these discrepancies either within children with CIs or in comparison to their hearing peers.

Definitions of Social Competence

Although social competence has been extensively studied at different stages of development, there is no universally accepted definition, and the term has undergone numerous transformations over time (Cook & Oliver, 2011). Early definitions focused strictly on social behaviors (e.g., smiling and eye contact) (Gesten, Weissberg, Amish, & Smith, 1987), but more recent studies have expanded to include cognitive (e.g., perception of self and others) and affective components (e.g., emotional awareness) (Topping, Bremner, & Holmes, 2000). This study utilized a definition that has been used in prior research and could be easily operationalized.

Cook and Oliver (2011), suggested categorizing social behaviors as both macro- (e.g. engaging in conversation, relationship building) and micro-skills (e.g. maintaining appropriate eye contact) that encompass a range of behaviors tied specifically to the social context (Waters & Sroufe, 1983). Thus, in the proposed study, social competence was defined broadly as the ability to spontaneously utilize social skills in a flexible and adaptive manner (Lillvist et al., 2009), measuring both macro- (e.g., engaging in conversation, perspective taking) and micro-skills (e.g., eye contact, requesting help) (Gresham & Elliot, 1990). We operationalized social competence by creating a latent variable using subscales of the Behavior Assessment Scale for Children, Second Edition (Kamphuas & Reynolds, 2007) and Social Skills Rating System (Gresham & Elliot, 1990). This allowed for measurement of the true, underlying construct of social competence while filtering out the error associated with individual measures.

The use of broad, consensus definition in addition to the creation of a latent variable circumvents issues that have plagued prior research. For example, previous definitions have been both broad and vague, such as "An ability to take another's perspective concerning a situation...and apply that learning to the ever-changing social landscape" (Semrud-Clikeman, 2007, p. 1). This type of definition is difficult to operationalize and apply consistently across populations. Other definitions have been more descriptive, defining social competence as the ability to exhibit self-control, comply with directions, and take the perspective of others (Hogan et al., 1992; Waters & Sroufe, 1983). This lack of consensus on how to define and operationalize this construct has led to inconsistencies in its measurement, results and interpretation. For example, Merrell and Popinga (1994) compared extent of social competence and adaptive behavior in preschoolers, treating these as separate constructs, whereas Greenfield and colleagues (2004) measured social competence *using* a scale of adaptive behavior. These differences make comparisons across studies difficult.

Definitional problems have also permeated the literature on social competence in children with hearing loss, yielding mixed results that are difficult to interpret. In addition to measuring social competence in different ways, studies have often referred to a similar construct using different titles. Early studies, such as Cappelli and colleagues (1995), measured competence as "social knowledge," which focused on children's interpersonal goals within a social game and ratings of social anxiety. The results suggested that children with hearing loss were more likely to be rejected by their peers than hearing children, and younger vs older children with hearing loss experienced more social rejection, signaling a need for early social intervention. Antia and Kriemeyer (1996) measured social functioning through coded observations of peer interactions during free-play and social acceptance via ratings by peers. Children with hearing loss had significantly fewer social interactions and lower ratings of social acceptance than hearing peers.

More recent studies have utilized prosocial behaviors and peer interactions to measure social competence, however, each study has operationalized this construct using different types of skills (Brown, Bortoli, Remine, & Othman, 2008; Moog et al., 2011). For example, Nicholas and Geers (2003) used parent ratings of social competence on a deaf-specific measure, the Meadow-Kendall Social-Emotional Assessment Inventory (SEAI) (Meadow-Orlans, 1983), and found that children with CIs performed better than the normative data. In another study, Moog and colleagues (2011) used the Social Skills Rating Scale and found no significant differences between the adolescents with CIs and the normative sample on the Assertion, Cooperation, and Empathy subscales. Interestingly, parents rated adolescents with CIs as significantly higher than the normative sample on the Self-Control subscale, which assesses behaviors that emerge in conflict situations (e.g., responding appropriately to teasing). These discrepant results are potentially due to the use of very different measures and raters. Given the differences in definitions of social competence and measurement approaches, it is difficult to draw conclusions about whether children with CIs are delayed compared to their hearing peers (Cook & Oliver, 2011; Matson & Boisjoli, 2007).

In contrast, by using Cook and Oliver's definition (2011), this study builds upon previous research and allows for comparisons with other studies that utilized the same definition. Furthermore, by operationalizing social competence through a latent variable, this study utilized a more elegant methodological design than prior research. Lastly, this study used an age-matched hearing cohort as a control group, which provided a more stringent test of social competence those of previous studies, which used normative data.

Methodological Limitations

Prior research on social competence in children with hearing loss is limited in several other important ways. First, many studies do not reflect the implementation of universal newborn hearing screening, which has facilitated earlier diagnosis and intervention for childhood deafness. In 1999, The American Academy of Pediatrics first recommended universal newborn hearing screening. Later, The Centers for Disease Control and Prevention and Healthy People advocated for newborn hearing screening in 2010. Following these recommendations, all US states implemented legislation requiring hearing screening (Shulman et al., 2010). Roughly 77% of children with permanent hearing loss are detected at birth and enrolled in intervention programs by six months of age (National Institute on Deafness and Other Communication Disorders, 2013). Older studies also failed to reflect advances in cochlear implant technology; for example, few included multi-channel implants which capture a wider range of pitch and provided access to auditory input at younger ages (Andersson, Olsson, Rydell, & Larser, 2000; Antia & Kreimeyer, 1996).

Second, most findings have been based on small samples (i.e., n = 26) (Tasker, Nowakowski, & Schmidt, 2010), with data collected at single centers (Bat-Chava, Martin, & Kosciw, 2005). Third, these studies reported primarily on middle-class, Caucasian populations (Antia & Kreimeyer, 1996; Cappelli et al., 1995). This lack of diversity limits the generalizability of the findings to the larger deaf population. Finally, all previous studies have been cross-sectional, limiting our understanding of the development of social competence in children with CIs over time. In contrast, this study utilized longitudinal data from a large, nationally diverse study at six implant centers (Fink et al., 2007; Niparko et al., 2010). Thus, this comprehensive, multisite dataset provided an opportunity to test our hypotheses, while avoiding the limitations of previous research.

Effects of Age of Implantation

Another methodological issue to consider is age of implantation, which has been identified by several studies as having a significant effect on the development of children with CIs (Dammeyer, 2010; Niparko et al., 2010; Quittner et al., 2013). Those who are implanted at an earlier age experience a wide range of linguistic benefits compared to those implanted later, including higher levels of receptive and expressive language (Holman et al., 2013; Niparko et al., 2010), greater language acquisition (M. A. Svirsky, Teoh, & Neuburger, 2004), and better auditory perception (Nikolopoulos, O'Donoghue, & Archbold, 1999). In keeping with the dynamical systems model (Smith & Thelen, 1993; Thelen & Smith, 1994), children with fewer language delays are also likely to experience fewer deficits in other areas, such as social skills, emotional awareness, and interpersonal problem-solving (Arnold & Tremblay, 1979; Barker et al., 2009; Kennedy et al., 2006).

An extensive literature exists on the linguistic benefits of early implantation. (Cruz, Quittner, Marker, DesJardin, & CDaCI Investigative Team, 2013; Tobey et al., 2013; Tomblin, Peng, Spencer, & Lu, 2008). Children receiving early implantation have also demonstrated better visual attention and fewer externalizing behavior problems than children implanted at a later age (Barker et al., 2009; Yucel & Derim, 2008). However, few studies have evaluated these effects on social outcomes (Barker et al., 2009). Given the effects of early implantation on other domains of functioning, we hypothesized that children who were implanted earlier, typically before the critical period of language development at age two, would have higher levels of social competence than those implanted after age two.

Interrater Discrepancies in Measures of Social Competence

An additional methodological issue to consider is the respondent who is evaluating the child's competence, given that most measures rely on parent, teacher, and child report (Greenfield et al., 2004; Merrell & Popinga, 1994; Topping et al., 2000). However, discrepancies among these raters are quite common because different informants often disagree on ratings of children's behaviors and social skills (Achenbach, McConaughy, & Howell, 1987; De Los Reyes, 2013). Meta-analyses and major reviews have demonstrated low agreement between parents and children (rs=.20) (Achenbach, Krukowski, Dumenci, & Ivanova, 2005; Achenbach et al., 1987), and parents and teachers (rs = -.06 - .60) (Hartman, Rhee, Willcutt, & Pennington, 2007; Kolko & Kazdin, 1993; Youngstrom, Loeber, & Stouthamer-Loeber, 2000). These discrepancies do not represent measurement error, but instead arise from each informant's unique perspective of the child and the attributions they make about the child's behaviors (De Los Reyes & Kazdin, 2005). This methodological complexity has been termed "interrater discrepancies" (De Los Reyes & Kazdin, 2004). Despite these discrepancies, obtaining ratings from multiple informants remains the "gold standard" for measuring behaviors across contexts (De Los Reyes & Kazdin, 2005). Thus, new analytic approaches have been used to assess the extent of disagreement across raters, to better understand their meaning and potential consequences. This study utilized standardized difference scores to evaluate the magnitude of discrepancies across parents, teachers and children.

In the deaf literature, social competence has also been measured using parent, teacher and child-report (Huber & Kipman, 2011; Moog et al., 2011; Percy-Smith et al., 2008). However, few studies have attempted to make statistical comparisons or integrate data across raters (Mitchell & Quittner, 1996). For example, Huber and Kipman (2011) utilized the Strengths and Difficulties Questionnaire to measure peer problems and prosocial behaviors in adolescents with CIs, using parent, teacher and teen report. Using a clinical cut-score, 0-10% had elevated scores by parent report and 8.7-21.7% had elevations by teacher report. However, only 0-4.3% had clinically elevated problems by self-report. Surprisingly, given the wide range of scores by various informants, no efforts were made to address these discrepancies. Moog and colleagues (2011) also found differences between adolescents and parents on the SSRS, but did not offer an explanation for their findings.

To address these discrepancies among raters, new cutting-edge statistical methods have been developed to evaluate their directionality and magnitude (i.e., standardized difference scores, polynomial regression with response surface analysis), as well as predictive validity for later outcomes (Edwards, 2012; Shanock, Baran, Gentry, Pattison, & Heggestad, 2010). In the current study, we evaluated rater discrepancies as a function of hearing status across parents, teachers, and children (ages 4 to 9 years). Given that prior studies in hearing children have found discrepancies in dyads with poorer communication and greater family dysfunction (Kolko & Kazdin, 1993), with similar family issues identified in families who are “mismatched” in their hearing status (i.e., hearing parent-deaf child; (Quittner, Jackson, & Glueckauf, 1990; Quittner, Leibach, & Marciel, 2004), greater interrater discrepancies were expected between informants in the CI vs. hearing groups.

Longitudinal Trajectories of Social Competence

Although the literature on social competence in children with hearing loss has been limited by cross-sectional data, an extensive body of research details the typical, longitudinal growth of social competence over time, from infancy to young adulthood (Bar-On & Parker, 2000; Brown et al., 2008; Ladd, 2005; Semrud-Clikeman, 2007). These studies have shown that socialization begins early in life with interactions and communication with a caregiver (Semrud-Clikeman, 2007), laying the foundation for later social competence (Carpenter, Akhtar, & Tomasello, 1998). Importantly, these early efforts to socialize depend on communication with others, which are disrupted in young children with hearing loss, due to mismatches in hearing status with their caregivers (Meadow-Orlans & Spencer, 1996; Quittner et al., 1990). Further, hearing parents of children with CIs have been shown to display less warmth, positive regard, and respect for child autonomy, leading to difficulties forming positive relationships (Quittner et al., 2013).

As toddlers reach preschool age, they must learn to play with others, requiring assertiveness, sharing, and emotion regulation (Denham, von Salisch, Olthof, Kochanoff, & Caverly, 2002). To develop these skills, the preschooler must be able to process information smoothly and quickly, taking cues from the environment to adapt his/her behavior (Denham et al., 2002). In children with hearing loss, these skills may be delayed due to language deficits and difficulties regulating their attention and behavior (Barker et al., 2009; Wiefferink, Rieffe, Ketelaar, & Frijns, 2012). This may lead to fewer friendships with hearing peers, greater risks of peer rejection, and long-term delays in social competence (Denham et al., 2002; Diener & Kim, 2004; Eisenberg et al., 1996; Kouwenberg, Rieffe, Theunissen, & de Rooij, 2012; Ladd & Price, 1987). However, no studies to date have examined these processes longitudinally.

During middle childhood, children shift the focus of their relationships to peers and socialization experiences at school (Semrud-Clikeman, 2007). Integration into the classroom is important because children spend more time outside of the home and away from their parents (McHale, Dariotis, & Kauh, 2003). During this period, two underlying skills, essential to establishing peer relationships, are emotion regulation and conversational ability (Burleson et al., 1986; Semrud-Clikeman, 2007; Wang, 2002), both of which are delayed in children with CIs (Barker et al., 2009). In a recent study, school-age children with hearing loss had more difficulty generating effective strategies to regulate their emotions than hearing children (Rieffe, 2012). Thus, children with CIs are at risk for difficulties with self-regulation as their social demands increase in early and middle childhood. Assessment of this process requires studies which use longitudinal designs.

The current study was the first to examine the longitudinal development of social competence in children with CIs. Using data from multiple raters (i.e., parent, teacher, child) and analyses of rater discrepancies, we compared the trajectories of social competence in children with CIs and their hearing peers over a five-year period.

Current Study: Aims and Hypotheses

Due to deficits in language development, social competence is likely to be delayed in children with CIs and their hearing peers as rated by all informants. To date, no studies have compared the longitudinal trajectories of social competence over time among these populations or have examined differences between raters. These data were drawn from the CDaCI (Childhood Development after Cochlear Implantation) study, the largest, most representative study of children using CIs. This study had seven aims:

Aim 1. To create a latent variable of social competence using three subscales (BASC Adaptability, BASC Social Skills, and SSRS Social Skills) from validated measures. Six confirmatory factor analyses (CFA's) were conducted, using separate ratings from parents and teachers at three time points (i.e., 48, 72, and 96 months post-implantation).

Hypothesis 1. The indicators will successfully load onto a latent variable of social competence using both parent and teacher ratings across all three time points.

Aim 2. To compare social competence in children with CIs and their hearing peers using the latent social competence variable for parents and teachers report over time (i.e., 48, 72, and 96 months post-implantation).

Hypothesis 2. Children with CIs vs. hearing peers will have significant delays on the latent variables for both raters across all assessment points.

Aim 3. To compare social competence in the CI vs. hearing groups using scores on self-reported standardized measures at 96 months post-implantation.

Hypothesis 3. Children with CIs will rate themselves as having significant deficits in social competence in comparison to their hearing peers.

Aim 4. To compare the trajectories of the latent social competence variable between the CI and hearing groups at three time points (i.e., 48, 72, and 96 months) over five years.

*Hypothesis 4.C*hildren with CIs would display worse social competence at 48 months, but exhibit more improvement in social skills than their hearing peers over time.

Aim 5. To compare social competence in children with CIs implanted before vs. after age two, using the latent variables derived from parent and teacher reports.

Hypothesis 5. Greater deficits in social competence will be observed in those implanted after age 2 because of their longer period of auditory deprivation and delays in language, using both parent and teacher report.

Aim 6. To compare the magnitude of parent-teacher discrepancies on standardized measures of social competence at 48, 72 and 96 months post-implantation.

Hypothesis 6. There will be greater discrepancies between parent and teacher ratings in the CI versus hearing groups.

Aim 7. To compare the magnitude of parent-child discrepancies on a measure of social competence at 96 months post-implantation.

Hypothesis 7. There will be greater interrater discrepancies between dyads in the CI versus hearing groups.

CHAPTER 2

METHODS

Participants

Data from this study were drawn from a larger, longitudinal study of developmental outcomes following pediatric cochlear implantation (CDaCI; NIH #DC004797). The parent study evaluated a variety of outcomes in children with CIs before and after cochlear implantation, including receptive and expressive language, joint attention, problem-solving, psychosocial skills, and parent-child interactions (Quittner et al., 2013; Quittner et al., 2004). At enrollment, participants were between the ages of five months and five years, and were followed at six-month intervals for three years after implantation, and at one-year intervals from three to five years post-implantation.

Criteria for inclusion were: 1) severe to profound sensorineural hearing loss, 2) presence of a caregiver to participate in evaluations, and 3) commitment to educate the child in spoken English. Participants with CIs were enrolled at the following six implant centers: House Ear Institute in Los Angeles, John's Hopkins University, University of Miami, University of Michigan, University of North Carolina, and University of Texas, Dallas. Age and gender-matched hearing controls were recruited from preschool programs at the University of Texas, Dallas and the River School in Washington, D.C. (See Table 1 and Fink et al., 2007 for a detailed description of the sample).

Comparisons of the demographic data in the CI and hearing cohorts revealed significant differences on some demographic variables (Fink et al., 2007). Children with CIs and their hearing peers were similar in age at enrollment, however, the CI sample had a higher proportion of Hispanic children (20% vs. 9%), lower parental education (49%

completed college vs. 84%), and a larger proportion fell into the lower income level than the hearing sample (20% vs. 9%). Exclusion criteria in the larger study included significant cognitive impairment (i.e., a Bayley Mental or Motor score of less than 70 or Leiter International Performance Scale—Revised score of less than 66).

In addition, for the purposes of the current study, participants diagnosed with a significant developmental or behavioral disorder following enrollment were also excluded (e.g., attention deficit hyperactivity disorder, autism spectrum disorder). Thus, 31 children with CIs and 12 hearing children from the larger sample were excluded, creating a subsample of 157 children with CIs and 85 hearing children (see Tables 2 and 3 for details on those who were excluded). Comparisons of the demographic data between the CI and hearing cohorts indicated that these groups were similar on child age and gender.

The mean age for children with CIs was 6.17 years at 48 months post-implantation (*SD* = 1.20 years), with a mean age of 6.27 years (*SD* = 1.13 years) for the hearing sample. Among the CI sample, age of onset of hearing loss varied between birth and 44 months (*M* = 2.74 months, *SD* = 7.14 months), and all children were severely to profoundly deaf. Hearing loss was diagnosed at a mean age of 10.42 months (*SD* = 10.42) and average length of hearing aid use before implantation was 20.34 months (*SD* = 13.45). For a majority of children with CIs in this sample (73%), onset of hearing loss was at birth. Similar to the larger study, this subset of the CI sample had a higher proportion of Hispanic children (CI = 19.60%, hearing = 9.90%), lower mean parental education, and lower mean income (see Table 4). To account for these differences, all analyses controlled for maternal education and income. The majority of the CI sample was mainstreamed (86.7%) and used oral language in school (90.7%); 11.4% of the sample was enrolled in self-contained classrooms (e.g. special education classrooms) and 5.6% reported using sign language in school. Post-hoc analyses examined the effects of school placement and mode of communication on measures of social competence.

Procedures

As part of the larger study, all assessments were conducted over two days to prevent fatigue. During the first day, parents completed demographic and self-report measures of communication and behavior, and children were assessed with language measures, cognitive tests, and an audiological exam. On the second day, children participated in videotaped structured play and problem-solving tasks with and without parents, and parents completed psychosocial questionnaires about their children. Following this visit, psychosocial questionnaires were mailed to teachers, who received a small incentive to complete these measures and mail them back (e.g., $10 Starbucks gift card). Families of children with CIs were given a two-year extension of the warranty for the implant after completing three years of follow-up. Data for these analyses were drawn from yearly intervals between 48 and 96 months post-implantation.

Measures

Behavior Assessment System for Children, Second Edition (BASC-2). Social competence was measured, in part, using the parent, teacher, and child report forms of the BASC-2. The BASC-2 is a multidimensional system used to evaluate the behavior and self-perceptions of children and young adults ages 2 to 25 (Kamphaus & Reynolds, 2007). These forms consisted of 134 to 160 questions, depending on the age of the child and the rater (parent, teacher or self-report). The parent and teacher forms consist of short statements (e.g. "adjusts well to new teachers") that describe how children behave. The rater is asked to decide if the statement describes how the child behaved using the response options of “never,” “sometimes,” “often,” or “almost always.” The self-report form includes similar questions (e.g., I like everyone I meet) rated on likert scales or “true” or “false” responses. Children 8 years and older completed the self-report form.

As specified in the manual, items from the BASC-2 were collapsed to form different scales (Attitude to School, Sensation Seeking, Social Stress, etc.) and subscales (Internalizing and Externalizing Problems, Behavioral Symptoms Index), depending on the age of the child and rater. Responses were summed into raw scores and then converted into T-scores. Higher T-scores indicated more difficulty, with those above 60 considered “At-Risk” and those above 70 “Clinically Elevated.” For this study, scores from the Adaptability and Social Skills subscales were used to measure social competence.

The Adaptability subscale measures a child’s ability to act in a flexible and adaptive manner, a key component of social competence (Lillvist et al., 2009). Sample items from the subscale included: “Shares toys or possessions with other children,” “Is easily soothed when angry,” and “Adjusts well to new teachers.” The Social Skills subscale measures prosocial behaviors that must be utilized to display high levels of social competence. Sample items included: “Congratulates others when good things happen to them,” “Shows interest in others’ ideas,” and “Offers to help other children.” Previous estimates of reliability on the parent, teacher, and child reports have been strong (Cronbach’s alpha = .79 to .88). Internal consistency for this sample could not be calculated because the data were not available at the item level. The BASC-2 is a well-established instrument and has been used in many clinical studies, including studies with children with hearing loss. (Kreisman, John, Kreisman, Hall, & Crandell, 2012; Mahan & Matson, 2011; Papazoglou, Jacobson, & Zabel, 2013). However, no previous studies have validated the BASC-2 in a sample of children with CIs.

Social Skills Rating System (SSRS). Social competence was also measured using the Social Skills Rating System (Gresham & Elliot, 1990), a broad, multi-rater assessment of social behaviors that affect teacher-student relationships, peer acceptance, and academic performance. The parent version consists of 38 items rated on a 3-point frequency scale (from "never" to "often"), with an additional 3-point scale evaluating how important that behavior is to their child's development, ranging from "not important" to "critical." The teacher report form is similar to the parent form, but includes 57 questions. Children ages 8 to 12 completed the self-report version, which consisted of 34 items rated on the same 3-point frequency scale from "never" to "often."

The SSRS consists of three scales: Social Skills, Problem Behaviors, and Academic Competence. Only the Social Skills composite score was used in this study. It has five subscales: Cooperation, Empathy, Assertion, Self-Control, and Responsibility. Each composite and subscale represents a series of specific behaviors and scores are classified by their frequency of occurrence. Thus, scores were classified as either *Fewer, Average,* or *More*. For example, a child who is classified as *More* on the Social Skills Scale is rated as exhibiting more positive social skills than the normative population. Depending on the scale, a rating of *More* or *Fewer* can be considered abnormal for that age.

Raw scores were converted into standard scores, with 85 to 115 falling within the *Average* range. Those below 85 are within the *Fewer* range and those above 115 are within the *More* range. Previous estimates of reliability for individual subscales on the parent and teacher reports have been adequate to strong (Cronbach's alpha = .65 to .95), with slightly lower estimates of reliability for the child report (Cronbach's alpha = .51 to .83). Cronbach's alpha could not be calculated for the individual subscales in this sample because item level data were not available.

Statistical Analysis Plan

Social competence was compared using scores on the individual subscales and latent variables. The level of interrater discrepancies was compared using standardized difference scores. All analyses controlled for income and maternal education due to demographic differences between groups. Post-hoc analyses evaluated the effects of school placement and mode of communication (e.g., oral, sign, combination) on social competence.

Missing Data and Distribution Normality

All participants with missing parent or teacher data at all three time points were excluded, leaving a subsample of 199 children with parent report data (n = 132 CI, n = 72 Hearing) and 180 children with teacher report data (n = 119 CI, n = 61 Hearing). Missing data was handled using full-information maximum likelihood (FIML), which estimates parameters using all available data (Kline, 2004). For parent report, missing data was as follows: 14.57% at 48 months, 25.63% 72 months, and 28.14% at 96 months. For teacher report, 21.85% of the data were missing at 48 months, 27.59% at 72 months, and 56.67% at 96 months. The assumption of missing completely at random was met using Little's test: Parent report: X^2 (123) =121.45, p >.05; Teacher report: X^2 (80) =54.52, p >.05).

Confirmatory Factor Analyses

To fulfill Aim 1, a latent variable of social competence utilizing scales from the BASC and SSRS was created. This facilitated parsing measurement error from the underlying, true construct. Confirmatory Factor Analysis (CFAs) of the latent variable were evaluated for significant factor loadings using parent and teacher report at all three time points. These analyses were conducted using Mplus statistical software (version 6.0). Goodness of fit was examined using the comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). CFI values greater than .95, RSMEA values less than .05, and SRMR values less than .08 were considered satisfactory (Hu & Bentler, 1999; Kline, 2004).

Comparisons of Social Competence Using Parent and Teacher Report

Aim 2 compared social competence between the CI and hearing groups across raters. These differences were evaluated using analysis of variance (ANOVA), controlling for maternal education and income. Group means of the latent variable were compared at three time points: 48, 72, and 96 months post-implantation. All analyses were conducted separately for parent and teacher data. Post-hoc ANOVAs were conducted to examine the effects of school placement on social competence. After removing those who were home schooled (n =4), the remaining categories for school placement (i.e. mainstreamed, mainstreamed with pull-out classes, self-contained classroom in school for Deaf, self-contained classroom in mainstream school) were collapsed into two categories: those who are mainstreamed and those in self-contained classrooms. Post-hoc analyses also examined the effects of mode of communication on social competence. Children with CIs were divided into three categories: sign language, combination of sign language/spoken language, or spoken language.

Comparisons of Social Competence Using Child Report

To compare social competence between the CI and hearing groups using self-report ratings, data were drawn from 96 months post-implantation. This time point was chosen for two reasons: 1) children were eight years of age and older at this time point and thus, better able to report on this construct, and 2) self-report data on children was limited at the earlier time points. Group differences were evaluated in ANOVA using scores from the SSRS subscales. Post-hoc analyses examined the effects of school placement and mode of communication on child ratings using the methodology described above.

Latent Growth Modeling

To evaluate the longitudinal growth of social competence in children with CIs and their hearing peers over 5 years, longitudinal modeling was used to plot the trajectory of social competence in both groups using data from 48, 72, and 96 months post-implantation. Two models were created using parent and teacher report, separately. Multiple Group Analysis was used to examine the fit of the models over time, with hearing status as a moderator.

Children Implanted Before vs. After Age Two

Aim 5 examined social competence in children with CIs who were implanted before vs. after age 2, using an independent samples t-test of the latent variables from parent and teacher report. Within-CI group differences were also analyzed using group means of the latent variable at all three time points.

Magnitude of Discrepancies as a Function of Hearing Status

Aim 6 evaluated interrater discrepancies between parent and teacher report at 48, 72, and 96 months post-implantation, utilizing standardized difference scores of the subscales. Using ANOVA, group means reflecting the magnitude of these discrepancies (CI vs. hearing) were compared. Interrater discrepancies were examined at the individual subscale level rather than using the latent variable because latent scores are only interpretable in relation to themselves. Intraclass correlations of subscales across raters were also examined. Post-hoc ANOVAs were also conducted to compare the magnitude of discrepancies using the latent difference scores.

For Aim 7, the magnitude of parent-child discrepancies were compared at 96 months post-implantation, using standardized difference scores from the Social Skills subscale of the SSRS. The BASC-2 Adaptability and Social Skills subscales could not be compared because they do not appear on the self-report form. Using ANOVA, group means of these difference scores (CI vs. hearing) and intraclass correlations of the subscales were compared.

CHAPTER 3

RESULTS

Confirmatory Factor Analyses

For Aim 1, it was hypothesized that all of the indicators of the latent social competence variable would significantly load onto a unitary construct using both parent and teacher report across all time points. This hypothesis was fully supported. All of the indicators and correlations were significant for each social competence latent variable. The CFAs were perfectly identified; therefore, goodness-of-fit did not need to be evaluated. See Table 5 for individual standardized factor loadings and correlations of each latent variable.

The three latent variables using parent report data had standardized factor loadings ranging from .67 to .87. By squaring the standardized coefficients, the amount of variance in the latent variable accounted for by each indicator was calculated, and ranged from 45% to 76%. The three latent variables using teacher report data had standardized factor loadings ranging from .72 to .88. The amount of variance accounted for by individual indicators ranged from 52% to 77%.

Comparisons of Social Competence using Parent and Teacher Report

We hypothesized that children with CIs vs. hearing peers would display significant delays on the latent social competence variable for both parent and teacher report across all assessment points. This hypothesis was fully supported using parent report data but was not supported using teacher report data. Controlling for maternal education and income, parents rated children with CIs as having significant deficits compared to their hearing peers in social competence at all three points (48 months: *F*(1,

190) = 6.82, $p<.05$, $d = .46$; 72 months: $F(1, 190) = 7.89$, $p<.05$, $d = .48$; 96 months: $F(1, 190) = 7.58$, $p<.05$, $d = .47$). In contrast, teachers rated the CI and hearing groups as having equal levels of social competence at all three time points (48 months post-implantation: $F(1, 173) = 0.87$, $p>.05$; 72 months: $F(1, 173) = 0.27$, $p>.05$; 96 months: $F(1, 190) = 0.54$, $p>.05$). Tables 6 and 7 present the comparison of the CI vs. hearing groups on each individual subscale using parent and teacher report, respectively.

Post-hoc analyses evaluated the effects of school placement on ratings of social competence using parent and teacher report. No differences were found on ratings of social competence between children in mainstreamed and self-contained classrooms at any time point across raters (Parent report 48 months: $F(1, 80) = 2.26$, $p>.05$; Parent report 72 months: $F(1, 80) = 2.00$, $p>.05$; Parent report 96 months: $F(1, 80) = 1.80$, $p>.05$)(Teacher report 48 months: $F(1, 80) = 0.61$, $p>.05$; Teacher report 72 months: $F(1, 80) = 0.93$, $p>.05$; Teacher report 96 months: $F(1, 80) = 0.30$, $p>.05$). The CI vs Hearing group comparison was also run after removing the 11 children with CIs who were in self-contained classrooms. Results support the a priori findings presented above; parents reported significant differences between groups at each time point (48 months post-implantation: $F(1, 179) = 5.88$, $p<.05$; 72 months: $F(1, 179) = 6.78$, $p<.05$; 96 months: $F(1, 179) = 6.46$, $p<.05$), but teachers did not (48 months post-implantation: $F(1, 162) = 0.78$, $p>.05$; 72 months: $F(1, 162) = 0.11$, $p>.05$; 96 months: $F(1, 162) = 0.54$, $p>.05$).

Post-hoc analyses also evaluated the effects of mode of communication on ratings of social competence. No differences were found on ratings of social competence between children who used sign language, a combination of sign/oral language, or oral language at any time point across raters: (Parent report 48 months: $F(2, 85) = 0.26$, *p*>.05; Parent report 72 months: *F*(2, 85) = 0.25, *p*>.05; Parent report 96 months: *F*(2, 85) = 0.49, *p*>.05)(Teacher report 48 months: *F*(2, 85) = 1.06, *p*>.05; Teacher report 72 months: *F*(2, 85) = 0.21, *p*>.05; Teacher report 96 months: *F*(2, 85) = 0.67, *p*>.05). The 6 children with CIs who relied solely on sign language in school were removed to see if they were driving the effects. Parents still reported that children with CIs were significantly delayed compared to their hearing peers at all three time points (48 months post-implantation: *F*(1, 184) = 6.80, *p*<.05; 72 months: *F*(1, 184) = 7.79, *p*<.05; 96 months: *F*(1, 184) = 7.47, *p*<.05). In contrast, teachers reported no differences between groups at any time point (48 months post-implantation: *F*(1, 167) = 0.57, *p*>.05; 72 months: *F*(1, 167) = 0.05, *p*>.05; 96 months: *F*(1, 167) = 0.36, *p*>.05).

Comparisons of Social Competence Using Self-Report Ratings

We hypothesized that children with CIs would rate themselves as having lower levels of social competence than their hearing peers at 96 months post-implantation. This hypothesis was fully supported. Using standardized scores from the SSRS Social Skills Subscale, children rated themselves as having significant delays (96 months: *F*(1,145) = 4.42, *p* <.05; *d* = 1.11). Post-hoc analyses compared children with CIs in different school settings to examine any potential differences in social competence. None were found: (*F*(1, 83) = 1.50, *p*>.05). Post-hoc analyses also compared children with CIs based on mode of communication; no differences were found across groups (*F*(2, 89) = 1.50 , *p*>.05).

Growth Modeling

It was hypothesized that children with CIs vs hearing peers would display worse trajectories of social competence, as rated by both parents and teachers over time. This hypothesis was fully supported using the parent report data but could not be evaluated using the teacher report data due to large amounts of missing data.

Parent-Reported Trajectories

As mentioned above, CFAs were run at 48, 72, and 96 months post-implantation to ensure that the indicators loaded onto a unitary construct at each time point. The latent variables were then tested for metric invariance across groups. These variables demonstrated significant improvements in model fit when the factor loadings were free to vary *across* groups (Social Competence at 48 months difference test: X^2 (2) =4.13, p >.05; 72 months: X^2 (2) =7.39, p >.05; 96 months: X^2 (2) =5.65, p >.05). Thus, each CFA was run with the factor loadings constrained *between* groups. Similarly, each CFA was tested for scalar invariance, during which models with factor loadings and intercepts constrained across groups were compared to models with the intercepts free to vary (Social Competence at 48 months difference test: X^2 (2) =2.34, p >.05; 72 months: X^2 (2) =2.52, p >.05; 96 months: X^2 (2) =1.85, p >.05) (Hu & Bentler, 1999; Kline, 2004). None of the X^2 difference tests were significant, suggesting that each CFA had both scalar invariance across groups.

A latent growth model was run to assess change in social competence over time. The default model contained factor loadings across indicators constrained over time and between groups. The residual error variances and latent variances were free to vary. This model resulted in extremely poor model fit. Therefore, an adjusted default model was run in which the residual variances within groups were constrained to be equal over time and the latent variances within groups were constrained to be equal. Further, the residual variances of the same observed variables were constrained to be equal over time (e.g. Adaptability at 48, 72, and 96 months).

Adding these constraints to the model created consistent measurement models across time in the latent variables. This model still yielded poor fit (X^2 (58) =90.93, p <.05). To improve model fit, one residual covariance was added as suggested by the modification indices (See Figure 1 for path diagram). This model yielded significant improvement in model fit (X^2 difference test (2) = 22.54, p <.05) and fit the data well, (X^2 (58) = 70.67, p <.05; RMSEA = .05; CFI = .98). However, the SRMR value of .12 was above the suggested maximum of .08. This may be due to small sample size given that the SRMR value improves with larger samples.

According to the model, children with CIs had significantly lower levels of social competence at 48, 72, and 96 months post-implantation than hearing children (difference between groups at 48 months = .47 points, p<.05; 72 months: .43 points, p<.05; 96 months: .73 points, p<.05). Although children with CIs had a steeper slope over time (the slope of the hearing group was .86 points less than the CI group), these slopes were not significantly different (p = .23). The CI group did not significantly change over time (F(1, 125) = 1.41, p>.05).

This aim also included modeling the longitudinal trajectories of social competence using teacher report. However, due to large amounts of missing data and minimal covariance coverage, it could not be analyzed. Although it was hypothesized that teachers would rate children with CIs as having a worse trajectory of social competence compared to their hearing peers, this aim was likely unsupported because teachers reported no difference between groups at any time point. Therefore, longitudinal modeling would have likely displayed minimal differences between groups at the intercept and slope.

Comparisons of Social Competence for Children Implanted Before and After Age 2

It was hypothesized that children who were implanted after age 2 would have significant deficits in social competence compared to those implanted prior age 2, due to a longer period of auditory deprivation and more severe delays in language. Group differences were expected for both parent and teacher report. This hypothesis received weak support. Controlling for maternal education and income, parents of children implanted earlier vs. later reported no differences at any time point (48 months: $F(1,124) = 0.72$, $p>.05$; 72 months: $(1,124) = 0.46$, $p>.05$; 96 months: $F(1,124) = 0.36$, $p>.05$) Teachers rated children implanted after age 2 as significantly delayed at 48 months ($F(1,113) = 4.14$, $p<.05$), but not at 72 and 96 months post-implantation (72 months: $F(1,113) = 0.22$, $p>.05$; 96 months: $F(1,113) = 0.09$, $p>.05$).

Interrater Discrepancies between Parent and Teacher

It was hypothesized that there would be greater discrepancies between parent and teacher ratings in the CI vs hearing group. This hypothesis was not supported. At all three time points, the magnitude of rater discrepancies did not differ as a function of hearing status. See Table 8 for group comparisons of individual subscales. Intraclass correlations between raters on the same scales were low to moderate across all time points, ranging from .02 to .50 in the CI group and from -.02 to .55 in the hearing group. See Table 9 for all correlations between subscales.

Post-hoc analyses evaluated the magnitude of discrepancies between parent and teacher ratings using the latent variable scores, rather than the individual subscale scores.

Using this method, the magnitude of interrater discrepancies did not differ at 48 and 96 months post-implantation (48 months: $F(1,172) = 3.77$, $p > .05$; 96 months: $F(1,172) = 3.15$, $p > .05$). However, there was a significant difference at 72 months after implantation ($F(1,172) = 5.18$, $p < .05$).

Parent-Child Interrater Discrepancies

We hypothesized that there would be greater interrater discrepancies between dyads in the CI versus hearing groups. This hypothesis was not supported, which was consistent with the results from group comparisons of parent and teacher discrepancies. No differences were found in the magnitude of discrepancies as a function of hearing status ($F(1,121) = 0.12$, $p > .05$).

CHAPTER 4

DISCUSSION

This study evaluated the trajectory of social competence over a 5-year period in the largest, youngest cohort of school-age children with CIs in the US. Although social competence has been evaluated cross-sectionally in children with CIs (Moog et al., 2011; Wiefferink et al., 2012), this is the first study to utilize a longitudinal design, with data from parents, teachers, and children to evaluate interrater discrepancies in this population. The results of this study strongly supported the dynamical systems model, which posits that deficits in one area of development have cascading effects in other areas (Smith & Thelen, 1993; Thelen & Smith, 1994). According to both parent and child report, children with CIs were significantly delayed in social competence across time compared to their hearing peers. In contrast, teachers reported no differences between groups at any time point. The level of agreement among raters was low, although the magnitude of interrater discrepancies did not differ as a function of hearing status.

Comparisons of Social Competence Using Parent and Teacher Report

We hypothesized that a latent variable of social competence, using subscales from the BASC and SSRS, would successfully load onto a unitary construct separately for both parents and teachers. This hypothesis was fully supported, with statistically significant associations found between the two indices of social skills, and strong loadings between social skills and adaptability for both parents and teachers. Overall, more than half of the variance in each of these scales was accounted for by the latent construct for both respondents, indicating that it formed a robust measure of social competence. In contrast, prior studies in the deaf population have relied on single measures completed by one respondent. As recommended by Cook and Oliver (2011), we utilized a multi-measure, multiple-rater approach, which yielded highly consistent factor loadings across the 5-year period. This latent variable, which was reliable over time and across raters, builds upon previous literature by providing a more elegant statistical approach to the assessment of social competence. It allows for an assessment of the true underlying construct, while parsing out measurement error associated with a single instrument.

It was also hypothesized that children with CIs would be significantly delayed compared to their hearing peers on both parent and teacher reports across all time points. This hypothesis received partial support. Parent data indicated that, in comparison to hearing children, children with CIs were significantly delayed on the latent social competence variable at each of the three time points. These findings contradict previous studies evaluating social competence in school-age children with CIs using parent report (Moog et al., 2011; Nicholas & Geers, 2003). However, previous studies compared the CI group to normative data, and furthermore, some of these comparisons were made to deaf children born in the 1970's who wore hearing aids and were often educated in special education classes (Nicholas & Geers, 2003). In contrast, this study was the first to use a time- and age-matched hearing sample, providing a more appropriate comparison group. Our findings suggested that delays in social competence are persistent over time, signaling a need for interventions that remediate social skills. Surprisingly, teachers reported no significant differences in social competence by hearing status across time. No previous research has examined teacher ratings of social competence in school-age children with CIs. However, these findings highlight the importance of obtaining ratings from multiple respondents. These results also suggested that children may behave differently in school than at home.

There are several theories that may explain the discrepancies in results between raters aside from these different social contexts. First, these results may be due to natural differences in communication between children and parents vs. children and teachers. Children with CIs may be more likely to express concerns about social difficulties with their parents, but not discuss these worries at school. Second, parents may have more opportunities than teachers to evaluate their child's social behaviors. Teachers only witness how a child interacts with their peers in the classroom, whereas parents witness their children interacting with others across multiple settings.

Third, the teachers may be engaging in a form of response shift when rating children with CIs (Schwartz & Sprangers, 1999). For example, a teacher may give a child with CIs high ratings because they are performing well "in spite of their deafness." A majority of children in this study were enrolled in mainstream schools (86.7% of the present data), thus, teachers were likely comparing children with CIs to their hearing peers. Studies of social functioning in children with other chronic diseases, such as spina bifida, have also emphasized the importance of obtaining multiple raters, given that different patterns emerge across parent, teacher and child report (Holmbeck et al., 2003). However, it is unclear which teachers completed the forms (e.g. regular classroom teacher or pull-out teacher), therefore, we cannot determine the reasons for these discrepant ratings.

Next, post-hoc analyses examined the effects of school placement on ratings of social competence. No differences were found between those children with CIs in mainstreamed vs self-contained classrooms. These data suggested that regardless of school placement, children with CIs had deficits in social competence compared to their hearing peers according to parents but not teachers.

Post-hoc analyses also examined the effects of mode of communication on social competence. No differences in social competence were found between those who used sign language, a combination of sign and oral language, or oral language. Thus, children who used oral language in school experienced the same delays in social competence as those who signed.

Comparisons of Social Competence Using Self-Report

Children with CIs were expected to rate themselves as significantly delayed compared to their hearing peers at 96 months post-implantation. This hypothesis was fully supported. Children with CIs viewed themselves as having significantly impaired social competence 8 years following implantation. These results converged with the parents' perspective, who rated their children as delayed in social competence in comparison to hearing peers at every time point. Previous studies have reported no differences between children with CIs and those with normal hearing—but using normative data (Moog et al., 2011; Nicholas & Geers, 2003). There are two possible explanations for these discrepant results. First, the Moog et al., study re-enrolled adolescents with CIs who performed better on speech and reading measures than the full sample; thus, they may not have been representative of the typical teen using a CI. Second, the Nichols & Geers (2003) study used the SEAI as the sole measure of social competence, which was published in 1983 and reflected a very different "era" in the diagnosis and treatment of childhood deafness. In contrast, we used a diverse and nationally representative sample of children with hearing loss receiving CIs at six cochlear implant centers and compared them to a current cohort of hearing peers.

In considering differences in ratings across parents, teachers and children, our results indicated substantial agreement between parents and children on the presence of deficits in social competence. As mentioned earlier, children may be more open to discussing their social difficulties with their parents (e.g., teasing, being left out, bullying) and teachers may also be less “attuned” to deficits in this area. This supports the importance of using multiple raters to measure these complex skills and to gather perspectives on social competence in different settings.

Attending to children’s ratings is also important because of the potential cascading effects of these social deficits on other areas, such as emotional functioning. It is possible that these children would also rate their levels of depression and anxiety higher than normal hearing children. Previous studies have also shown that children with CIs experience higher rates of psychosocial difficulties than their hearing peers (Dammeyer, 2010).

Longitudinal Trajectories of Social Competence

This was the first study to model the longitudinal trajectory of social competence in a CI population. We hypothesized that children with CIs would display worse social competence at 48 months, but exhibit more improvement in social skills than their hearing peers over time. This received partial empirical support. Despite use of a cochlear implant for 48-96 months, parents noticed significant delays in social competence at all time points, and children, themselves, reported these deficits at 96 months. These results provided little evidence that children using CIs had “caught up” to their hearing peers across time. Similarly, children using CIs have not been shown to "catch up" to their hearing peers in oral language skills (Ruffin et al., 2013), which supports the dynamic systems theory of interconnections among domains of development.

Effects of Age at Implantation

This study examined age of implantation in relation to the development of social competence. It was hypothesized that both parents and teachers would rate children implanted before age two as more socially competent than those implanted after two. No support for this hypothesis was found, indicating that early implantation does not remediate the deficits in social competence observed in children implanted later. Although results of oral language assessments showed that children implanted before age two had better spoken language than those implanted after two (Niparko et al., 2010), this did not result in differences in social competence. An alternative variable that may have effects on social competence is maternal sensitivity. This was measured in the larger, parent study in videotaped parent-child interactions in several structured and unstructured tasks. This construct consists of warmth, positive regard, respect for autonomy and affective mutuality, all of which are relevant to social competence. In a previous study, we found that mothers of children with CIs who were high vs. low on sensitivity, had children with better oral language (Quittner et al., 2013). It is possible that sensitive parenting serves as an early model for the development of social competence with peers.

Interrater Discrepancies in Measures of Social Competence

Interrater discrepancies among parents, teachers and children were compared both within and between the two groups. We expected greater discrepancies between parents and teachers, and parent-child dyads in the CI than hearing groups. No support for this hypothesis was found. Although correlations between raters were low, they did not differ as a function of hearing status. However, it is important to note that the average social competence score on the SSRS at 96 months for parents and children was quite similar (parent $M = 105.78$, child $M = 107.88$) and the correlation, $r = .63$, was significant. Thus, parents and children in the CI group appear to share similar perceptions of the child's level of social competence. In contrast, there was a slightly greater mean difference between parents and children in the hearing group (parent $M = 97.40$, child $M = 115.50$), with a negative correlation ($r = -.63$).

Previous meta-analyses and review articles in the general population have also demonstrated low agreement between parents and teachers (rs = -.06 - .60) (Hartman et al., 2007; Kolko & Kazdin, 1993; Youngstrom et al., 2000), as well as parents and children (rs=.20) (Achenbach et al., 2005; Achenbach et al., 1987). Thus, our results replicated this same pattern of low agreement in both hearing and hearing-impaired samples. Note also that these groups of respondents rated slightly different items, which may also account for differences in agreement. Extent of interrater discrepancies may also provide insight into a child's social functioning above and beyond the average scores. Previous studies have shown that greater discrepancies between parents and children are associated with worse behavioral outcomes (Brown-Jacobsen, Wallace, & Whiteside, 2011). By obtaining multiple ratings of social competence, a clinician can gain a broader perspective of the child's current social competence and potentially identify those at risk for later psychopathology.

Limitations

This study had several limitations. First, any children diagnosed with a developmental or behavioral disorder following enrollment in the parent study were excluded. These participants were removed to avoid confounds between the effects of the implant and emerging developmental disorders. Thus, this sample was not representative of the entire CI population. Second, the hearing group had significantly higher levels of mean income and maternal education. Although our analyses controlled for these differences, social competence may have been affected by other variables associated with economic advantage. Third, school placement was examined in post-hoc analyses, it was not clear what “metric” these teachers used in rating the children’s social skills. For example, a teacher working in a self-contained classroom has a different frame of reference for rating social competence than a teacher who works exclusively in a mainstreamed classroom. Finally, the mode of communication variable was limited in its ability to differentiate between children. Children who used sign 10% of the time and oral language 90% of the time were collapsed into the same category as the children who used sign language 90% and oral communication 10% of the time. A more precise measure of communication would have been helpful in distinguishing among these children. Note however, that this only affected 12.3% of the CI sample.

Clinical Implications and Future Directions

Our results indicated that children with CIs were delayed in social competence in relation to their hearing peers, four to eight years after implantation. This contradicts the notion that a surgical device, implanted early in life, will foster development across areas of functioning and promote “catch up” growth in and of itself. However, the focus of intervention post-implantation has been on remediation of auditory perception and speech and language skills, to the exclusion of other areas of development. Despite a number of studies documenting the effects of hearing loss (even with an implant) on multiple domains of functioning, such as visual attention, behavioral regulation, and rates of anxiety and depression, there is minimal focus on the "whole child" (Barker et al., 2009; Cruz et al., 2013; Quittner et al., 2013; Quittner et al., 1990; Quittner et al., 2007; Smith et al., 1998). Cochlear implant teams should systematically assess progress in these other areas and provide early interventions for those at-risk. Across a variety of chronic conditions (e.g., diabetes, cystic fibrosis), there are multidisciplinary teams, often including psychologists, which typically address and remediate functioning in these areas.

Given that the US has universal newborn hearing screening, cochlear implantation is now performed at a very young age (typically in the first year of life), which provides an opportunity for systematic early intervention with parents and children. A large body of literature indicates that early intervention is highly effective for children with a variety of risk factors and disabilities (Brotman et al., 2012; Dawson et al., 2010; Sonuga-Barke, Koerting, Smith, McCann, & Thompson, 2011), however, this model has not yet been adopted by cochlear implant teams.

Another important finding is the discrepancy in perceptions of social competence between teachers and our other raters (parents, children) in the CI sample. Teachers did not appear to recognize the social deficits the hearing-impaired children were experiencing and thus, may not be the most relevant raters for these types of behaviors. In contrast, several studies have shown that teachers are able to identify elevated externalizing behavior problems in children with hearing losses (Barker et al., 2009; Mitchell & Quittner, 1996). This may be more in line with their training as teachers, since these behaviors directly affect academic performance.

Finally, our results indicated that the deaf-specific measure of social competence (SEAI) did not correlate with more well-established measures of this construct (SSRS). In reviewing the items and scoring algorithm for this measure, it became obvious that the questions were developed over 30 years ago ("lacks appropriate range of emotional responses," "avoids eye contact"), in an era when many children with severe to profound hearing losses were educated in state schools for the deaf (1793 children in the normative sample were in residential schools for the deaf) or in separate classrooms (572 were from "day programs"). Further, this measure was normed in 1983 and therefore, does not reflect advances the diagnosis and treatment of childhood deafness (e.g., newborn hearing screening, cochlear implantation). Surprisingly, this measure is still commonly used in clinical practice.

In terms of future directions, more in-depth studies measuring social competence in children with CIs are needed. Observational studies, which measure social exchanges between children with CIs and their hearing peers would provide a greater understanding of the challenges children with hearing losses are experiencing. In addition to having more limited oral language, it is also possible that children with CIs have difficulty interpreting social cues, inhibiting impulsive responding (Barker et al., 2009), and expressing empathy. These types of studies would provide specific targets for intervention.

Another area for future research is identification of predictors of social competence. One variable that is likely to be strongly related to social competence with peers is maternal sensitivity. Interactions with parents lay the foundation for the development of social skills, including turn-taking, sharing, compromising, and behavioral regulation. Given that hearing parents of deaf children have a “mismatch” (Quittner et al., 2004) in terms of their communication, it can be more challenging to model these early social behaviors. This may partly explain the deficits in social competence that were observed in this study in the CI group. Thus, training in sensitive parenting may also serve as an important target for research and early intervention.

Lastly, future research should evaluate the effects of social competence on current and future psychosocial outcomes, such as anxiety and depression. In keeping with the dynamical systems model, children who are experiencing delays in social competence may be at-risk for anxiety and depression. A child who recognizes they have difficulties socializing with peers may be more withdrawn or anxious during these interactions. Previous research has shown that children with hearing loss experience higher rates of psychosocial difficulties (Van Eldik, Treffers, Veerman, & Verhulst, 2004). However, more research is needed to understand the relationship between social competence and other psychopathology.

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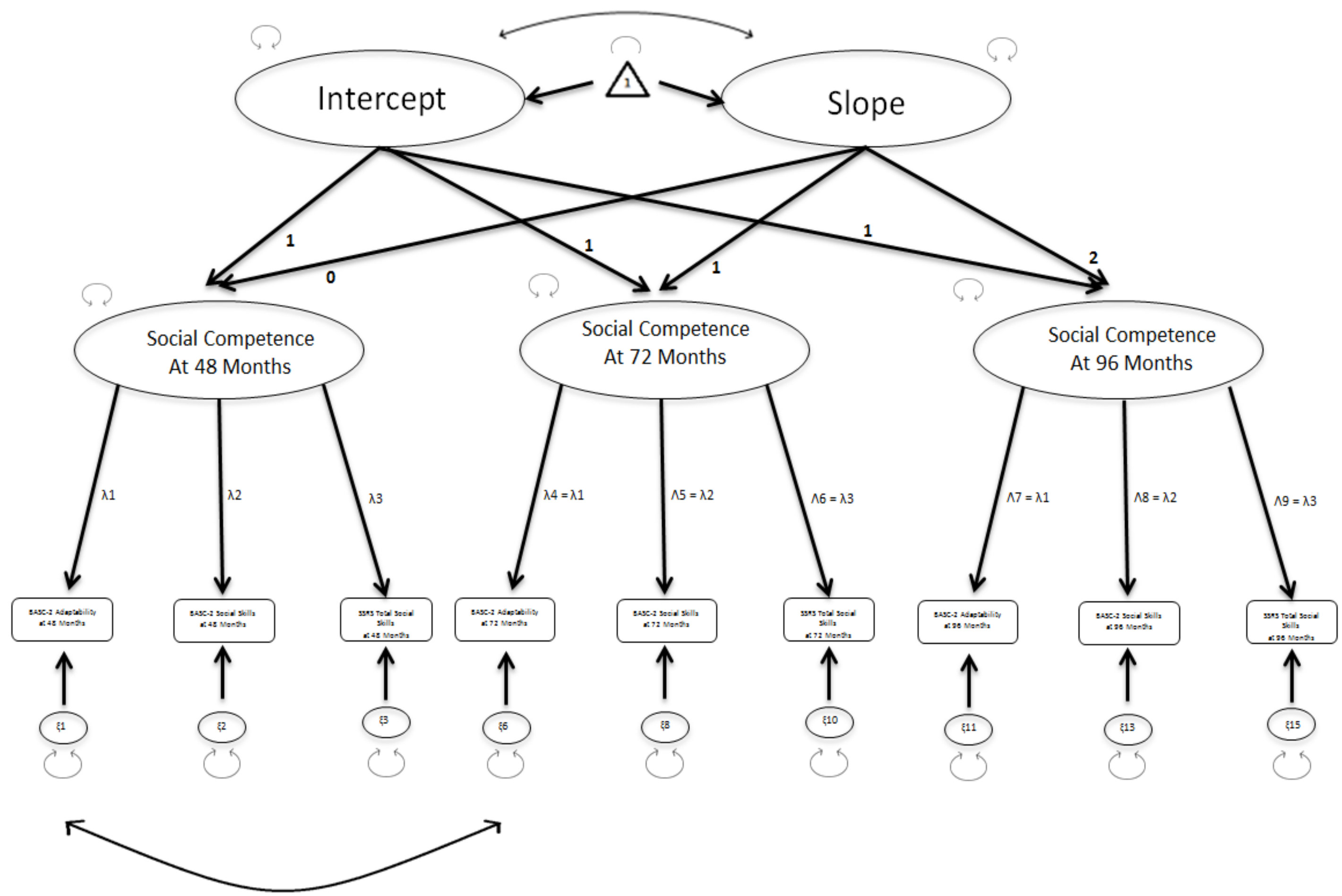
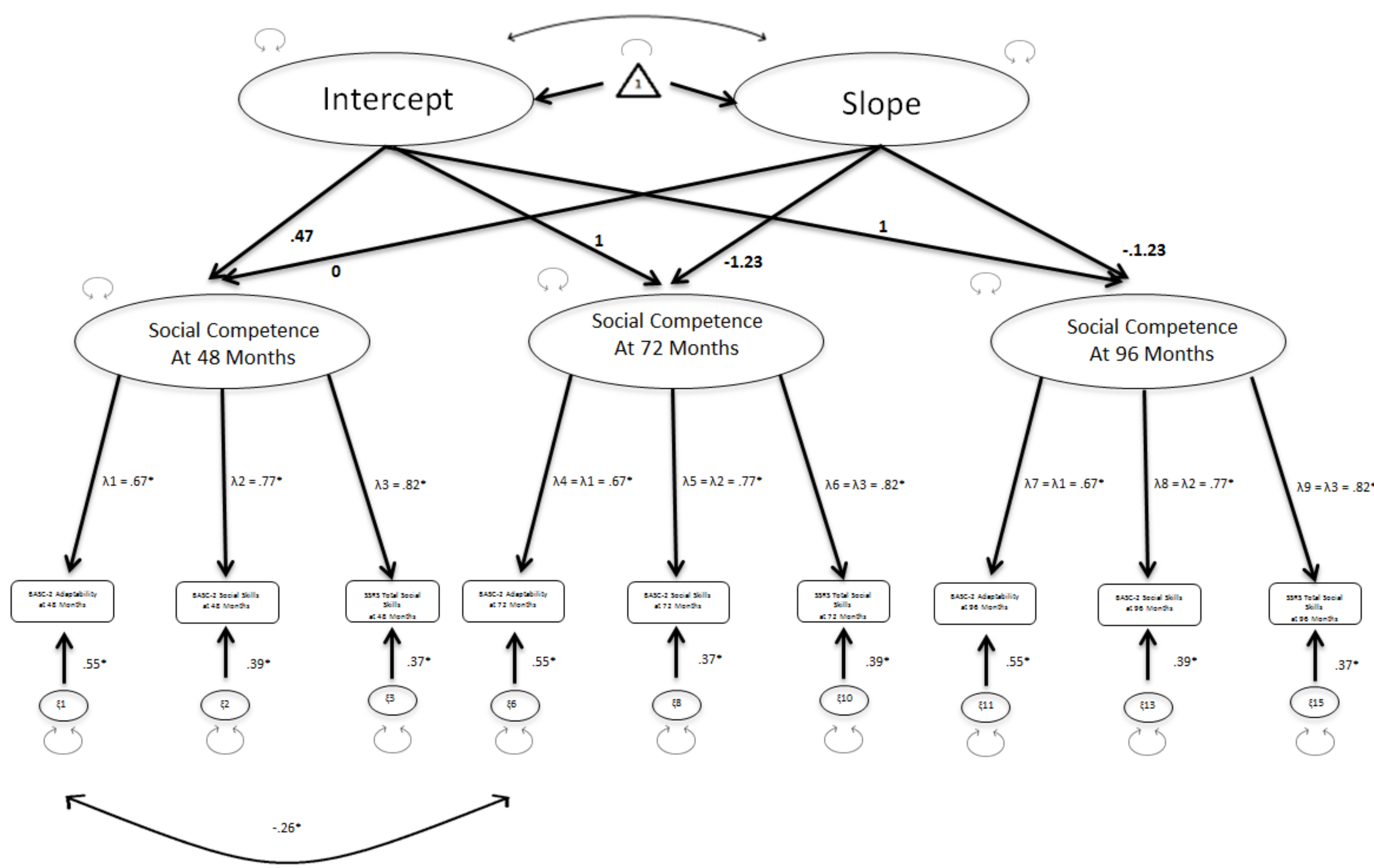
Figure 1
Theoretical Latent Growth Model Path Model



The residuals of the latent variables and factor loadings are constrained equal.

Figure 2

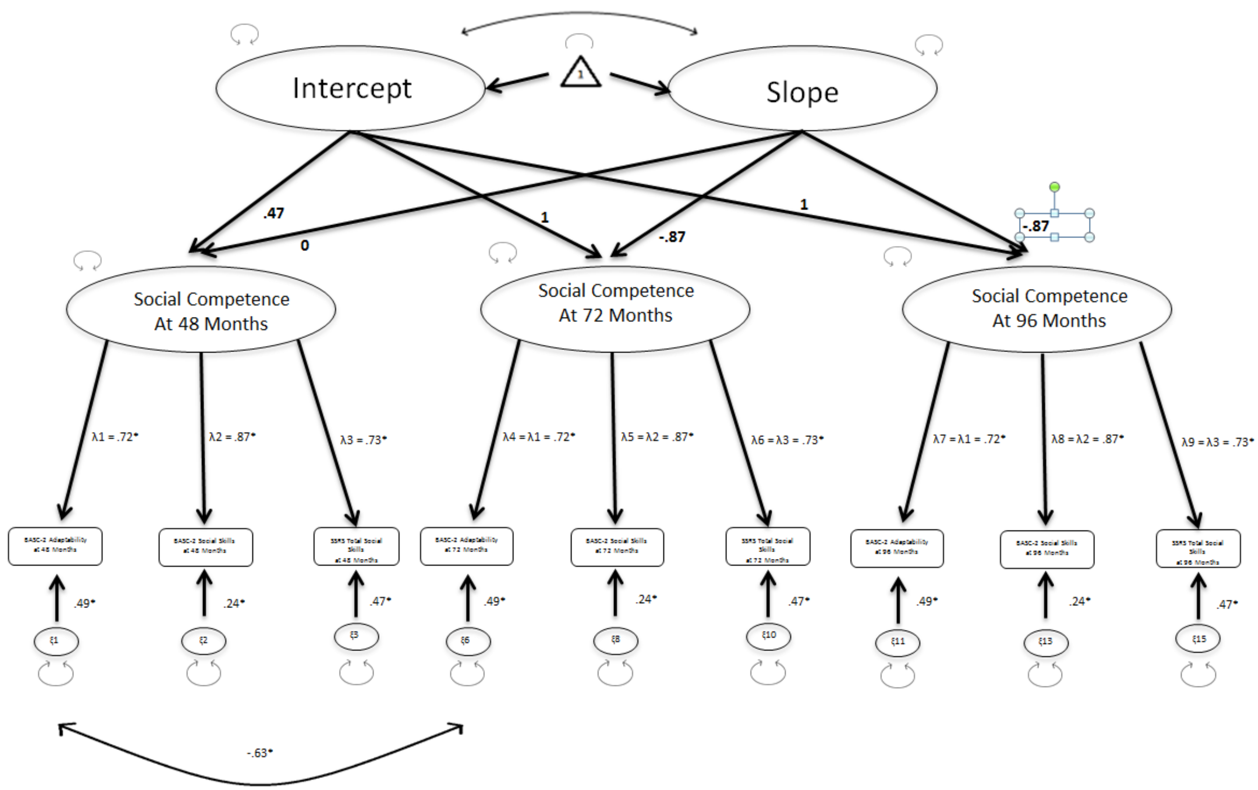
Latent Growth Model Path Model for Children with CIs



The residuals of the latent variables and factor loadings are constrained equal.

Figure 3

Latent Growth Model Path Model for Hearing Children



The residuals of the latent variables and factor loadings are constrained equal.

Table 1

Demographics of the Full CDaCI Cohort[a]

Characteristic	CI (n = 188)	Hearing (n = 97)
Mean age at enrollment (months) (SD)	26.40 (14.40)	27.60 (13.20)
Age of onset (months) (SD)	2.78 (7.39)	--
Pure-tone average (PTA4;better ear) (SD)	104.42 (20.05)	--
Age at diagnosis (months) (SD)	10.59 (10.51)	--
Age at first hearing aid use (months) (SD)	13.29 (10.65)	--
Length of hearing aid use (years) (SD)	13.24 (12.04)	--
Onset of hearing loss % (n)		
Sudden	5.85% (11)	--
Progressive	34.15% (64)	--
Congenital	55.90% (105)	--
Unknown	4.10% (8)	--
Cause of hearing loss % (n)	26.00% (47)	--
Genetic	28.19% (53)	--
Other	14.37% (27)	--
Unknown	57.44% (108)	--
Gender % (n)		
Male	47.87% (90)	38.14% (37)
Female	52.13% (98)	62.86% (60)
Race % (n)		
White	71.27% (134)	78.35% (76)
African American	9.04% (17)	13.40% (13)
Asian	5.31% (10)	2.06% (2)
Other	10.63% (20)	5.15% (5)
No answer	4.02% (7)	1.04% (1)
Ethnicity* % (n)		
Hispanic	19.68% (37)	9.27% (9)
Non-Hispanic	77.12% (145)	88.65% (86)
No response	3.20% (6)	2.08% (2)
Communication Mode at Baseline % (n)		
Sign Language	22.87% (43)	--
Auditory verbal/oral/aural	52.12% (98)	--
Total communication	17.55% (33)	--
Other	1.06% (2)	--

Don't know/missing	6.38% (12)	--
Parents' education** % (*n*)		
< High school	7.44% (14)	5.15% (5)
High school grad	13.38% (26)	2.06% (2)
College	78.81% (147)	91.75% (89)
No response	1.06% (1)	1.04% (1)
Parents' Income** % (*n*)		
< $15,000	7.97% (15)	5.15% (5)
$15 – 29,999	11.70% (22)	4.12% (4)
$30 – 49,999	22.34% (42)	6.18% (6)
$50 – 74,999	16.48% (31)	14.43% (14)
$75 – 100,000	13.82% (26)	12.37% (13)
$100,000 +	16.48% (31)	52.57% (49)
Declined/don't know	11.17% (21)	6.18% (6%)
Full term pregnancy % (*n*)		
Yes	85.64% (161)	78.35% (76)
No	11.17% (21)	11.34% (11)
Don't know/missing	3.19% (6)	10.03% (10)

* $p < .05$, ** $p < .01$;

Table 2
Diagnoses of Participants with CIs Excluded

Participant (*n* =35)	ADD	ASD	PDD	LD	CP	Other
Participant 1	X			X		X
Participant 2		X				X
Participant 3	X			X		X
Participant 4			X			
Participant 5		X		X		
Participant 6				X	X	
Participant 7		X				
Participant 8	X			X		
Participant 9				X		
Participant 10						X
Participant 11			X			
Participant 12	X					X
Participant 13	X			X		
Participant 14				X		
Participant 15				X		X
Participant 16	X					
Participant 17		X	X			
Participant 18	X					
Participant 19	X	X	X	X	X	
Participant 20	X					
Participant 21	X					
Participant 22	X			X		X
Participant 23				X		
Participant 24		X	X			
Participant 25				X		

Participant 26	X					
Participant 27			X		X	
Participant 28	X			X		
Participant 29					X	
Participant 30	X					
Participant 31				X		
Participant 32	X					
Participant 33	X					
Participant 34	X	X	X	X	X	
Participant 35	X	X	X	X		
Totals	**18**	**8**	**8**	**17**	**5**	**7**

ADD = Attention Deficit Disorder, ASD = Autism Spectrum Disorder, PDD = Pervasive Developmental Disorder, CP = Cerebral Palsy, LD = Learning Disorder, OTH = Other

Table 3

Diagnoses of Hearing Participants Excluded

Participant (*n* =35)	ADD	ASD	PDD	LD	CP	Other
Participant 1	X					
Participant 2	X					X
Participant 3			X			
Participant 4	X					X
Participant 5						X
Participant 6	X			X		
Participant 7	X					
Participant 8	X					
Participant 9	X					
Participant 10	X	X	X	X	X	
Participant 11	X					
Participant 12	X					
Totals	**10**	**1**	**2**	**2**	**2**	**3**

ADD = Attention Deficit Disorder, ASD = Autism Spectrum Disorder, PDD = Pervasive Developmental Disorder, CP = Cerebral Palsy, LD = Learning Disorder, OTH = Other

Table 4
Demographics of Participants in this Study

Characteristic	Deaf Group (*n* = 157)	Hearing Group (*n* = 85)
Age at 48 months post-implantation (years) (*SD*)	6.17 (1.20)	6.27 (1.13)
Age of onset (months) (*SD*)	2.74 (7.14)	--
Age at diagnosis (months) (*SD*)	10.42 (10.42)	--
Length of hearing aid use before implant(months) (*SD*)	20.34 (13.45)	--
Onset of hearing loss % (*n*)		
Sudden	5.90% (9)	--
Progressive	34.20% (58)	--
Congenital	55.30% (86)	--
Missing/Unknown	4.60% (7)	--
Pure tone average in better ear (*SD*)	103.78 (18.24)	--
Age at implantation (months) (*SD*)	27.61 (14.29)	--
Communication mode at 72 months % (*n*)		
Sign language	3.80% (6)	--
Simultaneous/equal emphasis	2.50% (4)	--
Oral Language	62.00% (97)	--
Missing/Unknown	31.60% (50)	--
Composite IQ at baseline (*SD)*	97.91 (21.61)	107.79 (14.82)
Gender % (*n*)		
Male	48.40%	36.10%
Female	51.60%	63.90%
Race % (*n*)		
White	75.8%	80.70%
African American	7.80%	9.60%
Asian	5.90%	1.20%
Other	10.40%	8.40%

Ethnicity* % (*n*)		
Hispanic	19.60% (31)	29.90% (25)
Non-Hispanic	81.40% (126)	71.10% (60)
Maternal Education** % (*n*)		
< High school	7.90% (12)	4.80% (4)
High school graduate	14.50% (23)	2.40% (2)
College	77.6% (122)	92.80% (79)
Parents' Income** % (*n*)		
< $15,000	7.00% (11)	4.70% (4)
$15 – 29,999	12.10% (19)	3.52% (3)
$30 – 49,999	21.01% (33)	7.05% (6)
$50 – 74,999	16.56% (26)	14.11% (12)
$75 – 100,000	15.28% (24)	12.94% (11)
$100,000 +	15.28% (24)	49.41% (42)
Declined/don't know	12.73% (20)	6.21% (7)

* $p < .05$, ** $p < .01$;

Table 5

Results of Confirmatory Factor Analyses Using Parent and Teacher Report 48, 72, and 96 Months Post-Implantation

Children with CIs	Est.	SE	Sig.	% Var. Exp.
Parent Report BASC Adaptability at 48 months	.67	.05	<0.01*	49
Parent Report BASC Social Skills at 48 months	.78	.04	<0.01*	61
Parent Report SSRS Social Skills at 48 months	.82	.05	<0.01*	67
Parent Report BASC Adaptability at 72 months	.67	.05	<0.01*	45
Parent Report BASC Social Skills at 72 months	.76	.05	<0.01*	58
Parent Report SSRS Social Skills at 72 months	.80	.05	<0.01*	64
Parent Report BASC Adaptability at 96 months	.67	.05	<0.01*	49
Parent Report BASC Social Skills at 96 months	.78	.05	<0.01*	61
Parent Report SSRS Social Skills at 96 months	.81	.05	<0.01*	66
Teacher Report BASC Adaptability at 48 months	.81	.03	<0.01*	65
Teacher Report BASC Social Skills at 48 months	.86	.03	<0.01*	74
Teacher Report SSRS Social Skills at 48 months	.85	.03	<0.01*	72
Teacher Report BASC Adaptability at 72 months	.81	.03	<0.01*	66
Teacher Report BASC Social Skills at 72 months	.86	.03	<0.01*	74
Teacher Report SSRS Social Skills at 72 months	.85	.03	<0.01*	72
Teacher Report BASC Adaptability at 96 months	.83	.03	<0.01*	69
Teacher Report BASC Social Skills at 96 months	.87	.03	<0.01*	76
Teacher Report SSRS Social Skills at 96 months	.87	.03	<0.01*	76
Hearing Children	**Est**	**SE**	**Sig.**	**% Var. Exp.**
Parent Report BASC Adaptability at 48 months	.72	.07	<0.01*	52
Parent Report BASC Social Skills at 48 months	.87	.06	<0.01*	76
Parent Report SSRS Social Skills at 48 months	.73	.07	<0.01*	53
Parent Report BASC Adaptability at 72 months	.69	.07	<0.01*	48
Parent Report BASC Social Skills at 72 months	.85	.06	<0.01*	72
Parent Report SSRS Social Skills at 72 months	.70	.07	<0.01*	49
Parent Report BASC Adaptability at 96 months	.70	.07	<0.01*	49
Parent Report BASC Social Skills at 96 months	.86	.05	<0.01*	73
Parent Report SSRS Social Skills at 96 months	.72	.07	<0.01*	51
Teacher Report BASC Adaptability at 48 months	.72	.06	<0.01*	52
Teacher Report BASC Social Skills at 48 months	.85	.05	<0.01*	72
Teacher Report SSRS Social Skills at 48 months	.80	.05	<0.01*	64
Teacher Report BASC Adaptability at 72 months	.74	.06	<0.01*	55
Teacher Report BASC Social Skills at 72 months	.87	.05	<0.01*	76
Teacher Report SSRS Social Skills at 72 months	.81	.05	<0.01*	66
Teacher Report BASC Adaptability at 96 months	.76	.07	<0.01*	58
Teacher Report BASC Social Skills at 96 months	.88	.05	<0.01*	77
Teacher Report SSRS Social Skills at 96 months	.83	.06	<0.01*	69

* Statistically Significant Value

Table 6

Comparison of Individual Measures According to Parent Report

Scale	*df*	*F*	Sig.
48 months			
BASC Adaptability	139	1.05	.31
BASC Social Skills	139	0.50	.48
SSRS Social Skills	139	0.82	.37
Cooperation	139	0.43	.51
Assertion	139	0.89	.38
Responsibility	139	3.86	.05*
Self-control	139	0.04	.84
72 months			
BASC Adaptability	125	0.05	.83
BASC Social Skills	127	1.74	.19
SSRS Social Skills	118	7.98	.01*
Cooperation	103	0.56	.45
Assertion	103	5.48	.02*
Responsibility	103	12.26	.01*
Self-control	103	1.74	.19
96 months			
BASC Adaptability	75	0.02	.88
BASC Social Skills	75	2.53	.15
SSRS Social Skills	137	5.47	.02*
Cooperation	119	0.80	.37
Assertion	119	6.38	.01*
Responsibility	119	3.15	.08
Self-control	119	1.43	.23

Table 7
Comparison of Individual Measures According to Teacher Report

Scale	*df*	*F*	Sig.
48 months			
BASC Adaptability	167	0.01	.93
BASC Social Skills	167	1.65	.21
SSRS Social Skills	132	0.66	.42
Cooperation	117	0.01	.95
Assertion	117	1.26	.26
Self-control	117	1.60	.21
72 months			
BASC Adaptability	153	0.89	.35
BASC Social Skills	153	3.24	.07
SSRS Social Skills	124	0.01	.98
Cooperation	110	5.05	.03*
Assertion	110	1.10	.30
Self-control	110	1.23	.27
96 months			
BASC Adaptability	140	0.06	.81
BASC Social Skills	140	1.61	.21
SSRS Social Skills	72	1.99	.16
Cooperation	58	2.64	.11
Assertion	58	0.39	.54
Self-control	58	.01	.92

Table 8
Magnitude of Parent-Teacher Discrepancies as a Function of Hearing Status

Subscale	*df*	*F*	sig.
Adaptability (BASC) at 48 months	131	0.09	.76
Social Skills (BASC) at 48 months	131	0.09	.76
Social Skills (SSRS) at 48 months	114	0.07	.78
Adaptability (BASC) at 72 months	118	0.31	.58
Social Skills (BASC) at 72 months	118	0.31	.58
Social Skills (SSRS) at 72 months	86	3.77	.06
Adaptability (BASC) at 96 months	76	0.13	.91
Social Skills (BASC) at 96 months	76	0.26	.87
Social Skills (SSRS) at 96 months	133	3.51	.56

* $p < .05$, ** $p < .01$;

Table 9. *Correlations of Individual Subscales*
Lower Matrix = CI Group Upper Matrix = Hearing Group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.Par. Adapt. (BASC) at 48 months		.69*	.21	.23	.08	.17	-.33	-.59	-.39	**.22**	-.12	-.14	.07	-.09	-.01	-.62	-.34	-.55	-.22
2. Par. Soc. Skills (BASC) at 48 months	.63*		.60*	.49*	.76*	.58*	.42*	.50*	.42	-.32	**-.15**	.27	.28	.38	.35	-.95	-.60	-.78	.20
3. Par. Soc. Skills (SSRS) at 48 months	.46*	.54*		.50*	.59*	.84*	.28	.31	.63*	.08	.03	**.54***	.16	.19	.39	.11	-.14	-.41	.11
4. Par. Adapt. (BASC) at 72 months	.59	.37*	.45*		.83*	.70*	.79*	.67*	.58*	.45*	.55*	.52*	**.42**	.54*	.44*	.45	.35	.02	.37
5. Par Soc. Skills (BASC) at 72 months	.37*	.77*	.56*	.53*		.73*	.56*	.68*	.60*	.04	.29	.41	.24	**.55***	.40	-.36	-.22	-.75	.12
6. Par. Soc. Skills (SSRS) at 72 months	.46*	.52*	.77*	.57*	.68*		.61*	.58*	.81*	0.3	.35	.71*	.34	.49*	**.54***	.32	.15	-.49*	-.32
7. Par. Adapt. (BASC) at 96 months	.64*	.47*	.39*	.86*	.67*	.47*		.75*	.55*	.54*	.33	.48*	.39	.32	.38	**.36**	.05	.09	.42
8. Par. Soc. Skills (BASC) at 96 months	.28*	.72*	.36*	.59*	.82*	.55*	.71*		.64*	.26	.50*	.27	.21	.10	.09	-.34	**-.02**	.29	.09
9. Par. Soc. Skills SSRS) at 96 months	.44*	.45*	.76*	.54*	.60*	.84*	.54*	.65*		.22	.35	.44	.14	.23	.39	-.87	-.21	**-.32**	**.39**
10.Teach. Adapt. (BASC) at 48 months	**.38**	.34*	.30*	.37*	.46*	.13	.26	.11	.22		.68*	.63*	.50*	.02	.32	.54*	.56*	.31	**-.05**
11. Teach. Soc. Skills (BASC) at 48 months	.27	**.43***	.36*	.11	.32*	.13	.08	.09	.26	.79*		.73*	.49*	.33	.44*	.11	.42*	.38	.04
12. Teach. Soc. Skills (SSRS) at 48 months	.36*	.38*	**.51***	.15	.32*	.39*	.07	.22	.47*	.65*	.76*		.25	.17	.53*	.19	.30	-.21	.26
13.Teach. Adapt. (BASC) at 72 months	.37*	.32*	.15	**.44***	.17	.09	.24	-.17	-.06	.48*	.55*	.35*		.80*	.69*	.80*	.;78*	.78*	.15
14. Teach. Soc. Skills (BASC) at 72 months	.35*	.34*	.27	.44*	**.34***	.38*	.27	.17	.32	.41*	.63*	.49*	.81*		.81*	.69*	.71*	.89*	.17
15. Teach. Soc. Skills (SSRS) at 72 months	.48*	.37*	.42*	.42*	.19	**.49***	.29	.03	.16	.40*	.53*	.58*	.74*	.82*		.62*	.68*	.87*	.17
16.Teach. Adapt. (BASC)at 96 months	.12	.45*	.09	-.19	.23	.05	**.02**	.25	.13	.41*	.51*	.45*	.37	.50*	.34		.88*	.68*	-.80
17. Teach. Soc. Skills (BASC) at 96 months	.06	.45*	.06	-.19	.29	.09	-.08	**.21**	.14	.28	.47*	.39	.14	.39*	.25	.83*		.80*	-.23
18. Teach. Soc. Skills (SSRS) at 96 months	.25	.49*	.01	.13	.28	.19	.15	.26	**.09**	.24	.42*	.28	.58*	.59*	.68*	.74*	.83*		**-.64**
19. Child Soc. Skills (SSRS) at 96 months	.35*	.19	.51*	.23	.24	.50*	.28	.33*	**.63***	**.12**	.07	.28	.13	.21	.19	.06	**.01**	.11	

*= p <.05