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Meta-Analysis of Behavior Problems in Deaf and Hard of Hearing Children

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META-ANALYSIS OF BEHAVIOR PROBLEMS IN DEAF AND HARD OF HEARING CHILDREN

by

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Dissertation Approval Sheet

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Statement of Original Work

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As many may know, a dissertation is not just a paper or a book. It is the culmination of your training in your field of choice and, for many like me, a symbol of the privilege and freedom that you had the choice to pursue this degree at all. It is years' worth of late nights, hard work, and continually renewed perseverance. It is the result of sometimes literal blood (so many paper cuts), sweat (anxious nights awaiting revisions), and tears (self-doubt frustration, and, finally, triumph). The adage says it takes a village to raise a child; writing a dissertation requires nothing less.

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ABSTRACT

Keywords: deaf, hard of hearing, cochlear implantation, children, adolescents

Recent data regarding social-emotional challenges indicate elevations in behavior problems (BPs) in deaf and hard of hearing (DHH) children (Austen, 2010; Stevenson et al., 2010; van Eldik et al., 2004). Factors affecting this include family and social contexts, language development (LD), and cochlear implantation (CIs). The purpose of this dissertation was to analyze findings across studies for trends in BPs in DHH children. Specifically, a model of the effect of deafness, CI use, and LD on the emergence of BPs in DHH children as compared to hearing children was examined. Studies were collected through systematic searches of psychology databases supplemented by studies referenced in other sources therein discovered. Random-effects meta-analyses using the restricted maximum likelihood estimation method were non-significant ($g = 0.31$, $SE = 0.20$, CI [-0.09, 0.71]), as were subgroup analyses ($g = 0.36$, $SE = 0.22$, CI [-0.07, 0.80]). A meta-regression using CIs as a predictor evidenced a nonsignificant reduction in BPs for deaf children with CIs and CIs did not significantly predict BPs in deaf children. Unexplained heterogeneity remained elevated in all cases (I^2 above 96%). In sensitivity analyses, I^2 decreased to 87%, suggesting that designs of included primary studies may have impacted those studies' data collection, analysis, and interpretation. Unmeasured variables such as LD may explain much of the remaining heterogeneity. Collaborating with researchers worldwide, using more inclusive selection criteria, and enacting a longitudinal design could collect a greater variety of data, creating a more complete understanding of the effect of hearing loss on BPs.

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Chapter I: Statement of the Problem

Meta-Analysis of Behavior Problems in Deaf and Hard of Hearing Children

Deafness, regardless of its consideration as a disability, disease, or culture, frequently presents as a formidable risk factor to the social-emotional and language development of children. Its prevalence is difficult to estimate, and therefore usually underestimated, because its definition varies by the convention used to measure or explain hearing loss (Castrogiovanni, 2008). Additionally, a deaf person's functional and social abilities are often defined by the culture in which his or her hearing loss is experienced and are established in early childhood, when the child is learning to communicate and interact with peers (Mitchell, 2005). It is also during this time when behavior problems may first arise, and if not addressed, may lead to lasting behaviors that are linked to poor educational and interpersonal outcomes (Golly, Stiller, & Walker, 1998).

Statement of the Problem

It is unknown how many United States citizens of any age were identified as deaf or hard of hearing between 1930 and 1957 (Mitchell, 2005). To this day, it remains difficult to determine whether the rates of hearing impairment are changing. From the estimates that do exist, there are reportedly 738,000 people with severe to profound hearing loss in the United States; approximately 59,000 of these Americans are under 18 years old (American Speech-Language-Hearing Association[ASLHA], n.d.). Another estimate states that 1.5 to 6 in 1,000 children born in the United States are born deaf (Joint Committee on Infant Hearing [JCIH], 1994), meaning that up to 5,000 children are born deaf each year in the United States alone (Umansky, Jeffe, & Lieu, 2011). The absence of ongoing studies on the prevalence of deafness may be one explanation for the difficulty in its accurate estimation (Castrogiovanni, 2008). Additionally, its definition varies by the convention used to measure or explain hearing loss. The heterogeneous presentation of the condition (Austen, 2010), which may be caused by viral inflammation, vascular occlusive disease, allergic reactions, rupture of the intralabyrinthine membranes, local histamine production, and autoimmune disease (Castrogiovanni, 2008), complicates identifying and enumerating the deaf and hard of hearing people of the United States.

Adding to the difficulty in obtaining accurate estimates is the ambiguity of the terms “deaf,” “hard of hearing,” and “hearing impaired.” According to the Individuals with Disabilities Education Act (IDEA), hearing impairment is defined as a hearing loss that affects educational functioning, while deafness is defined as a severe hearing loss that impairs linguistic processing with or without the use of assistive devices (National Dissemination Center for Children with Hearing Loss [NICHCY], 2010). The U.S. Equal Employment Opportunity Commission (USEEOC; n.d.) describes a person as hard of hearing if he or she mainly relies on his or her hearing to communicate and has a mild to moderate degree of hearing loss. These labels define hearing by the social context yet do not consider the preferences of the people they intend to describe. As children with hearing impairments grow, the manner in which they interact with their hearing loss affects how they define themselves demographically, which may not match the labels set forth by the above groups.

The differentiation between those who are deaf and those who are hard of hearing may be more related to a person’s self-concept than a medical delineation. Using the

Survey of Income and Program Participation (SIPP), Mitchell (2005) postulated that deafness is a social construct, not just the lack of the hearing sense. He found that those who identify as deaf typically use sign language, while those who identify as hard of hearing often focus on speech as their main method of communication. Questions about hearing loss on the SIPP are structured around the respondent's ability to hear normal conversation with or without a hearing aid, thus, creating a social basis for defining oneself as deaf, hearing impaired, or hearing capable.

Based on his findings, Mitchell (2005) estimates that approximately 8,000,000 people would be classified as deaf or hard of hearing, meaning that they struggle to hear normal conversation with or without a hearing aid. Given the categorization on the SIPP, a portion of these people would be considered functionally deaf, that is, they identify as deaf or find that hearing aids do not allow them to hear normal conversation. According to the author, almost 37,000 people ages 6 to 17 years reported themselves to be functionally deaf. About 200,000 people in the United States over 5 years old listed themselves as simply "deaf," excluding themselves from questions about their ability to hear normal conversation, possibly because they consider this an inappropriate measure of their hearing status.

Mitchell's (2005) work is informative, but its generalizability and accuracy may be limited. Since the age groups under study were disproportionate, possibly due to wide variability in the sample, it is less likely that the sample gathered by the SIPP is representative of the deaf and hard of hearing population in the United States. The SIPP does not assess for or consider in its analyses the litany of possible etiologies of hearing loss and the effects these may have on the social construct of deafness. Additionally, the study does not comment on whether those who indicated that they are deaf or hard of hearing also indicated whether they consider themselves handicapped (“deaf”) or culturally “Deaf,” an important topic of debate in the d/Deaf communities and an indicator of a person’s social identity. Such limitations negatively affect the conclusions that can be drawn about the population that was studied and highlight the need for further studies examining the social outcomes of deafness, as well as identifying relevant developmental factors, and the need for various types of interventions in this population.

To this end, researchers and societies serving this population have attempted to enumerate the hearing-impaired children in the United States who require services for education. Findings indicate that, across the country, approximately 391,000 school-aged children have at least unilateral hearing loss (ASLHA, n.d.). According to the Centers for Disease Control Early Hearing Detection and Intervention data from 2010, as many as 9 per 1,000 children were diagnosed with hearing loss in the United States (Centers for Disease Control [CDC], 2012). Moreover, profound, early-onset deafness is present in up to 11 per 10,000 children, and educational services are provided to about 71,000 children in America under the Individuals with Disabilities Act (IDEA). Given the numbers of individuals who experience hearing loss, which may be greater than initially anticipated (Mitchell, 2005), investigating areas of need for this population would inform future research and service provision. Recent data regarding social-emotional challenges in children who are deaf or hard of hearing indicate a strong and elevated presence of behavior problems in children with hearing impairments (Fellinger, Holzinger, Sattel, & Laucht, 2008; Harvey & Kentish, 2010; Lochman, Powell, Boxmeyer, Andrade, Stromeyer, & Jimenez-Camargo, 2012; Stevenson, McCann, Law, Mullee, Petrou, Worsfold, et al., 2011).

Prevalence of Behavior Problems in Deaf and Hard of Hearing Children

An inclusive definition of behavior problems does not exist, since designating behavior as "problematic" depends on the demands of the context or situation (Austen, 2010). Throughout the literature, however, problematic behavior is generally described as a transgression against what is socially acceptable or expected in any given situation (Beard & Sugai, 2004; Feil & Severson, 1995; Kazdin, 1985; Walker, Colvin, & Ramsey, 1995). Feil & Severson (1995) qualify this by stating that, especially for very young children, the frequency and intensity of the behavior in question are significant in identifying problem behaviors as compared to those typical of a child of a similar age in a similar setting. Others suggest that a functional impairment must be present (Feil, Small, Forness, Serna, Kaiser, Hancock, et al., 2005). More specifically, researchers have studied problematic behaviors in young and adolescent children with hearing loss as measured on behavior and social skills questionnaires, such as Gresham and Elliott's (1990) Social Skills Rating Scales (SSRS; Antia, Jones, Luckner, Kreimeyer, & Reed, 2011), Achenbach's (1999) Child Behavior Checklist (CBCL; Cruz, Vicaria, Wang, Niparko, & Quittner, 2012), and the Strengths and Difficulties Questionnaire (SDQ; Hintermair, 2007) developed by Goodman and colleagues (Goodman, 1997; Goodman et al., 1998; Goodman et al., 2010).

Research shows that deaf children exhibit higher rates of behavior problems than their hearing counterparts (Davis, Elfenbein, Schum, & Bentler, 1986; Fellinger et al., 2008; Harvey & Kentish, 2010; Hindley et al., 1994; Lochman et al., 2012; Stevenson et al., 2011), but the exact prevalence of behavior disorders in deaf and hard of hearing children has not been studied. Notably, younger children may be overidentified on measures of behavioral problems, possibly due to the informants' lack of education on normal behaviors children exhibit at this stage of development (Feil et al., 2005). Regardless, deaf children are often described as being two to six times more likely to display behavior problems than hearing children (Austen, 2010; Stevenson, McCann, Watkin, Worsfold, & Kennedy, 2010; van Eldik et al., 2004). Children who display higher rates of behavior problems, including anger, low frustration tolerance, and restlessness (Kohn, 1977), carry a higher likelihood that they will develop antisocial characteristics (Feil & Severson, 1995), including high activity levels, aggression, and social withdrawal (Lerner, Inui, Trupin, & Douglas, 1985).

Findings indicate that the severity of deaf children's behavior problems is not proportional to the severity of their hearing loss (Stevenson et al., 2010), and early detection of hearing loss has not been found to prevent or impede the development of problem behaviors (Fellinger, 2011; Stevenson et al., 2011), suggesting that other factors are involved (Fellinger, 2011; Stevenson et al., 2010). It is likely that social and linguistic factors play a key role in this (Hindley, Hill, McGuigan, & Kitson, 1994), including family and school contexts as well as language acquisition and cochlear implantation.

Chapter II: Review of the Literature

Research on Potential Moderators of Behavior Problems in Deaf and Hard of Hearing Children

Several biopsychosocial factors may affect a deaf or hard of hearing child's behavioral development, including intelligence, low socioeconomic status, ethnic minority status, and use of a cochlear implant (Harvey & Kentish, 2010; Lochman et al., 2012). While such factors are relevant to a child's behavioral outcomes, they are only subject to observation, not intervention. Research has also examined factors and skills that may be modified in an effort to inform the literature on effective interventions targeting behavior problems in deaf children. As such, research on family and social contexts (including schools), as well as the development of language skills will be discussed next. Finally, studies discussing the impact of cochlear implantation on behavior problems will also be discussed, as it has been identified as a potent moderator in this population as well.

Family Context. The family context is where children first learn to interact with their peers in the social environment, but these interactions are also affected by hearing loss. Ninety percent of deaf children are born to hearing parents (Hindley, Hill, McGuigan, & Kitson, 1994; NICHCY, 2010). These families are often provided little information regarding their options for finding social support regarding their child's diagnosis (Sipal & Bayhan, 2010). Garcia and Turk (2007) state that at least 90% of these children lack an effective method of communicating with their hearing parents. This situation breeds challenges in communication between deaf children and their hearing parents, resulting in opportunities for the development of emotional and behavioral disorders (Garcia & Turk, 2007). As a result, deaf children in hearing families may experience sociocultural isolation because they then struggle to find a positive role model with whom they can identify (Harvey & Kentish, 2010).

When considering the development of aggression and antisocial behaviors in typically developing children, research indicates that families who engage in harsh punishments, who have weak parental involvement, and who utilize inadequate family and crisis management techniques may have poorer outcomes for children at risk for behavioral problems (Patterson, Reid, & Dishion, 1992). Additionally, this type of parenting may often be elicited by the child's coercive and avoidant behaviors. Notably, children learn to use antisocial behaviors for gain when contingencies are inconsistently enforced. With repeated success at avoiding or escaping undesirable activities, children's antisocial acts at home or school, including whining and hitting during elementary school, can progress and escalate to stealing and truancy by middle and high school. Children of parents who engage in effective and consistent disciplinary techniques, however, are less likely to exhibit these behavioral patterns (Patterson et al., 1992).

The presence and severity of hearing loss is not, in itself, a risk factor for behavior problems, though it is often used as an excuse for behavioral difficulties. Parents of deaf children who are not familiar with undesirable behaviors that are typically present in young children may attribute such behaviors to the child's deafness. Thus, parents who make these attributions are likely to refrain from disciplinary action, claiming that the child does not know better or believing that the child cannot learn more appropriate methods of communication (Austen, 2010; Stevenson et al., 2010). Undesirable behavior should instead be assessed for purpose or function, as it is often used as a means to escape an unfavorable activity or to attract attention when the child does not have the skills to communicate their feelings appropriately. This is modeled by hearing mothers when they terminate situations eliciting problem behaviors in their deaf children instead of engaging in the appropriate disciplinary tactics. Such interference leads to the development of avoidance behaviors and problem solving using physical means to terminate or evade unpleasant activities instead of the understanding of why these behaviors are undesirable (Austen, 2010).

The effects of hearing impairment on children's development partially depend on how the children and their families interact. In a review of the literature on factors related to behavioral difficulties in children with hearing impairments, Harvey and Kentish (2010) found that parental acceptance of the child's deafness, family adaptability, and family cohesion are protective factors for the child's social-emotional outcomes; behavioral problems will likely surge in the absence of these factors. According to their literature review, controlling and overprotective parenting leads to the development of emotional problems and parent dependence in deaf children. Positive communication patterns and cohesiveness protected against maladjustment and decreased the likelihood of these children becoming depressed as they aged (Harvey & Kentish, 2010). Parental motivation to seek early intervention for their children with hearing impairment is a pivotal factor in the children's development (Davis et al., 1986; Harvey & Kentish, 2010; National Institutes of Health [NIH], 1993). Children whose parents were sufficiently motivated to seek the appropriate interventions, such as special services through their schools and communities, may have better outcomes than children who were not granted access to such services.

Social Context and Schooling. Another area that has been considered in the development of problem behaviors in deaf children is the school setting and social experience each child encounters. Fellinger et al. (2008) studied the quality of life and mental health of 99 deaf students ages 6 to 16 years in both mainstream and special schools. Parents, teachers, and participants reported on participants' behavioral problems and quality of life via assessment questionnaires. Deaf children scored significantly higher than their hearing peers on parent ratings of emotional symptoms, conduct problems, and peer problems, and teacher ratings of conduct and peer problems. Children with severe hearing impairments were reported to exhibit the greatest number of externalizing problems with their peers, per teacher and parent reports compared to children with less severe hearing losses, though group differences were not significant. The findings suggest that children with hearing impairment face additional difficulties establishing their social status as either deaf or hearing because they struggle with both sign and speech. These children may feel marginalized, and therefore stressed, which may cause them to act out inappropriately with peers.

Relatedly, Fellinger et al. (2008) found that older children and adolescents with severe hearing loss are often described as exhibiting more problematic behaviors, specifically externalizing behaviors, by both parents and teachers. Older children and adolescents seek social groups in which to participate, but those with hearing impairment may be marginalized when they struggle with participating in both Deaf culture and hearing society (Fellinger et al., 2008; Harvey & Kentish, 2010). Hearing impaired children missing this sense of belonging may gain less experience in group interactions and social skills, especially since they must visually attend to peers as well as their environment (Harvey & Kentish, 2010). Thus, simply attempting to socialize will provoke behavioral conflicts between deaf children and their hearing peers (Fellinger et al., 2008).

Additionally, parents of deaf children rated their satisfaction with their children's quality of life more highly in the areas of family, interests, recreational activities, and physical health and lower on satisfaction with their children's peer contacts than did parents of the hearing control participants. The deaf children in the sample were less satisfied with social areas of their lives, including their areas of interest and recreational activities, when compared to hearing children. These ratings were in direct contrast to their parents' ratings of their quality of life in these areas. It seems that these parents were unaware of their children's dissatisfaction, placing an additional burden of communication on the children that they likely struggle to express.

Thus, Fellinger et al. (2008) and Harvey and Kentish (2010) conflict on their conclusions and recommendations with regard to the schooling of deaf and hard of hearing children. The former believe that a mainstream environment is more beneficial to deaf children because the preferred method of communication is the same when the child transitions from home to school; the latter state that deaf children in mainstream schools face bullying, teasing, and isolation while they would find a sense of belonging and identity with like peers in special schools for the deaf. Additionally, some of these conflicts may happen because the deaf child often displays a hostile attribution bias or lacks social problem-solving skills due to experiencing fewer social interactions (Lochman et al., 2012). It should also be noted, however, that it is difficult to distinguish the children who developed behavioral problems as a result of the school environment from those who displayed inappropriate behaviors before involvement in a mainstream school system (Harvey & Kentish, 2010).

Hindley et al. (1994) concluded as much after studying the presence of psychiatric disorders of 81 deaf and hard of hearing children ages 11 to 16 years in the United Kingdom. Children in mainstream schools exhibited a greater number of difficulties than children in deaf schools (though the difference was not significant), likely as a result of low scores on self-report measures of self-image. Children studying in a Hearing Impaired Unit (HIU) within a mainstream school reported experiencing more teasing and bullying centered on their deafness. Their peers in a deaf school experienced relatively fewer instances of teasing overall, as well as a homogenous peer group, resulting in significantly more positive scores on the self-image measure (Hindley et al., 1994).

Harvey and Kentish (2010) agree, stating that children with hearing loss who attend schools for the deaf interact with like peers and staff, use sign language, and have opportunities to establish their identity as members of Deaf culture. Children whose hearing impairment was diagnosed before reaching 9 months of age are usually referred to the appropriate intervention services in time to moderately increase their receptive language skills. Such an increase, however, does not remove the discrepancy in language mastery between hearing-impaired children and their hearing peers. Children with hearing loss, therefore, continue to be at greater risk of developing more problematic behaviors than their same-aged peers (Stevenson et al., 2011) due to various factors, including language development. While the social context is pivotal in the development of various interpersonal skills for deaf children, language acquisition also has a strong effect on socioemotional development.

Language. Language development is very sensitive to the degree of a child's hearing loss; the more severe the hearing loss, the more the child's language development lags behind that of his or her hearing peers (Davis et al., 1986; Harvey & Kentish, 2010). Several studies claim that poorly developed language and communication skills are a moderating factor in the emergence of behavior problems in children who have a hearing loss, though predictive models of behavioral development rarely take them into account (Barker, Quittner, Fink, Eisenberg, Tobey, & Niparko, 2009; Fellinger et al, 2008; Garcia & Turk, 2007; Harvey & Kentish, 2010; Stevenson et al., 2010). It is likely that the parent-child language discrepancy (spoken vs. sign language) deprives the child of language acquisition, a factor that negatively impacts the parent-child relationship (Austen, 2010; Barker et al., 2009). Furthermore, parents in a strained relationship with their deaf children may interpret innocuous behaviors as problematic ones (Austen, 2010). In contrast, as mentioned above, healthier communication patterns often result from family cohesiveness, leading to a reduction in reported behavior problems (Harvey & Kentish, 2010). Fellinger et al. (2008) discovered that only 25% of parents in families with children who prefer to communicate in sign language considered themselves competent in the language, leaving the majority of deaf children without a reliable way to acquire language from or use language with their parents.

Barker et al. (2009) conducted a multi-site longitudinal study on the effect of language on problematic behaviors in young, deaf children whose families sought cochlear implantation for them. They found that these children displayed a greater number of problematic behaviors than their hearing peers as described above. Specifically, deaf children exhibited increased aggression, attention problems, internalizing behaviors, and negativity towards their parents. These effects were mediated, however, through language development: Children with less developed language skills demonstrated elevated behavior problems. Stevenson et al. (2010) found similar results in his longitudinal study on the effects of language development on the rates of problematic behaviors in deaf children. They stated that poor communication ability in deaf and hard of hearing children played a key role in the elevated rate of behavioral problems in their sample.

Though language ability plays an important role in a deaf child's social development via the child's communication with parents and peers, its significance is often underestimated in the literature. Children whose language skills are more fully developed can communicate their needs and wants more effectively, thus reducing the need to express themselves physically and, often, aggressively. When children with hearing impairments are provided with cochlear implants, however, they are provided the opportunity to obtain oral language skills, which could have other powerful effects on their socioemotional development in hearing-dominant contexts.

Cochlear Implantation. A cochlear implant is an electronic device that conveys electronic signals through a speech processor and transdermal transmission to the auditory nerve via an external microphone connected to electrodes surgically inserted into the cochlea. In this way, synthetic sound information bypasses the damaged portions of the inner ear and directly stimulates the auditory nerve, which then conducts the signal to the brain for interpretation (NIDCD, 2014). As of the end of 2012, as many as 38,000 children had received a cochlear implant (Food and Drug Administration [FDA; as cited by NIDCD], 2014). Cochlear implants are given to children with severe or profound hearing loss after they reach 12 months of age. The earlier they receive the implant, the more exposure to language they receive during the critical period in which young children acquire such skills (NIDCD, 2014).

Jimenez-Romero (2015) studied the influence of cochlear implants on behavior problems in deaf children. In a matched sample of 104 children with cochlear implants and 104 children with normal hearing, she found that those deaf children who were able to meaningfully integrate the sounds provided by the implant and to socialize and communicate effectively displayed significant behavior problems less frequently and of less severity than deaf children with implants who struggled in those areas. She postulates that cochlear implantation allowed these children to develop the ability to comprehend sounds in their environment and to use clear oral language. This then created opportunities for children to establish healthier peer relationships and decreased the presentation of behavior problems. The author cautions, however, that cochlear implantation does not guarantee that auditory and language skills will develop at rates similar to those of hearing children, as deaf children displayed significantly more problematic behaviors than hearing children in the sample despite all participants being well-matched for sociodemographic characteristics.

Researchers have focused their efforts on studying psychosocial factors in deaf children’s environment that may be modified to curb the development of problematic behaviors. Family context, including disciplinary methods and the conveyance of acceptance, bears heavily on how children first learn to interact with peers. The social environment may be a risk or protective factor, depending on how deaf children view their status among their peers. Language, in many ways, holds the key to deaf children’s social-emotional development, as it is the tool by which children can express themselves appropriately. Cochlear implantation can give a deaf child access to auditory stimulation, but it is only as beneficial as the child's ability to interpret that information as meaningful language. Given the wide variety of studies exploring the detrimental effect childhood deafness can have on various areas of development, it is essential to create a compilation of this information from which future research can progress.

Summary and Conclusions

While the exact prevalence of hearing loss in the United States is unknown and difficult to determine accurately, available estimates in the literature indicate that there are nearly 60,000 deaf or hard of hearing children in the United States alone. Estimates of numbers of children who are deaf or have hearing impairments are specious since funding is scarce and the definition of deafness differs from study to study, but various studies estimate that up to 6 per 1,000 children born in the United States are born deaf (JCIH, 1994). Behavior problems are reported in deaf children up to six times more frequently than the same behaviors in their hearing peers (Austen, 2010; Stevenson et al., 2010; van Eldik et al., 2004). While the rate of behavior problems is higher, problems do not appear to increase as the severity of a child's hearing loss increases (Stevenson et al., 2010).

Causes for these elevated levels of problem behaviors in deaf and hearing-impaired children are varied, but research has shown that various aspects of child, parent, and teacher interaction, communication, and behavioral management are involved in shaping behavioral outcomes for these children. Each study's contribution to the literature is significant, though individually, they may lack power or reach when disseminating relevant information. Specifically, language development and the use of a cochlear implant seem to be the most powerful predictors of problematic behaviors in children with hearing loss. Thus, they also seem to be the most studied, both individually and in conjunction. Though a number of studies examine these effects, and a systematic review of the literature examines the effect of deafness itself on the development of behavior problems (Stevenson, Kreppner, Pimperton, Worsfold, & Kennedy, 2015), none to date have specifically suggested a model regarding the relationship that language and cochlear implantation may have on the development of behavior problems.

Purpose of the Study

An amalgam of the present literature on behavior problems in young deaf children is needed in order to more accurately estimate the effects and relationships of language development and cochlear implantation on the development of behavior problems in deaf and hard of hearing children and adolescents. The goal of this dissertation was to analyze the findings across studies for trends in the problematic behavior of these children and to examine a model describing the relationship between the aforementioned factors as mediators. It was expected that this population of children will exhibit more behavior problems than their hearing peers. It was further expected that these behavior problems would be mediated by the factors described in this chapter (See Figure 1 below).

Hypotheses

This study examined the magnitude of the effect of deafness and hearing loss on the development of behavioral problems in children up to age 18 years. This research was designed to evaluate the following hypotheses:

(1) Deaf and hard of hearing children present with significantly higher ratings on

measures of behavior problems than their hearing peers.

(2) The effect of hearing loss on behavior problems is greater than that expected by chance.

(3) Cochlear implantation and language ability are significant mediators of the effect deafness and hearing impairment have on children's behavioral outcomes.

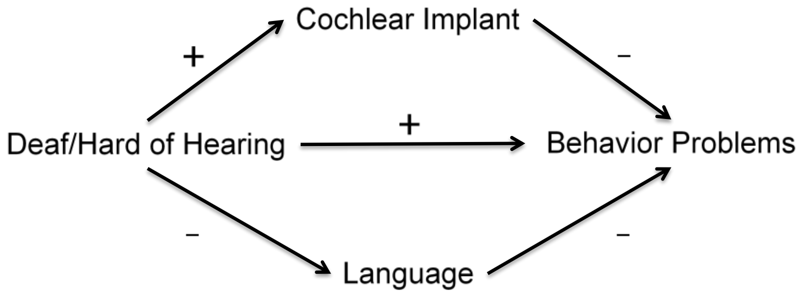

Figure 1. Proposed Model. The initial model proposed that children with hearing loss would present with significantly higher ratings on measures of behavior problems than their hearing peers. It was also hypothesized that hearing loss would negatively impact language development. Furthermore, it was proposed that improved language development would decrease ratings of behavior problems and that cochlear implantation would improve language development.

Chapter III: Method

Procedure

Literature Search. In June 2016, a Boolean search of the 45 databases listed in Table 1 using the terms (behavior* problem*) AND (deaf* OR hard of hearing) AND (child* OR adolescen*) returned 1,360 results. The purpose of this dissertation was to review recent literature, so the search was then limited to publications appearing from the year 2000 onward. Of those 544 results, items not presented in English were removed, leaving 503 entries. The search was further limited by excluding newspapers, magazines, reports, wire feeds, and “other sources” using the Source Type filter, leaving 471 records for perusal. Finally, using the Document Type filter, news, reference documents, commentaries, general information articles, instructional materials and guidelines, and editorials were removed from the search and 434 documents remained. In October 2018, the Boolean search described above was repeated in order to update the literature review and to ensure that the most recent data was presented in the analyses. This search, which specified a date range from 2016 to 2018, returned 32 results. After applying the filters described above, 26 results remained.

Additional searches were conducted for supplementary materials to include in the meta-analysis. Dissertations examining behavior problems in deaf and hard of hearing children were considered eligible for entry into analyses pending they met criteria similar to those of other published studies, as described below. Discovered book chapters listed in the search results were also examined for relevant articles and information. The Boolean search conducted to find the published resources available through Nova Southeastern University’s library was also entered into Google Scholar in an attempt to

Table 1

Databases Used in the Literature Search

Applied Social Sciences Index and Abstracts (ASSIA)	ProQuest Technology Collection
Dissertations & Theses @ Nova Southeastern University	PsycARTICLES
ebrary® e-books	PsycBOOKS
Education Resources Information Center (ERIC)	PsycCritiques
Linguistics and Language Behavior Abstracts (LLBA)	PsycINFO
Periodicals Archive Online	PsycTESTS
ProQuest Dissertations & Theses Global	Social Services Abstracts
ProQuest Natural Science Collection	Sociological Abstracts
ProQuest Central:	
• ABI/INFORM Collection	• Latin America & Iberian Database
• Austrialia & New Zealand Database	• Linguistics Database
• Biology Database	• Middle East & Africa Database
• Canadian Business & Current Affairs Database	• Military Database
• Canadian Newsstream	• Nursing & Allied Health Database
• Career & Technical Education Database	• Religion Database
• Computing Database	• Research Library
• Continental Europe Database	• Science Database
• East & South Asia Database	• Social Science Database
• Education Database	• Sociology Database
• Family Health Database	• Telecommunications
• Health & Medical Collection	• Turkey Database
• India Database	• UK & Ireland Database

find further resources for analysis. The additional searches returned 121 new sources. Finally, authors appearing three or more times in the discovered studies were contacted in efforts to obtain any unpublished work in this area and to reduce the presence of publication bias in the proposed analyses. Forty-two authors were contacted once via e-mail for unpublished results. Some contact information was out of date; these authors were contacted via a second e-mail address if available. While 30 authors did not respond, 12 confirmed that all of their results had been published, that they did not have any unpublished data available, or that there was no unpublished data that they could share at the present time. In total, 581 items were discovered and filtered through the inclusion and exclusion criteria, and the selected articles were subjected to the coding procedures to gather data for analysis.

Inclusion Criteria. Studies were included in the analyses if the following conditions were met:

1. The title or abstract referenced deaf or hard of hearing children.
2. The title or abstract referenced behavior problems in those deaf or hard of hearing children. For the purpose of this dissertation, behavior problems were defined as undesired behavior occurring at a significant frequency or intensity as indicated on direct assessments of behavior problems as described below.
3. The study included a direct assessment of behavior problems. A direct assessment of behavior problems was defined as the use of a structured interview; parent-, teacher-, or self-report measure; or a direct observation of children in varied settings, assessing children's behaviors, including problem behaviors as defined above.

4. The study included participants who may have diagnoses of Attention-Deficit/Hyperactivity Disorder (ADHD), Oppositional Defiant Disorder (OD), and Conduct Disorder (CD).
5. All participants in the study, not including parents, teachers, and other non-child informants, were under 18 years of age at the start of data collection.
6. The authors presented the information necessary to perform the analyses as described below.

Exclusion Criteria. Studies were not included in the analyses if the following conditions were met:

1. The focus of the study was not on participants' hearing status, behavior problems, and related outcomes.
2. The study included participants with comorbid disorders that may confound outcomes related to participants' hearing status or behavior problems, and specifically Autism Spectrum Disorders and Intellectual Disabilities.
3. The study was a duplicate record of a study that was already evaluated for inclusion.

Article Selection. The principal investigator worked with at least two research assistants at all times to aid in and corroborate the selection of studies. All research assistants selected as coders were graduate students or holders of master's degrees who had taken a course on research design. Coders were trained on the inclusion and exclusion criteria, as well as the data collection and article coding procedures, in training sessions as described by Stock (1994) and conducted by the principal investigator. During the training sessions, coders learned to recognize key words that may indicate that a study meets inclusion or exclusion criteria. Coders also learned how to search for and recognize the data required by the coding procedures in various locations of each study.

Each of the 581 discovered items was listed in a spreadsheet on a cloud storage service so that it was accessible wherever an Internet connection was present and given a simple and unique numerical identifier to streamline the article assignment, identification, and evaluation process. Appendix A illustrates a section of the database used to select articles. The principal investigator assigned a section of articles to each coder, including herself. Coders were instructed to locate the item under question, apply the inclusion and exclusion criteria in the presented order, decide whether the item met the stated criteria, then notate such in the spreadsheet with their initials and the date.

Each article was required to be selected for either inclusion or exclusion independently by two coders. Once an article was selected for inclusion, its line in the database was highlighted green and an electronic copy of the study was placed in a folder on the cloud storage service and made accessible to all coders. Articles selected for exclusion by both coders were marked in gray and received no further review. For excluded articles, coders were required to list the reason they believed the study should be excluded based on the provided criteria. Disagreements were discussed between the respective coders, one of whom noted why each coder believed the article should be included or excluded. This was sent to a third coder, who decided, given such evidence, whether the study should be included or excluded. This decision was later confirmed by the dissertation chair. Using this process, the 581 items initially discovered presented 18 items that were suitable for analysis. The flowchart in Figure 2 depicts how many articles were excluded for each reason.

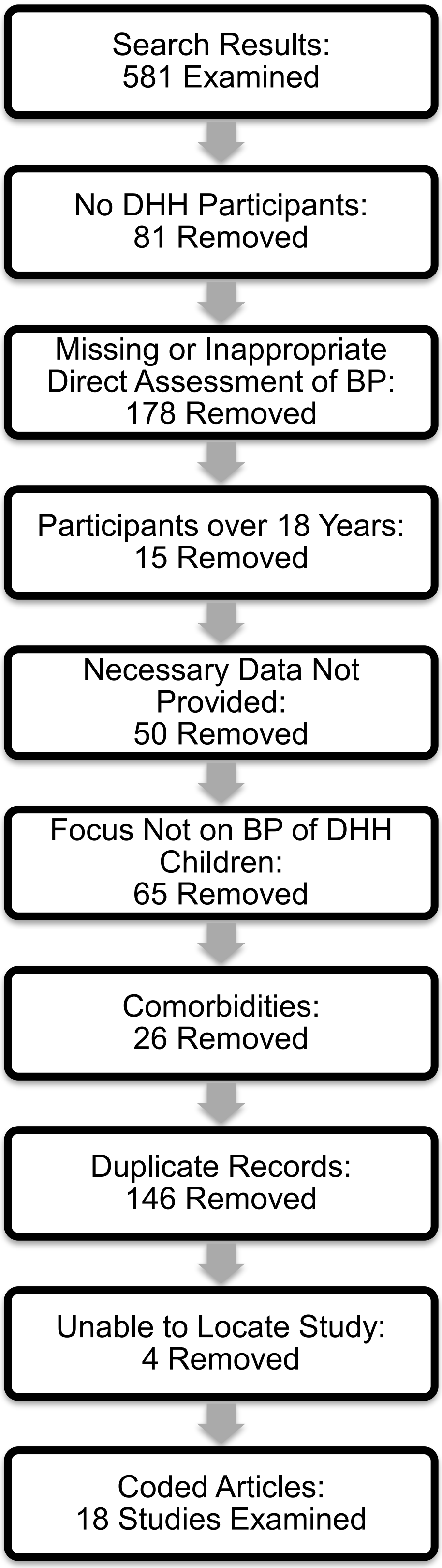

Figure 2. Article Selection Process. All coders filtered the 581 search results through the inclusion and exclusion criteria. In this figure, Inclusion Criteria 2 and 3 are combined into one category, “Missing or Inappropriate Direct Assessment of BP” for simplicity of presentation.

Despite clear search criteria, 81 articles were removed from consideration because they did not reference deaf or hard of hearing participants. An additional 178 items were excluded because they did not present a measure of externalizing behavior problems or because the presented measure of such was inaccurate or inappropriate. For example, many studies reported only the Total score on the SDQ without listing the data for the externalizing behavior scale in that measure. Fifteen studies included participants over 18 years of age at the start of data collection, so they did not meet the age requirement for analyses and were removed. Fifty studies did not provide the necessary data to calculate effect sizes, or the necessary data was presented in a way that could not be statistically converted into the relevant data. Some of these studies presented percentages of samples that presented with behavior problems rather than describing the numerical value of such on the appropriate measures.

Coders removed 65 studies from consideration because the focus of the article was not on behavior problems in deaf and hard of hearing children but rather on related topics (i.e., parenting stress or externalizing behaviors of siblings). Some studies examined participants with comorbid disorders, most commonly Autism Spectrum Disorder and CHARGE Syndrome; as a result, 26 articles were not included in the analyses. The “Remove Duplicates” feature was disabled for this search in order to reduce the chance that eligible studies were hidden due to the automated selectivity inherent in the search engine. Later, coders removed 146 duplicate records. Finally, four articles were presented in another language and could not be found in English or could not be found despite efforts to contact the authors. This left 18 studies to be examined for the current meta-analysis. These articles are described in more detail in the next chapter.

Coding Procedures. All coders were requested to code one of the selected articles, using the coding table developed by the principal investigator for this purpose (see Appendix B), to ensure their understanding of the task and adjust data collection procedures as necessary. Though this article served its purpose of confirming that the coders were able to complete the article selection task as assigned given their training, it was eventually removed from consideration, as it was discovered during this process that it did not provide the data necessary for analyses. Twenty percent of the final cadre of selected studies were pilot coded so that any necessary adjustments to the coding sheet could be made before full-scale data collection began.

Pilot coding of the first four eligible studies resulted in a minor revision to the coding table to reduce redundancy. Following this, each selected report was coded twice, independently, using the coding table. The principal investigator remained available to answer questions and assist with coding articles as necessary, and guided research assistants in appropriate and accurate coding practices throughout data collection while working to maintain the independence of each assistant's codes. The completed tables were scanned and uploaded to the cloud storage service. A simple inter-rater agreement of 80% determined whether data was collected reliably. These reliability values are reported in the Results section. Coders collaborated in producing one reconciled code per selected article. Any coding disagreements were discussed until an agreed-upon code was achieved. Prior to compiling the collected data for analysis, the principal investigator reviewed all reconciliation codes for accuracy and appropriate identification of the variables under study.

Validity. Cooper, Hedges, and Valentine (2009) describe study quality as the fit between a study's goals, design, and implementation. Each study selected for analysis was evaluated for quality as a confluence of internal, external, construct, and statistical conclusion validities. Though many selected studies did not include a specific intervention, studies including children with cochlear implants or interventions targeted at language development or behavior problems were assessed for confounding variables. The individual studies' sample characteristics spoke to each study's external validity, and thus provide the basis for the external validity of the meta-analysis conducted in the current dissertation. Construct validity for this meta-analysis has been addressed in the operational definitions described above and was monitored by the principal investigator in studies evaluated for inclusion. Finally, statistical conclusion validity was closely monitored, as small sample sizes and reduced power are common issues in research conducted with deaf and hard of hearing children. Violations of the assumptions of statistical methods used in each study are noted below.

The most relevant threat to validity in longitudinal studies of children is maturation, or the change in dependent variables due to the passage of time (Zedeck, 2014). Most studies included in the analyses included a comparison group, or the group under consideration was compared to the norms for the measure used to evaluate behavior problems in that study, effectively reducing concerns regarding maturation in research with child participants. Many studies included in this meta-analysis, however, studied older children or adolescents, whose developmental rate is much lower when compared to young children or infants, so maturation became a less relevant threat to validity as the available study samples increased in age. The most frequent threat to validity discovered across studies included in the analyses was the incomplete, unclear, or undisclosed description of the participants' demographics. Some studies listed parents' demographic data without describing the children specifically, insinuating that the children and parents shared these characteristics. This practice does not consider the possibility that some of these children were adopted or resulted from alternative methods of building families. Some articles did not report specific demographic information such as means or standard deviations of participant ages, describing them instead as being in certain grades or levels of school (pre-school, elementary, second through eighth grade, etc.). Given this, the summary of demographic information presented herein is an estimate based on the information reported in the studies and should be considered only as accurate overall as the reports themselves.

Most studies selected for analyses evidenced no concerns regarding statistical conclusion validity, though a few (7 out of 19) used small, non-random samples. Participants for these studies were drawn from schools or medical facilities local to the authors or were screened for participants meeting minimum requirements. Such sampling methods limited the generalizability of those studies. While these studies may also limit the generalizability of this meta-analysis, their impact on the data is limited due to the smaller weights given to them as described in the Statistical Method section below. Additionally, though some studies contained longitudinal data, only the first data point was used in these analyses in order to obtain the most authentic measure of behavior problems in deaf and hard of hearing children, that is, the severity of the presenting behavior problems in this population before time or treatment affected the outcomes. Furthermore, two studies (Dursun et al., 2014; Smith & Landreth, 2004) used a test-retest design. For the purpose of analyses, the baseline measurement was considered the treatment group. Participants' outcomes on the behavior measures were compared to the norms for those measures, so the normative values for those measures were considered the control group.

Other studies exhibited additional concerning threats to validity. One study (Antia et al., 2011) followed its participants if they moved out of town or changed local schools yet failed to address whether such psychosocial stressors may have affected the data. Additionally, this study did not mention that students in self-contained settings may have a higher baseline level of problematic behavior than students in general education settings. Data collected from this study were compared to the norms provided with the measure, however, providing an effective comparison of problematic behavior compared to a representative national sample. Another study may have created a false dichotomy by dividing participants inequitably, comparing the bottom quartile to the remaining children on a measure of language ability. This may have exaggerated the discrepancy in the presentation of behavior problems in this particular sample, as described by the state of the literature. The authors stated that participants in the low-language group are not delayed in language development, and that the groups were created as such to effectively compare behavior scores between groups of hearing and hearing-impaired children with comparable language skills (Stevenson et al., 2010). Similarly, a dissertation included in the analyses singled out participants who presented with problem behaviors over one standard deviation above the mean, which likely resulted in a skewed sample (Monaghan, 2005). This particular study, however, was assigned one of the smallest weights in the following analyses due to sample size. Thus, its effect on the overall analyses was greatly reduced. Finally, one dissertation (Kouwenberg, 2013a) used a shortened version of a measure presented in another study, though it is unclear if the selected questionnaire items were validated in another study as an effective measurement of externalizing behaviors.

Statistical Method

The present dissertation examined a number of studies that addressed the hypotheses described previously. Analyses were conducted using JASP (Jeffreys's Amazing Statistics Program) version 0.9.1 (JASP Team, 2018). The data collected from eligible studies were used to calculate Cohen's *d* (Cohen, 1988), to express an effect size of continuous variables between hearing loss and behavior problems. Notably, *d* has been found to overestimate the population mean difference, or δ, in small samples (Borenstein, 2009). This bias was corrected by converting Cohen's *d* into Hedge's *g* (Hedges & Olkin, 1985) using the correction factor *J* as follows:

$$g = J(df)d$$

where

$$J(df) = 1 - \frac{3}{4df - 1}.$$

The variance of Hedge's *g* is calculated using

$$v_g = [J(df)]^2 v_d$$

and

$$SE_g = \sqrt{v_g}$$

is used to calculate the standard error (Borenstein, 2009).

Additionally, 95% variance confidence and prediction intervals were constructed to support the accuracy of the presented interpretations. Confidence intervals describe with the stated amount of certainty where the true mean of the population under study lies

(Cumming & Fidler, 2009). If the confidence intervals touch or overlap with the line of no effect (i.e., include zero), it can be stated that the effect size of that particular study, or the overall effect size of the meta-analysis, is not statistically significant. This indicates with 95% certainty whether a valid effect exists in the population of studies under consideration. Prediction intervals, in addition, describe with the stated amount of certainty the range within which a future observation may fall given the current data (Nagashima, Noma, & Furukawa, 2018). Prediction intervals are interpreted much like confidence intervals. Should the stated prediction interval include zero, it is possible that hearing loss and cochlear implantation do not have a predictable effect on the development of behavior problems.

Graphical analysis of forest and funnel plots was also conducted. A forest plot depicts each study's effect size, weight, and confidence interval as well as the overall effect size including all studies in the analysis. Each effect size is indicated with a square. The size of the square indicates the weight of the study. Lines extend from either side of this square indicating the corresponding confidence interval (Zedeck, 2014). A funnel plot examines the presence of publication bias by graphically organizing the selected studies based on their coordinates on x and y axes. Studies with fewer participants exhibit a greater variety in their effect sizes, causing them to spread more widely near the bottom of the graph. Larger studies, however, should result in more precise effect sizes, creating a narrower spread near the top of the graph. Thus, if statistical analysis of the funnel plot indicates no statistically significant presence of publication bias, the plot will show a symmetrical and triangular shape upon visual inspection (Egger, Smith, Schneider, & Minder, 1997). Furthermore, a sensitivity analysis based on study design was conducted to determine if studies' methods and results covary with one another.

Model Selection. In order to calculate the weighting factor and subsequent analyses accurately and control for differences in study design, it is imperative to decide whether to use a fixed effects model or a random effects model of meta-analysis. Conceptually, the random effects model suits the data to be collected in this study due to the various study designs, sample sizes, and sources of random error found in research of this nature, such as etiology of deafness, access to therapies and treatments, and treatment adherence. Statistically, a random effects model assumes that the population variance (Θ) is heterogeneous. If, during the course of analyses, it is discovered that Θ is not significantly different from zero, or that it is homogenous, then the model may be reduced to a fixed effects model while maintaining the conservative adjustments inherent in the random effects model (Shadish & Haddock, 2009). Therefore, a random effects model was used because it allowed inferences to be made about the results under examination while accounting for error related to sampling and study design. The weighting factor for each study was then calculated as the inverse of the variance for that study. This method of weighting studies was selected because it optimizes the weighting factor, resulting in the maximum likelihood of the observations under examination while minimizing the variance of the distribution of those observations (Lee, Cook, Lee, & Han, 2016). Furthermore, analyses were conducted using the restricted maximum likelihood approach to estimation (REML), which calculates a transformed set of data in which the effects of nuisance parameters are eliminated (Dodge, 2006).

To test the assumption of heterogeneity, Cochrane's *Q* was used to determine whether the studies under consideration were homogeneous with respect to the population they presume to explain (Omnibus Test of Model Coefficients). If the Q statistic exceeds the critical value based on the χ^2 distribution, then it can be stated that the variances present in the analyses are significantly different from zero, statistically confirming the rationale for using a random effects model for further calculations. Presuming an approximately normal distribution of effect sizes, the z-test reported for the omnibus Q statistic indicates approximately where on a normal distribution the stated result fell, as well as the probability, or significance, of obtaining that result (Sprinthall, 2011). Considering Q also allows for the examination of whether the studies under consideration differ from each other (Test of Residual Heterogeneity), suggesting methodological sources of error over and above that expected from sampling error. The present dissertation also reported I^2, an index that quantifies the extent of heterogeneity present rather than simply stating whether such is present (Cooper et al., 2009). Specifically, it describes the percentage of variation across studies due to heterogeneity rather than chance alone. Small, medium, and large amounts of heterogeneity are present if I^2 approximates 25, 50, and 75 percent, respectively, and is calculated as such:

$$I^2 = \frac{Q - (k - 1)}{Q},$$

where I^2 is set to 0 when the value of Q is less than its degrees of freedom (Huedo-Medina, Sánchez-Meca, Marín-Martínez, & Botella, 2006; Shadish & Haddock, 2009). Due to the wide variety of language variables discovered in the research, language development was not assessed in these analyses. A meta-regression using cochlear implantation as a predictor was used to explore the effect of the devices on problematic behaviors with an alpha level of .05. Additionally, a sensitivity analysis was conducted to determine if the study design affected the presented outcomes.

Due to the high levels of variability in study characteristics and the lack of an extensive research base with randomized designs, a priori estimations of average sample size (*n*), average study variance (*v*), and expected number of studies to be included in these analyses (*k*) were likely to be inaccurate, arbitrary, or based on conjecture. For this reason, retrospective calculations were preferred for evaluating power and study quality. Retrospective power calculations are similar to prospective power calculations, except that the discovered values for *n*, *v*, and *k* are used in place of the estimated values (Valentine, Pigott, & Rothstein, 2010). An a priori approach may cause small but valuable studies to be excluded, thus reducing the power, potential generalizability, or impact of these analyses. As the hypotheses implied a directional effect of hearing loss on behavior problems, a one-tailed test of power was chosen over a two-tailed test.

Chapter IV: Results

Literature Search

Eighteen of the 581 search results described previously met inclusion criteria. One of these results included two separate studies that met inclusion criteria (Kouwenberg, 2013a, Kouwenberg 2013b), resulting in 19 studies of behavior problems selected for analysis. One of the 18 selected studies included three groups: one group of hearing children in mainstream schools, one group of deaf and hard of hearing children in mainstream schools, and one group of deaf and hard of hearing children in special schools (Wolters, Knoors, Cillessen, & Verhoeven, 2011). This article was included in analyses twice, comparing each of the deaf and hard of hearing groups to the hearing group, and resulting in 20 total effect size comparisons for analysis.

Demographics

Overall participant characteristics as well as characteristics for participants in each study are presented in Table 2 and Appendix C, respectively. Out of 20 comparisons included in the original analyses, seven did not report the mean age of their sample, an additional five did not report the standard deviation for the reported means, and one reported no specific age data for their participants. Participants in that study were reported to be in the second through eighth grades. Seventeen of 20 comparisons reported the minimum and maximum ages of participants. The average minimum age of participants, according to available data, was 5 years, 5 months and the average maximum age of participants was 11 years, 3 months. Very few studies provided data on the race or ethnicity of their participants, as well as the age of implantation for children

Table 2. Demographic Information

Total N	2,640	100.00%
Gender		
Male	1,318	49.42%
Female	1,294	49.02%
Not Reported	28	1.06%
Hearing Status		
Deaf	423	16.02%
Hard of Hearing	380	14.39%
Deaf OR Hard of Hearing	70	2.65%
Total Deaf AND Hard of Hearing	873	33.07%
Cochlear Implant	431	16.33%
Hearing	1,271	48.14%
Other Hearing Status[a]	33	1.25%
Unknown Hearing Status[b]	32	1.21%
Age[c]		
Minimum	1 year, 0 months	*M* = 5 years, 5 months
Maximum	16 years, 5 months	*M* = 11 years, 3 months

[a] One study listed 33 participants as having "at least unilateral hearing loss." These children were listed separately from children with mild, moderate, severe, or profound hearing loss.

[b] Three studies included a total of 34 participants whose hearing status was unknown.

[c] See page 35 for a more detailed description of this data.

with cochlear devices, making estimations of such information difficult. For the few studies that did provide this information, the majority of participants were Caucasian in all cases. Other represented minorities included Hispanic/Latino, African-American, and Asian-American.

Reliability

Initial inter-rater agreement for 19 coded studies, calculated as the percentage of responses that were the same on both coders' data sheets, ranged from 61% to 97% by individual article; agreement by dyad ranged from 61% to 86%. Disagreements between coders were the result of several reasons, including rounding or arithmetic errors and missing data on the part of the coder. This may have occurred due to difficulty understanding the information as it was presented in each article or because the coder did not collect the information from the article initially. When errors were the result of an inaccurate understanding of coding instructions, the principal investigator contacted the coder and clarified directions to prevent reiterations of the error. After correction, overall inter-rater agreement reached 80%. Once both codes for each article were completed, coders met in person, via telephone, or via videoconference software to review their data and discuss responses until one reconciliation code was completed in full agreement by both coders. This code was also scanned and uploaded for later use during data entry. The principal investigator reviewed each reconciled code closely for accuracy before entering the data for analysis.

Analyses included outcome variables from a number of measures with scales examining externalizing behavior problems. Internal consistency reliabilities (Cronbach's α) for these scales ranged from moderate to excellent and are presented in Appendix C. The Conduct Problems scale of the SDQ, when administered to children ages 11 to 18, achieved moderate internal reliability (α = .64; Cohen, 1988). Mellor (2004) explains that having few items on this subscale had a negative impact on its internal reliability. Teachers seemed to give more reliable responses than parents or children on this scale (α = .75). Another measure, used by Kouwenberg and colleagues (2013a) and described as an adaptation of a measure by Baerveldt, van Rossem, and Vermande (2003), also achieved moderate internal consistency (α = .68 for deaf and hard of hearing participants, .69 for hearing participants). The Social Skills Rating System evidenced acceptable to excellent reliability depending on the study (α ranged from .77 to .94). The Infant-Toddler Social and Emotional Assessment (ITSEA) also showed good reliability (α = .87; Carter, Briggs-Gowan, Jones, & Little, 2003). The Eyberg Child Behavior Inventory

(ECBI, α = .93 for the problem scale) and the Achenbach Child Behavior Checklist (CBCL; α = .92 for all ages) both evidenced excellent internal consistency on scales measuring externalizing behaviors (Achenbach & Rescorla, 2000; Achenbach & Rescorla, 2001; Eyberg & Pincus, 1999). Two studies included in analyses reported good to excellent internal consistency reliability, ranging from .87 to .93, for the CBCL (Smith, 2004; Vogel-Walcutt, 2011) One study used the Inventory for Client and Agency Planning (ICAP); this article reported that this measure has an overall internal consistency of .93 (Jiménez-Romero, 2015). Another study (Kouwenberg, 2013b) used the Instrument for Reactive and Proactive Aggression (IRPA; Polman, Orobio de Castro, Koops, Van Boxtel, & Merk, 2007) with good to excellent internal consistency (α = .89 for hearing participants, and α = .92 for deaf and hard of hearing participants). Finally, a 15-item questionnaire developed by Wolters, Knoors, Cillessen, & Verhoevan (2014) reached an internal consistency of .94 on its antisocial behavior scale, which included seven items.

Analyses

Hypotheses (1) and (2). Though no unpublished studies were discovered, there was no evidence of publication bias in this analysis, as suggested by the funnel plot in Figure 3 and statistically confirmed by the Rank Test of Funnel Plot Asymmetry (Kendall's $\tau = 0.06$, $p = .73$). More than half of included studies fell within the delineated cone of the distribution around the estimate of the effect size, which depicts where 95% of all studies based on these data would fall and further suggests that there is little to no publication bias in this group of studies. Notably, there seemed to be an increased density of studies toward the top of the plot. This is expected given that most of the included

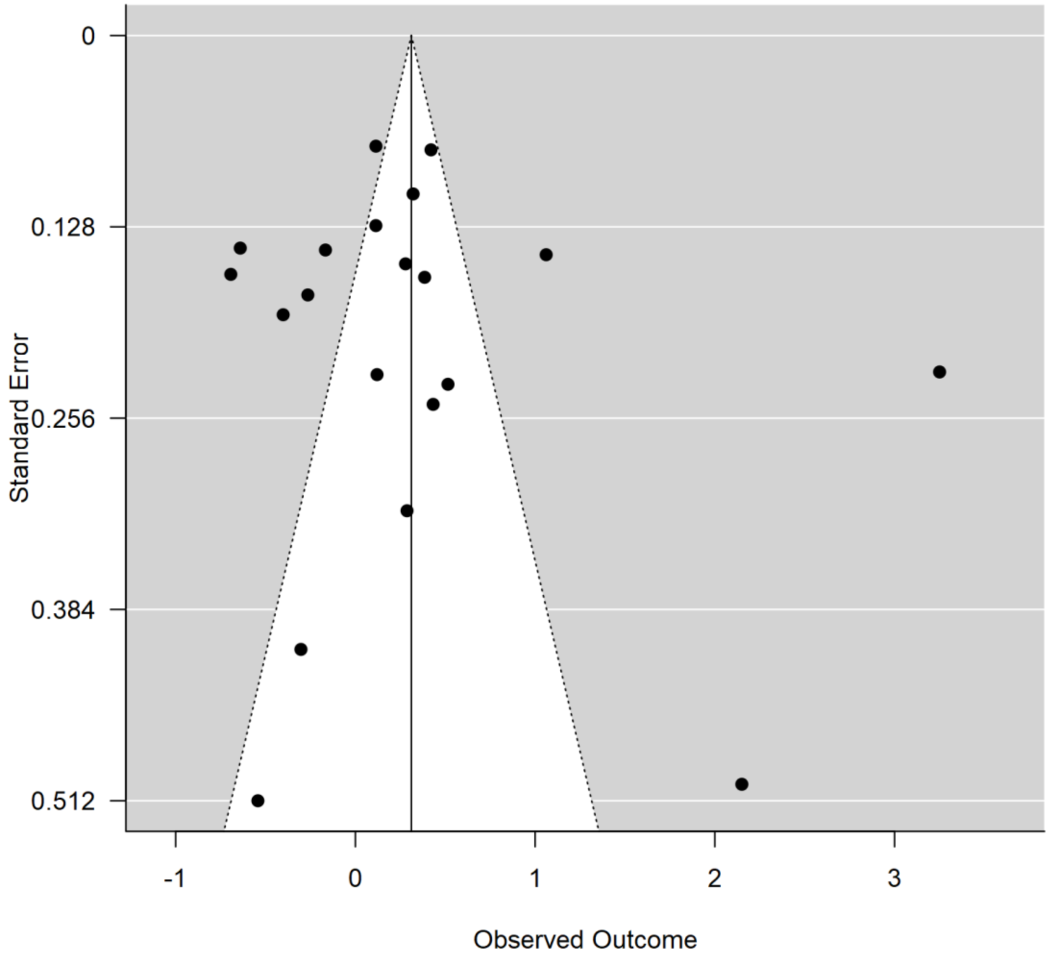

Figure 3. Funnel Plot for Initial Analyses ($k = 20$). Visual inspection indicates variability across studies, though publication bias was not present.

studies had larger sample sizes (13 of 20 studies with $n > 30$), and thus, likely resulted in more precise estimations of each population's true effect size (Sutton, 2009).Visual inspection of the funnel plot indicated that although there was variability in the effect sizes of small-sample studies, and this variability decreased as expected as standard error decreased, large-sample studies retained much of this variability. The variability amongst these studies likely contributed to the non-significant results presented below. Overall, these findings show that the following results can be taken as an accurate representation of the literature as it currently stands.

Due to the number of comparisons in these analyses ($k = 20$), Hedge's *g* was used in order to retain its inherent conservative adjustment. Initial analyses were conducted using a random effects model with the restricted maximum likelihood (REML) method of estimation to minimize variance and accommodate the larger studies. The resulting forest plot is presented in Figure 4 and the results of the meta-analyses are presented in Appendix D. The overall mean Hedge's *g* effect size was 0.31 ($SE = 0.20$, CI [-0.09, 0.71]). The 95% confidence interval included zero for this analysis, suggesting that the true effect size may be equal to zero and rendering this result non-significant. A prediction interval of -1.59 to 2.21 indicated that in 95% of all populations, the true effect size of a future observation would fall within this range. Because it also straddles zero, this prediction interval suggests that hearing loss may not have a predictable effect on the development of behavior problems.

The distribution of effect sizes of the sampled studies indicated that the effect sizes in question do not differ significantly from zero (Omnibus Test of Model Coefficients $Q = 2.34$, $df = 1$, $z = 1.53$, $p = .13$), providing support for the use of a fixed effects model. As the effect sizes of the studies under analysis were not equal to each other (Test of Residual Heterogeneity $Q = 342.79$, $df = 19$, $p < .001$), using a random effects model of meta-analysis was preferred for the inherent conservative adjustments. Over 97% of the heterogeneity in this sample remained unexplained ($I^2 = 97.14$). Given these results, analyses failed to reject the null hypothesis that deaf and hard of hearing children exhibit behavior problems at levels similar to hearing children. This is not

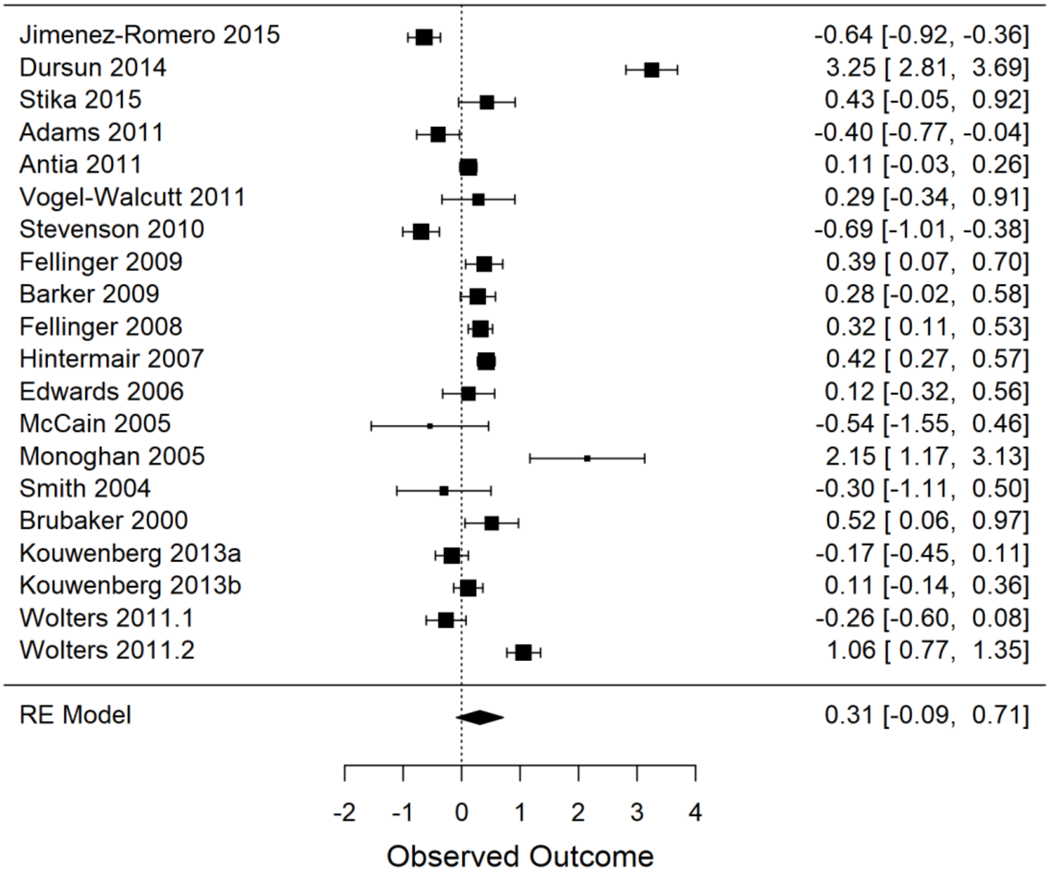

Figure 4. Forest Plot for Initial Analyses (*k* = 20). Initial analyses were conducted using a random effects model with the restricted maximum likelihood (REML) method of estimation.

unexpected, given that the included works sourced children of various ages and abilities. Further analyses were conducted to explore one reason for this variability.

The studies examined in the previous analyses included participants from two articles who were described as having “additional disabilities.” One study (Hintermair, 2007) did not clarify beyond this term, though another (Stevenson et al., 2010) reported that a small percentage of its deaf and hard of hearing participants had cerebral palsy, a visual disability, a learning disability, or a disability of chromosomal or syndromic origin. After controlling for the effects of the multiple handicaps present in the hearing-impaired sample, the authors state that their reported results were not affected by the presence of developmental disabilities in the deaf and hard of hearing participants. (Stevenson et al., 2010). These studies were initially included in analyses due to the ambiguous description of the disabilities. The stipulated inclusion and exclusion criteria did not categorically rule out all disabilities, only those that would cast uncertainty over the source of participants' behavior problems. As a result, coders were unable to state with certainty whether these disabilities affected children's behavioral expression.

A subsequent analysis was performed with a subgroup ($k = 18$) of the previous sample. The two studies described above were removed from further analysis so as to create a sample of studies that met the inclusion and exclusion criteria as previously described and without ambiguity. This subgroup evidenced little publication bias as well (Kendall's $\tau = 0.11$, $p = .55$; see Figure 5). Visual inspection of this plot indicated that the variability in the effect sizes of this subgroup mirrored that of the full sample approximately identically. The increased density of studies at the top of the plot again suggests that the variability in the more precise studies may have negatively impacted results presented below. Half of these studies were within the delineated cone, suggesting that the population's true effect size may fall within the identified distribution of studies around the estimate of the effect size (Sutton, 2009). As before, these findings lend credence to the results as representative of the available literature as it currently stands. Results using the REML method of estimation for a random effects model also mirrored previous analyses. The forest plot for this analysis is presented in Figure 6. Analyses showed a small-to- moderate effect size and the confidence interval included zero

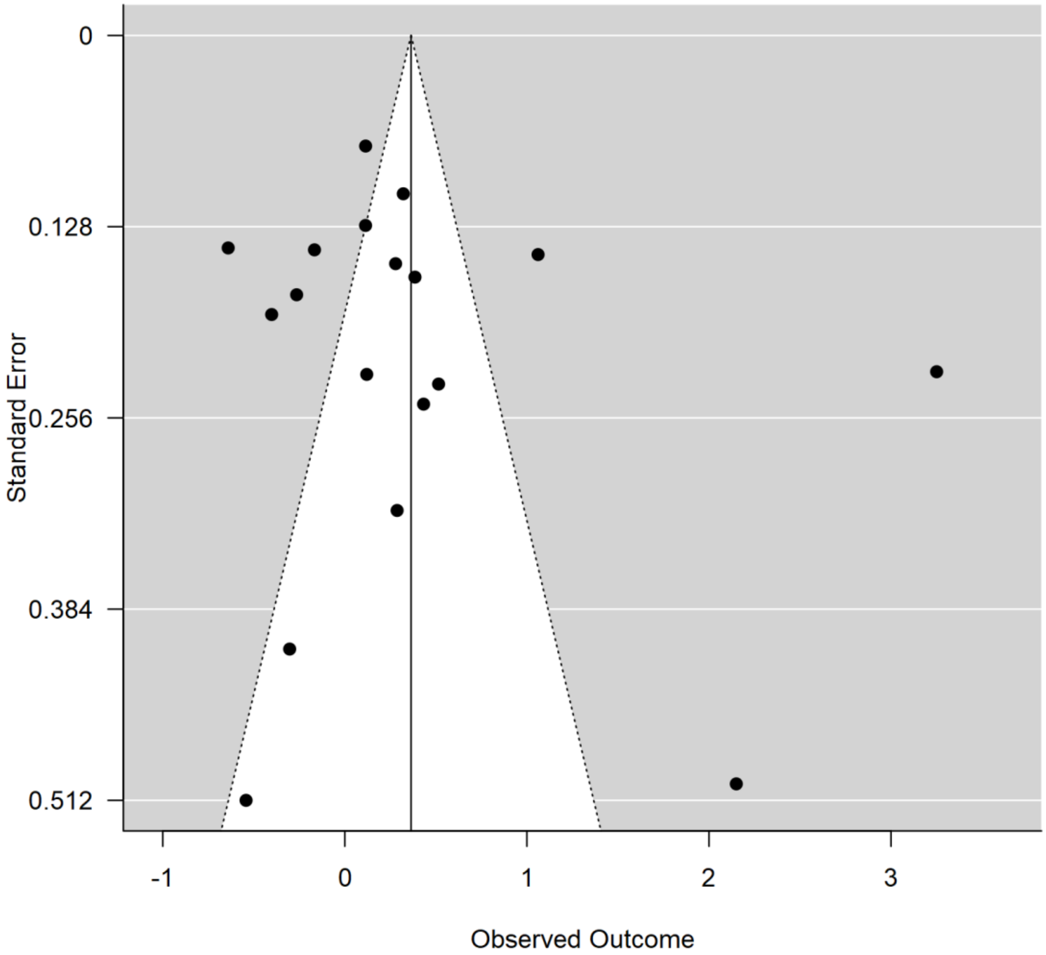

Figure 5. Funnel Plot for Subgroup Analyses (*k* = 18). Visual inspection indicates that this plot was similar to the first and also did not reveal publication bias in the sample.

(Hedge's *g* = 0.36, *SE* = 0.22, CI [-0.07, 0.80]), indicating that deaf and hard of hearing children exhibited behavior at levels comparable to those of hearing children. Because the prediction interval for this analysis also straddles zero (-1.60, 2.33), a future observation given the current data may support or refute the hypothesis that deaf and hard of hearing children exhibit more behavior problems than their hearing peers with approximately equal probability.

The studies in this subgroup were again found to cluster around zero (Omnibus

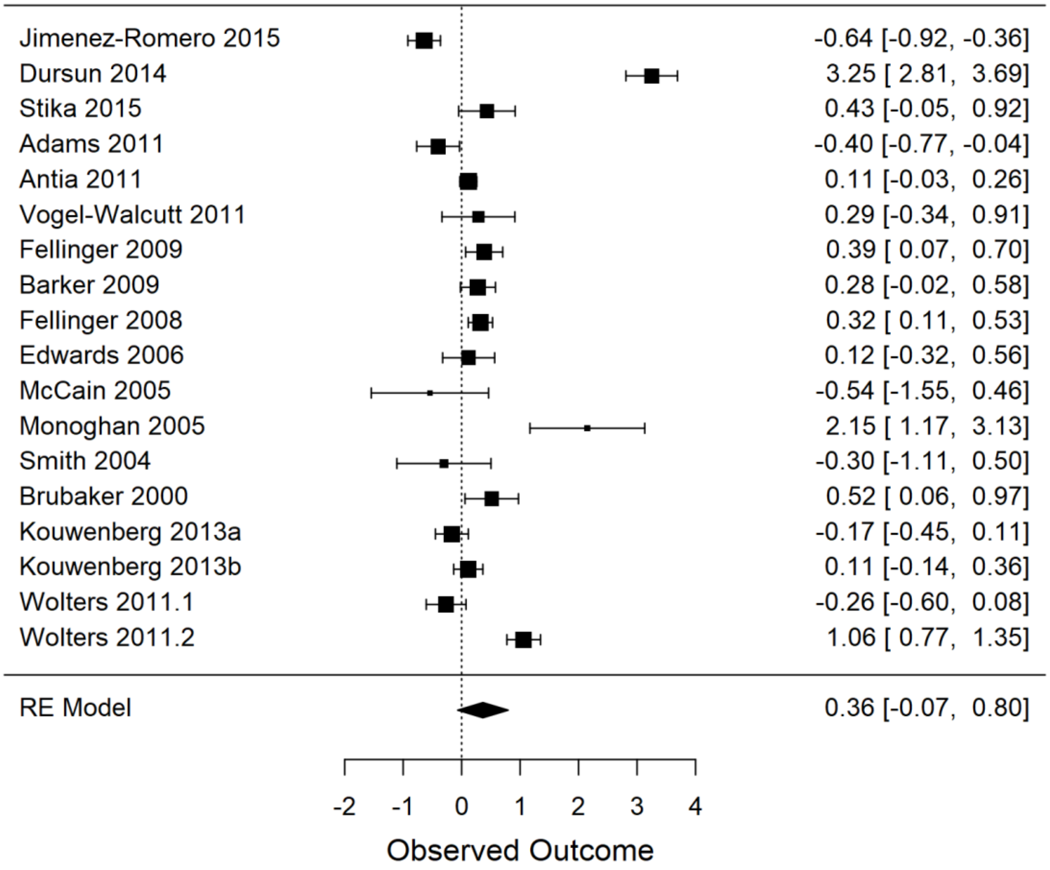

Figure 6. Forest Plot for Subgroup Analyses (k = 18). Subgroup analyses were conducted using the REML method for a random effects model.

Test of Model Coefficients *Q* = 2.73, *df* = 1, *z* = 1.65, *p* = .10), suggesting that these data could be analyzed using a fixed effects model. Some considerable discrepancy remained in the effect sizes retained for this analysis, however (Test of Residual Heterogeneity *Q* = 303.20, *df* = 17, *p* < .001), which again prompted the use of a random effects model for analysis for the inherent conservative adjustments. Disability, it seems, was not one of the factors explaining the variance in the previous full-sample analyses, as the unexplained heterogeneity remained very elevated (I^2 = 96.82).

Hypothesis (3). Due to the wide variability of the language data discovered in the selected articles, a singular language development variable could not be effectively calculated. As a result, data on language development was not entered into analyses and the model as previously proposed could not be evaluated. Further information is provided in the discussion. Instead of assessing whether cochlear implantation affected language development, and whether this affected the severity of behavior problems in deaf and hard of hearing children, the revised model evaluated whether cochlear implantation affected the strength of the relationship between hearing loss and behavior problems. This effectively converts cochlear implantation into a moderator as shown in Figure 7.

A meta-regression conducted on the subgroup of 18 studies while controlling for the effects of cochlear implantation produced results suggesting that cochlear implantation was not a significant predictor of behavior problems in deaf and hard of hearing children ($b = -.70$, $SE = 0.42$, CI [-1.52, 0.12]). In this case, a negative *b* value suggests that deaf and hard of hearing children with cochlear implants exhibited fewer behavior problems than deaf and hard of hearing children without cochlear implants. This difference was not statistically significant, however, and the unexplained heterogeneity suggests that cochlear implantation alone is not sufficient to explain the variability in the effect sizes ($I^2 = 96.17$).

Sensitivity Analyses. Sensitivity analyses conducted on the studies that did not include unspecified disabilities separated correlational study designs from all others. In total, 14 of the 17 selected studies used correlational designs. Two of the remaining studies used a test-retest design, and one dissertation included four case studies. Due to the severe discrepancy in group sizes for these analyses, the following analyses include

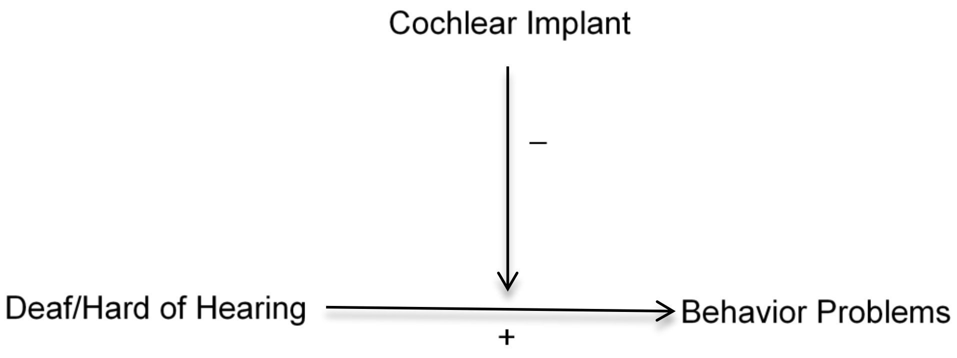

Figure 7. Analyzed Model. Due to the wide variability of the language data discovered in the selected articles, a singular language development variable could not be effectively calculated. The revised model examined whether cochlear implantation moderated the relationship between hearing loss and behavior problems.

only the 14 correlational studies, which provided 15 comparisons. This analysis mirrored previous results, presenting with a small effect of hearing loss on behavior problems (Hedge's $g = 0.13$, $SE = 0.12$, CI [-0.10, 0.35]) and properties of variability similar to previous analyses (Omnibus Test of Model Coefficients $Q = 1.18$, $df = 1$, $z = 1.08$, $p = .28$; Test of Residual Heterogeneity $Q = 100.25$, $df = 14$, $p < .001$).

These results suggest that, while all studies in this analysis seem to describe a singular population, there was significant variability in the effect sizes of those results. This variability is reflected in I^2, which posits that there was less heterogeneity in this analysis than in those conducted previously ($I^2 = 87.46$). Taking this into account, it can be stated that a noticeable amount of the heterogeneity in the main analyses may have resulted from differences in research designs in the present cohort of studies, though the unexplained heterogeneity described by I^2 remains elevated.

Following the calculations provided by Valentine et al., (2010), the power value for both main analyses reported above approached 1.000 based on the average sample sizes for each analysis. It is likely, therefore, that those analyses had the required power to describe the effects under investigation. Given that the analyses exhibited excess variability and did not reach significance, it can be said that the effect of hearing loss on behavior problems in children varies widely and is likely affected by factors not measured here. Furthermore, it is possible that this effect, previously leading researchers and practitioners to believe that deaf and hard of hearing children misbehave two to six times more frequently than hearing children, is not as prominent as once thought. Such high valuations of the outcomes of interest may reasonably be explained by sampling error, study design, or regional idiosyncrasies.

Chapter V: Discussion

The current dissertation aimed to summarize the present literature in order to obtain a more accurate estimate of behavior problems in deaf and hard of hearing children. This study also intended to examine a model describing the relationship between language development, cochlear implant use, and behavior problems in children with hearing loss as an extension of a meta-analysis conducted by Stevenson and colleagues (2015). Their findings showed that children with hearing loss were more likely to present with both emotional and behavioral disorders. The current dissertation examines the behavioral aspect of their findings and expands upon their hypotheses to suggest that cochlear implants, in conjunction with other variables not measured here, may play a part in reducing the prevalence of behavior problems in deaf children. Data on language development, however, were exceptionally varied and did not provide enough measurements of any one construct to effectively describe the effect of language on externalizing behaviors in this population. Various studies included measures of receptive and expressive language, sentence comprehension, or language production. These variables were too disparate to analyze as contributing to singular construct. As a result, the analyses discussed below did not take language development into consideration.

Hypotheses (1) and (2)

Initial and subgroup analyses did not support the first and second hypotheses, that deaf and hard of hearing children would present with significantly higher ratings on measures of behavior problems than their hearing peers. While many individual studies in these analyses support the proposed hypotheses (Dursun et al., 2014; Fellinger et al., 2008; Fellinger et al., 2009; Monaghan, 2005; Szakowski & Brubaker, 2000; Wolters et al., 2011), the strength of this relationship varied across the included publications. This suggests that the development of behavior problems in deaf and hard of hearing children has alternative explanations that likely contributed to the excess heterogeneity discovered and reported in the results. Given the literature reviewed previously, variations in the presence of consistent and supportive family environments (Harvey & Kentish, 2010) as well as a sense of belonging to a peer group (Fellinger et al., 2008) may have introduced variability into the development of problematic behaviors. When the population under study was specified more clearly, i.e., when the two samples including participants with disabilities were removed from analysis, the magnitude of the effect increased slightly, though this analysis also did not reach significance. It is possible that there were some confounding factors in those two studies that negatively impacted the magnitude of the relationship between hearing loss and behavior problems. For instance, children with multiple disabilities likely undergo more therapies than children with a single disability. Depending on the nature of the comorbidities, the conditions or the additional treatments may have behavior-inhibiting components. This could depress the participants' scores on externalizing behavior scales.

Hypothesis (3)

The analyses described previously did not separate participants with cochlear implants from those without the devices, which may also have minimized the magnitude of the effects under study. As suggested by Austen (2010) and Stevenson et al. (2010), parents may perceive more problematic behaviors in a child with hearing loss when compared to their hearing siblings or peers for various reasons, including parental inexperience, lack of parenting knowledge, and difficulty communicating disciplinary or social information. Furthermore, Garcia and Turk (2007) posit that deaf and hard of hearing children struggling to communicate difficult emotions may express their frustration by acting out, which may also be seen as misbehavior by parents and peers. Thus, according to the research, some of the elevation in behavior problems for deaf and hard of hearing children may be due to parental misperception or misinterpretation. The meta-regression, however, suggests that problematic behaviors may not rise to a clinical level as frequently for deaf and hard of hearing children with cochlear implants as it may for deaf and hard of hearing children without them.

As a factor, cochlear implantation was not a significant predictor of behavior problems in the meta-regression as conducted. It is possible that cochlear implant use masks the effects of deafness on behavior problems, as children who do not have such devices may exhibit more severe behavior problems than children who have them. This implies that other variables, which were not measured in this study, may be more effective predictors. One such variable is likely to be language development. Research conducted by Jimenez-Romero (2015) posited that using cochlear implants earlier allows children to understand the auditory clues in their environment and produce clearer oral messages, which provides opportunities for developing healthier relationships and behavior patterns. Theoretically, cochlear implantation gives children with severe to profound hearing loss access to auditory stimuli such as environmental sounds and spoken language. Such exposure accelerates deaf children’s language acquisition and development, providing them an avenue to express their emotions verbally rather than physically. As a result, deaf children with cochlear implants have opportunities to learn to communicate effectively and socialize appropriately through discussion with parents and peers. They also may be less likely to act aggressively, thereby reducing their ratings on measures of behavior problems.

The current dissertation did not examine whether cochlear implantation impacted language development, and whether that process would reduce reported behavior problems, due to the wide variability in language variables in selected articles. This caused a shift in the analyzable model from what was previously proposed to the final model tested in the analyses (See Figures 1 and 7). Research has demonstrated that language acquisition is sensitive to hearing loss, creating a discrepancy in language skills between children with mild or moderate hearing loss and children with severe or profound deafness (Davis et al., 1986; Harvey & Kentish, 2010) which then affects the presentation of problematic behaviors. Results presented here suggested similar trends in behavior problems in deaf and hard of hearing children, though no analyses reached significance. While deaf and hard of hearing children may present with more severe behavior problems than their hearing peers in some studies, the current meta-regression suggests that deaf children with cochlear implants may exhibit less severe behavior problems when compared to deaf children without cochlear implants. Such results, in tandem with research presented just previously, suggest that using a cochlear implant may provide deaf and hard of hearing children with an alternative method of understanding or expressing their frustration, thus potentially reducing the incidence or severity of behavior problems such as aggression.

Further complicating the interpretation of these results is the improvement of the cochlear implant technology over time. As the sound quality of the device improves (i.e., as more audio channels are added and as the stimulus presented to the auditory nerve approaches realistic sound reproduction), it is likely that deaf children with such implants would gain greater benefits from language exposure and instruction than deaf children using earlier models of cochlear implants. It is possible, therefore, that if the earlier studies under consideration in this meta-analysis were repeated once now and again in the future, the results presented therein would change and thus affect the results of this meta-analysis. Following this conjecture, future studies may show a greater, perhaps statistically significant, discrepancy in the severity of presenting behavior problems in deaf children with and without cochlear implants.

Sensitivity Analyses

Finally, sensitivity analyses using only those studies with correlational designs evidenced results similar to the main and subgroup analyses, though the effect of hearing loss on behavior problems was weakened. Additionally, some of the heterogeneity in the sample seemed to be attributable to the presence of other study designs (test-retest and case studies), since I^2 decreased from 96.17% in the meta-regression to 87.46% in the sensitivity analysis. It is possible that the other study designs were more susceptible to sampling error and thus introduced heterogeneity that otherwise would not have been present in this sample of studies. It is also possible that similar study designs used similar methods of data collection and analysis, limiting the type of data that could be collected and analyzed, and thus introducing less heterogeneity into this sample. Much of the heterogeneity in these analyses remains unexplained, however, suggesting that, as described previously, other factors not measured herein likely affect behavioral outcomes for deaf and hard of hearing children.

All analyses used a random effects model of meta-analysis in an effort to accurately describe the effects under investigation. A random effects model assumes that the population under study is heterogeneous and thus accounts for error due to the diversity of participants, treatment availabilities, and study designs expected from each of the studies included in the analyses. Such diversity likely contributed, as expected, to the elevated levels of unexplained heterogeneity (I^2 exceeded 87% in all analyses). Given, too, the power present in these analyses, it is likely that the statistical conclusions drawn here accurately describe the effect, or lack thereof, hearing status has on the development of behavior problems in deaf and hard of hearing children based on the present data. Essentially, it seems that hearing status does not impact behavior problems in deaf and hard of hearing children overall as strongly as previously thought.

Limitations

The current dissertation suffered some limitations. Less than 20 studies met the specified inclusion and exclusion criteria from a pool of over 580 search results. Sixty-five articles alone were excluded independently by two coders from analysis because they were not focused on behavior problems in deaf and hard of hearing children. A revision of this inclusion criterion may change this requirement to be more objective. Some studies may not discuss behavior problems in deaf and hard of hearing children as the primary focus of analysis but may still present the necessary data to conduct the proposed analyses. Including these articles would then make more studies available for meta-analysis and possibly change the statistical outcomes. Given that two coders independently excluded each of these articles, however, it is possible that too few studies would be added to the analyses to cause a shift in the effect sizes measured here. Furthermore, some of these studies included measures of problematic behaviors that did not fit the operational definition of such for this dissertation, which also would have called for their exclusion.

While most studies used appropriate sampling and statistical techniques, some studies had small samples or used convenience sampling methods. A few studies reported some methodological difficulties, as well. Most addressed those concerns effectively, and the others were absorbed by the current analyses with low weights, minimizing their negative impacts on the present results. Additionally, in some studies, demographic data were not reported. Articles including participants with disabilities that commonly co-occur with hearing loss were not entered into analysis. Specifically, autism spectrum disorder and intellectual disability were excluded due to those diagnoses' behavioral components and the potentially confounding effect they could have on behavioral data. Two studies originally included for analysis recruited participants with unspecified disabilities. As the nature and behavioral effects of the disabilities in those samples could not be determined, they were omitted from consideration and the analyses were repeated to ensure the more precise application of the inclusion and exclusion criteria. As a result, generalizability may be limited to deaf and hard of hearing children without comorbid diagnoses.

The scope of the works included in these analyses, however, shows that the effects described above are present in many Western nations, including the United States, the United Kingdom, Germany, Austria, and Spain. Several researchers published articles translated from their original language, but there was a notable absence of works from Central and South American, African, and Asian nations. This likely occurred because search results were limited to articles published in English. Alternatively, there may not have been studies done in this area in those parts of the world. Collaborating with researchers who speak languages other than English would allow for the investigation of this question and the verification that discovered articles in diverse languages are relevant to the proposed research question.

In fact, results presented herein may have been tempered due to cultural and societal differences in the perception and treatment of deaf and hard of hearing children as well as the availability and accessibility of services and therapies for them and their families. Collaborating with researchers around the world would provide access to research in multiple languages. Including international studies would allow for a greater variety of data and a more complete understanding of the effect of hearing loss on behavior problems. Summarizing data from disparate countries could mute the aforementioned cultural and societal effects on behavior, though controlling for the data's nation or culture of origin could open the door for more generalizable results, especially if the effects under study retain their significance.

The analyses performed in this dissertation were concerned with a single timepoint in each of the included studies, regardless of whether additional timepoints were available. Meta-analytic methods exist that could analyze the appearance and development of behavioral problems over time and across studies, allowing for the completion of a meta-analysis using longitudinal data. This could contribute significantly to the literature, allowing researchers to examine variables believed to affect the outcomes in families of deaf and hard of hearing children over time. Ideally, data could be collected over the participants' childhood years, from birth to age 18. Such a study would give an epidemiological overview of deafness and its effects in infancy, childhood, and adolescence from which future clinicians and researchers could draw when determining protective factors and designing interventions.

Future Directions

Future studies in this area could re-examine the available literature using more inclusive selection criteria to create more opportunities to study how language development and comorbid disorders affect behavior problems in children with hearing loss. With a sufficient research base, the various language variables discovered previously may be grouped and modeled with the intent to describe a latent variable, possibly called “language development,” as previously proposed. Such an undertaking and the resulting model may be feasible with the execution of a collaborative study as described previously, given that individual researchers likely would have access to various databases uniquely available to them due to native language, geographical location, or institutional affiliation. Additionally, behavior is likely to be affected depending on the nature of the comorbid disorder. The current study focused on externalizing behavioral problems to the exclusion of emotional and internalizing symptoms. It is likely that the sources of some of these behavioral problems are, in fact, emotional. With more inclusive selection criteria, researchers could examine whether language development and cochlear implantation affect both internalizing and externalizing behaviors and whether the severity of hearing loss truly has no effect on these.

Conclusions

The analyses presented here suggest that primary studies across the last 18 years describe an effect of hearing loss on the development of behavior problems that, overall, is not as strong as previously thought. Individual studies vary on the direction and magnitude of the relationship between hearing loss and the development of behavior problems. Statistical analyses show that, across studies, children with hearing loss show no significant difference in the expression of problematic behaviors from their hearing peers. Furthermore, cochlear implantation did not differentiate deaf children with behavior problems from those without, though some trends were visible throughout all analyses. Much of the heterogeneity between studies in these analyses remains unexplained, suggesting that other variables not measured in this dissertation affect behavioral outcomes in deaf and hard of hearing children. Language development following cochlear implantation may mitigate the development of behavior problems in deaf children, however, these analyses could not be conducted with the few and varied language variables discovered in the literature.

This dissertation discusses some of the advantages and disadvantages of cochlear implantation. It must be noted that the decision to use a cochlear implant carries a divisive connotation amongst those who consider themselves deaf and those who are members of Deaf culture. The cochlear implant is a medical device that stimulates the auditory nerve, and the research presented herein examines a hypothesis about its mitigating effects on behavior problems in deaf and hard of hearing children. Other researchers (Barker et al., 2009; Jimenez-Romero, 2015) provide evidence that cochlear implantation allows a child with hearing loss access to oral language, though this does not preclude the use of sign should parents of deaf and hard of hearing children become competent in the language. This dissertation is not intended as medical advice or an overarching recommendation or condemnation of cochlear implantation. Such a decision is best made on a case-by-case basis following direct consultation between medical professionals and families of children affected by hearing loss.

Progressing from this, future studies could employ more inclusive selection criteria and, as a result, examine the effect of language development and the impact of cochlear implantation on such in diverse samples. A larger pool of selected studies would likely allow researchers to create various groupings of relevant language variables and therefore describe a latent "language development" variable for use in analyses. It is suggested that future researchers collect data on, and control for, comorbid disabilities and international differences in the presentation of behavior problems in deaf and hard of hearing children.

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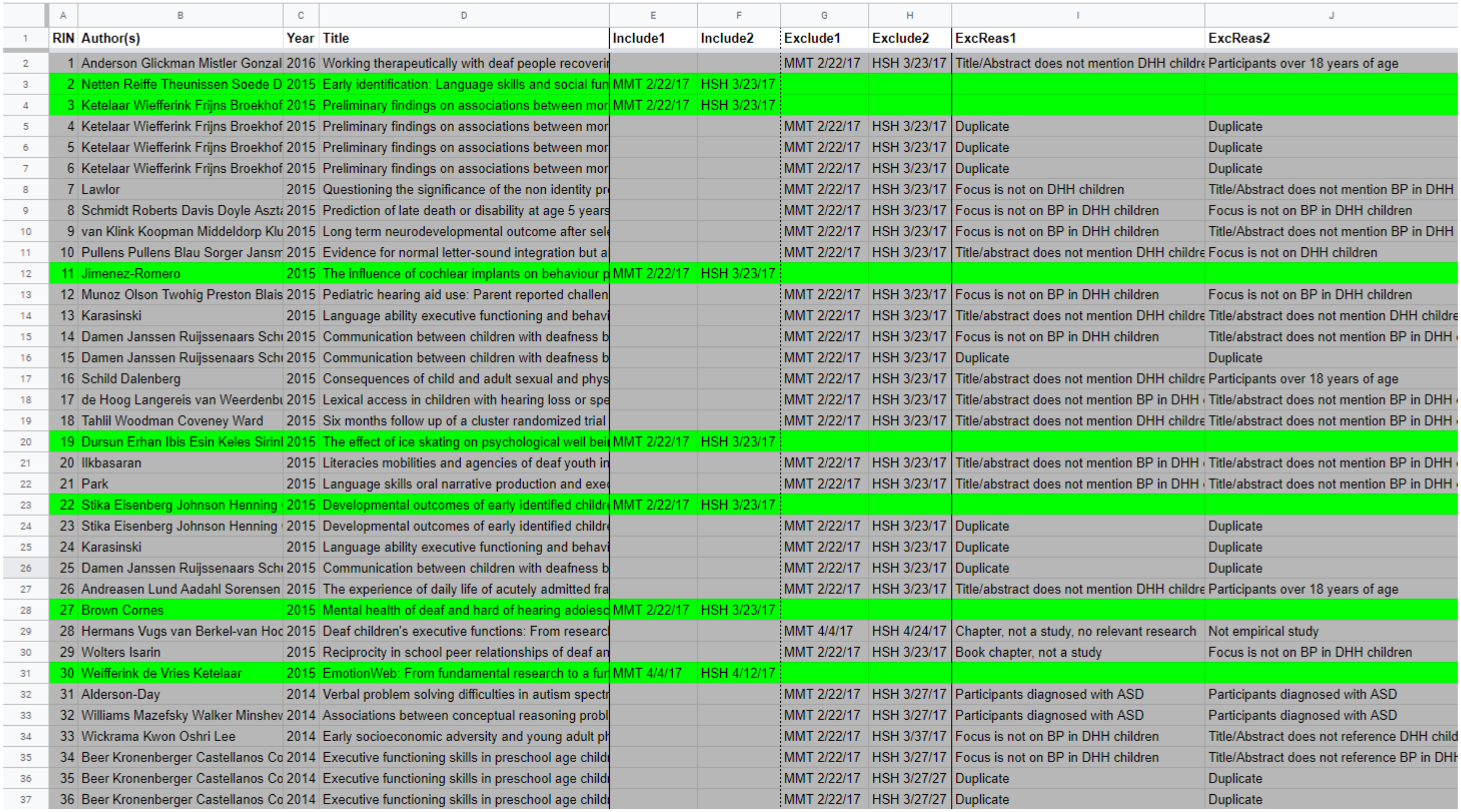
Appendix A:

Sample Section of the Article Tracking Database



RIN	Author(s)	Year	Title	Include1	Include2	Exclude1	Exclude2	ExcReas1	ExcReas2
1	Anderson Glickman Mistler Gonzal	2016	Working therapeutically with deaf people recoveri			MMT 2/22/17	HSH 3/23/17	Title/Abstract does not mention DHH childre	Participants over 18 years of age
2	Netten Reiffe Theunissen Soede D	2015	Early identification: Language skills and social fun	MMT 2/22/17	HSH 3/23/17				
3	Ketelaar Wiefferink Frijns Broekhof	2015	Preliminary findings on associations between mor	MMT 2/22/17	HSH 3/23/17				
4	Ketelaar Wiefferink Frijns Broekhof	2015	Preliminary findings on associations between mor			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
5	Ketelaar Wiefferink Frijns Broekhof	2015	Preliminary findings on associations between mor			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
6	Ketelaar Wiefferink Frijns Broekhof	2015	Preliminary findings on associations between mor			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
7	Lawlor	2015	Questioning the significance of the non identity pr			MMT 2/22/17	HSH 3/23/17	Focus is not on DHH children	Title/Abstract does not mention BP in DHH
8	Schmidt Roberts Davis Doyle Aszt	2015	Prediction of late death or disability at age 5 years			MMT 2/22/17	HSH 3/23/17	Focus is not on BP in DHH children	Focus is not on BP in DHH children
9	van Klink Koopman Middeldorp Klu	2015	Long term neurodevelopmental outcome after sel			MMT 2/22/17	HSH 3/23/17	Focus is not on BP in DHH children	Title/Abstract does not mention BP in DHH
10	Pullens Pullens Blau Sorger Jansm	2015	Evidence for normal letter-sound integration but a			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention DHH childre	Focus is not on DHH children
11	Jimenez-Romero	2015	The influence of cochlear implants on behaviour p	MMT 2/22/17	HSH 3/23/17				
12	Munoz Olson Twohig Preston Blais	2015	Pediatric hearing aid use: Parent reported challen			MMT 2/22/17	HSH 3/23/17	Focus is not on BP in DHH children	Focus is not on BP in DHH children
13	Karasinski	2015	Language ability executive functioning and behavi			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention DHH childre	Title/abstract does not mention DHH childre
14	Damen Janssen Ruijssenaars Sch	2015	Communication between children with deafness b			MMT 2/22/17	HSH 3/23/17	Focus is not on BP in DHH children	Title/abstract does not mention BP in DHH
15	Damen Janssen Ruijssenaars Sch	2015	Communication between children with deafness b			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
16	Schild Dalenberg	2015	Consequences of child and adult sexual and phys			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention DHH childre	Participants over 18 years of age
17	de Hoog Langereis van Weerdenb	2015	Lexical access in children with hearing loss or spe			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention BP in DHH	Title/abstract does not mention BP in DHH
18	Tahlil Woodman Coveney Ward	2015	Six months follow up of a cluster randomized trial			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention DHH childre	Title/abstract does not mention BP in DHH
19	Dursun Erhan Ibis Esin Keles Sirin	2015	The effect of ice skating on psychological well bei	MMT 2/22/17	HSH 3/23/17				
20	Ilkbasaran	2015	Literacies mobilities and agencies of deaf youth in			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention BP in DHH	Title/abstract does not mention BP in DHH
21	Park	2015	Language skills oral narrative production and exe			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention BP in DHH	Title/abstract does not mention BP in DHH
22	Stika Eisenberg Johnson Henning	2015	Developmental outcomes of early identified childr	MMT 2/22/17	HSH 3/23/17				
23	Stika Eisenberg Johnson Henning	2015	Developmental outcomes of early identified childr			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
24	Karasinski	2015	Language ability executive functioning and behavi			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
25	Damen Janssen Ruijssenaars Sch	2015	Communication between children with deafness b			MMT 2/22/17	HSH 3/23/17	Duplicate	Duplicate
26	Andreasen Lund Aadahl Sorensen	2015	The experience of daily life of acutely admitted fra			MMT 2/22/17	HSH 3/23/17	Title/abstract does not mention DHH childre	Participants over 18 years of age
27	Brown Cornes	2015	Mental health of deaf and hard of hearing adolesc	MMT 2/22/17	HSH 3/23/17				
28	Hermans Vugs van Berkel-van Hoc	2015	Deaf children's executive functions: From researc			MMT 4/4/17	HSH 4/24/17	Chapter, not a study, no relevant research	Not empirical study
29	Wolters Isarin	2015	Reciprocity in school peer relationships of deaf an			MMT 2/22/17	HSH 3/23/17	Book chapter, not a study	Focus is not on BP in DHH children
30	Weifferink de Vries Ketelaar	2015	EmotionWeb: From fundamental research to a fu	MMT 4/4/17	HSH 4/12/17				
31	Alderson-Day	2014	Verbal problem solving difficulties in autism spect			MMT 2/22/17	HSH 3/27/17	Participants diagnosed with ASD	Participants diagnosed with ASD
32	Williams Mazefsky Walker Minshev	2014	Associations between conceptual reasoning probl			MMT 2/22/17	HSH 3/27/17	Participants diagnosed with ASD	Participants diagnosed with ASD
33	Wickrama Kwon Oshri Lee	2014	Early socioeconomic adversity and young adult pl			MMT 2/22/17	HSH 3/37/17	Focus is not on BP in DHH children	Title/Abstract does not reference DHH child
34	Beer Kronenberger Castellanos Co	2014	Executive functioning skills in preschool age child			MMT 2/22/17	HSH 3/27/17	Focus is not on BP in DHH children	Title/Abstract does not reference BP in DH
35	Beer Kronenberger Castellanos Co	2014	Executive functioning skills in preschool age child			MMT 2/22/17	HSH 3/27/27	Duplicate	Duplicate
36	Beer Kronenberger Castellanos Co	2014	Executive functioning skills in preschool age child			MMT 2/22/17	HSH 3/27/27	Duplicate	Duplicate

Appendix B:

Data Collection Form

REPORT CHARACTERISTICS			
Date:	Time:	Coder ID:	Role:

Coding Phase:	Pilot	Reliability	First	Second	Reconciliation
Type:	Journal Article	Book Chapter	Dissertation	Thesis	Poster
Peer Reviewed:	Yes	No	Design:		
Funding:	None	Unspecified	Country:		
Funding Source:					

Setting:	DHH Residential	DHH Daily School	DHH Special School – Residence Unspecified
	Mainstream	Integrated	Laboratory
	Home	Unspecified School	Unspecified Setting
	Other:		

OVERALL STUDY DEMOGRAPHICS			
N:	Grade Levels:		# of Groups:
Diagnoses:	ADHD	ODD	CD

Categories:	Deaf	Hard of Hearing	Hearing	Unilateral CI
	Bilateral CI	CI – Number Unspecified	Mild Hearing Loss	Moderate Hearing Loss
	Severe Hearing Loss	Profound Hearing Loss	Other:	

%Deaf:	%HH:	%Hearing:	%CI:
Age Min:	Age Max:	Age M:	Age SD:
CI Impl Age Min:	CI Impl Age Max:	CI Impl Age M:	CI Impl Age SD:
%Male:	%Female:	%Cauc:	%AfAm:
%HispLat:	%EthHispLat:	%AsAm:	%Other:
Describe %Other:			

FIRST GROUP DEMOGRAPHICS			
n:	Grade Levels:		CONTROL OR COMPARISON
Diagnoses:	ADHD	ODD	CD

Categories:	Deaf	Hard of Hearing	Hearing	Unilateral CI
	Bilateral CI	CI – Number Unspecified	Mild Hearing Loss	Moderate Hearing Loss
	Severe Hearing Loss	Profound Hearing Loss	Other:	

%Deaf:	%HH:	%Hearing:	%CI:
Age Min:	Age Max:	Age M:	Age SD:
%Male:	%Female:	%Cauc:	%AfAm:
%HispLat:	%EthHispLat:	%AsAm:	%Other:
Describe %Other:			

SECOND GROUP DEMOGRAPHICS			
n:	Grade Levels:		TREATMENT OR INTERVENTION
Diagnoses:	ADHD	ODD	CD

Categories:	Deaf	Hard of Hearing	Hearing	Unilateral CI
	Bilateral CI	CI – Number Unspecified	Mild Hearing Loss	Moderate Hearing Loss
	Severe Hearing Loss	Profound Hearing Loss	Other:	

%Deaf:	%HH:	%Hearing:	%CI:
Age Min:	Age Max:	Age M:	Age SD:
%Male:	%Female:	%Cauc:	%AfAm:
%HispLat:	%EthHispLat:	%AsAm:	%Other:
Describe %Other:			

<table>
<tr><td colspan="8">ADDITIONAL GROUP DEMOGRAPHICS – GROUP #</td></tr>
<tr><td colspan="2">n:</td><td colspan="4">Grade Levels:</td><td colspan="2">Describe:</td></tr>
<tr><td colspan="2">Diagnoses:</td><td colspan="2">ADHD</td><td colspan="2">ODD</td><td colspan="2">CD</td></tr>
<tr><td rowspan="3">Categories:</td><td colspan="2">Deaf</td><td colspan="2">Hard of Hearing</td><td colspan="2">Hearing</td><td>Unilateral CI</td></tr>
<tr><td colspan="2">Bilateral CI</td><td colspan="2">CI – Number Unspecified</td><td colspan="2">Mild Hearing Loss</td><td>Moderate Hearing Loss</td></tr>
<tr><td colspan="2">Severe Hearing Loss</td><td colspan="2">Profound Hearing Loss</td><td colspan="3">Other:</td></tr>
<tr><td colspan="2">%Deaf:</td><td colspan="2">%HH:</td><td colspan="2">%Hearing:</td><td colspan="2">%CI:</td></tr>
<tr><td colspan="2">Age Min:</td><td colspan="2">Age Max:</td><td colspan="2">Age M:</td><td colspan="2">Age SD:</td></tr>
<tr><td colspan="2">%Male:</td><td colspan="2">%Female:</td><td colspan="2">%Cauc:</td><td colspan="2">%AfAm:</td></tr>
<tr><td colspan="2">%HispLat:</td><td colspan="2">%EthHispLat:</td><td colspan="2">%AsAm:</td><td colspan="2">%Other:</td></tr>
<tr><td colspan="8">Describe %Other:</td></tr>
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<table>
<tr><td colspan="8">ADDITIONAL GROUP DEMOGRAPHICS – GROUP #</td></tr>
<tr><td colspan="2">n:</td><td colspan="4">Grade Levels:</td><td colspan="2">Describe:</td></tr>
<tr><td colspan="2">Diagnoses:</td><td colspan="2">ADHD</td><td colspan="2">ODD</td><td colspan="2">CD</td></tr>
<tr><td rowspan="3">Categories:</td><td colspan="2">Deaf</td><td colspan="2">Hard of Hearing</td><td colspan="2">Hearing</td><td>Unilateral CI</td></tr>
<tr><td colspan="2">Bilateral CI</td><td colspan="2">CI – Number Unspecified</td><td colspan="2">Mild Hearing Loss</td><td>Moderate Hearing Loss</td></tr>
<tr><td colspan="2">Severe Hearing Loss</td><td colspan="2">Profound Hearing Loss</td><td colspan="3">Other:</td></tr>
<tr><td colspan="2">%Deaf:</td><td colspan="2">%HH:</td><td colspan="2">%Hearing:</td><td colspan="2">%CI:</td></tr>
<tr><td colspan="2">Age Min:</td><td colspan="2">Age Max:</td><td colspan="2">Age M:</td><td colspan="2">Age SD:</td></tr>
<tr><td colspan="2">%Male:</td><td colspan="2">%Female:</td><td colspan="2">%Cauc:</td><td colspan="2">%AfAm:</td></tr>
<tr><td colspan="2">%HispLat:</td><td colspan="2">%EthHispLat:</td><td colspan="2">%AsAm:</td><td colspan="2">%Other:</td></tr>
<tr><td colspan="8">Describe %Other:</td></tr>
</table>

HEARING LOSS – GROUP #			
Operational Definition:			M:
Measure:			SD:
COCHLEAR IMPLANTATION – GROUP #			
Age Impl. Min:	Age Impl. Max:	Age Impl. M:	Age Impl. SD:
HEARING LOSS – GROUP #			
Operational Definition:			M:
Measure:			SD:
COCHLEAR IMPLANTATION – GROUP #			
Age Impl. Min:	Age Impl. Max:	Age Impl. M:	Age Impl. SD:
HEARING LOSS – GROUP #			
Operational Definition:			M:
Measure:			SD:
COCHLEAR IMPLANTATION – GROUP #			
Age Impl. Min:	Age Impl. Max:	Age Impl. M:	Age Impl. SD:
HEARING LOSS – GROUP #			
Operational Definition:			M:
Measure:			SD:
COCHLEAR IMPLANTATION – GROUP #			
Age Impl. Min:	Age Impl. Max:	Age Impl. M:	Age Impl. SD:

VARIABLES: OPERATIONAL DEFINITIONS			
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
Operational Definition:			
Measure:			
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
Operational Definition:			
Measure:			
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
Operational Definition:			
Measure:			
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
Operational Definition:			
Measure:			
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
Operational Definition:			
Measure:			

VARIABLES: MEANS AND STANDARD DEVIATIONS			
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	
T: 1 2 3 4 5	G: 1 2 3 4 5	V: LDP LDO BP	#: 1 2 3 4 5
M:	SD:	Notes:	

VARIABLES: CORRELATIONS			
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*
Dependent Variable:		R^2 for model:	
Predictor:	*b:*	Predictor:	*b:*
Predictor:	*b:*	Predictor:	*b:*

END CODING		
Is there any reason to believe that you may have coded this study differently in the beginning than you did in the end? No Yes (Please explain below.)		
THREATS TO VALIDITY		
Please list any threats to validity that were not appropriately addressed in the report.		
NOTES ON THIS REPORT		
Please list any questions, comments, or concerns you may have regarding this article.		
Date:	Time:	Total Coding Time:

Appendix C:

Characteristics of Participants, Country, and Internal Consistency Reliability per Study

Author	N	Male	Female	DHH	CI	NH	Race/Ethnicity	Country	Measure	Cronbach's α
Jimenez-Romero 2015	208	116	92		104	104		Spain	ICAP	.93
Dursun 2014	20	12	8	20				Turkey	SDQ	*.64-.75
Stika 2015	61	27	34	26		35	75% Caucasian 10% African-American	United States	ITSEA	*.87
Adams 2011	30	22	8	14	16			United States	CBCL	*.92
Antia 2011[a]	191	100	91	142			62% Caucasian 24% Hispanic/Latino	United States	SSRS	.78-.88
Vogel-Walcutt 2011	40	20	20	12	8	20	50% Caucasian 32% African-American	United States	CBCL	.87-.90
Stevenson 2010	183	104	79	104	16	63		England	SDQ	*.64-.75
Fellinger 2009	43	17	26	43				Central Europe Austria	SDQ	*.64-.75
Barker 2009	185	77	108		116	69	72% Caucasian 18% Hispanic/Latino[b]	United States	CBCL	DHH .65-.91 Hearing .66-.89
Fellinger 2008	99	46	53	81	18			Austria	SDQ	*.92
Hintermair 2007	213	120	93	163	50			Germany	SDQ	.79
Edwards 2006	20	10	10		20			England	CBCL	*.92
McCain 2005	28			10		18	50% Caucasian 46% Hispanic/Latino	United States	SSRS	.77-.87
Monaghan 2005	4	1	3	4				United States	SSRS	.94
Smith 2004	24	13	11	24				United States	CBCL	.93
Brubaker 2000	76	40	36	39		37		United States	ECBI	*.93
Kouwenberg 2013a[c]	208	95	113	43	29	130		Netherlands Belgium	See note[d]	DHH .68 Hearing .69

Author	N	Male	Female	DHH	CI	NH	Race/Ethnicity	Country	Measure	Cronbach's α
Kouwenberg 2013b	248	119	129	63	54	121		Netherlands Belgium	IRPA	DHH = .92 Hearing = .89
Wolters 2011	759	379	380	85		674		Netherlands	See note[e]	.94

Note. Reported demographic information per study included in analyses. Most studies did not report racial or ethnic identity of participants. Internal consistency reliabilities marked with an asterisk (*) could not be calculated from the information provided in that study and were drawn from manuals or studies of reliability rather than from the analyzed articles themselves. DHH = deaf and hard of hearing participants, CI = participants with at least one cochlear implant, NH = normal hearing participants. ICAP = Inventory for Client and Agency Planning, SDQ = Strengths and Difficulties Questionnaire, ITSEA = Infant-Toddler Social and Emotional Assessment, CBCL = Achenbach Child Behavior Checklist, SSRS = Social Skills Rating Scales, ECBI = Eyberg Childhood Behavior Inventory, IRPA = Instrument for Reactive and Proactive Aggression.

[a] This study included 33 participants with “Other” hearing status, 16 participants with unreported hearing status.

[b] This study allowed participants to indicate whether they were Hispanic/Latino in addition to their racial identity.

[c] This study included 6 participants with unreported hearing status.

[d] This study used the 10 most frequently-reported items on a measure of delinquency from a pilot study by Baerveldt, van Rossem, and Vermande (2003).

[e] This study used seven items about antisocial behavior adapted from various questionnaires and verified in an article by Wolters, Knoors, Cillessen, and Verhoeven (2014).

Appendix D:

Meta-Analysis Results

			Confidence Interval		Prediction Interval							
	g	SE	Lower	Upper	Lower	Upper	*Q*		df	*z*	*p*	I^2
k = 20	0.31	0.20	-0.09	0.71	-1.59	2.21	Omnibus	2.34	1	1.53	.13	97.14
							Residual	342.79	19		< .001	
k = 18	0.36	0.22	-0.07	0.80	-1.60	2.33	Omnibus	2.73	1	1.65	.10	96.82
							Residual	303.20	17		< .001	
Sensitivity Analyses	1.80	0.44	0.93	2.67			Omnibus	12.27	1	4.05	< .001	94.54
							Residual	158.12	16		< .001	