ABSTRACT

The Impact of Communication Methods on the Reading Development of Children with Cochlear Implants

Ali Groves

Director: Michaela Ritter, Ed.D.

Historically children who are deaf have struggled to read, but with the invention of cochlear implants they now have the ability to read at levels equal to their hearing peers. One variable that may affect a cochlear implant user's ability to read at such a high level is the communication method they use. Parents must select the communication method that will best foster their child's reading development because children who cannot read will encounter social, personal, and economic limitations. However it is often difficult for parents to decide which communication method their child should use. This paper seeks to help parents of children with cochlear implants identify the communication method that will be most beneficial for their child's reading development. This research paper provides a meta-analysis of studies assessing the effects that oral communication methods and manual communication methods have on the reading achievement of children who are deaf and use cochlear implants. Examination of the literature suggests that oral communication methods are most likely to benefit the reading development of children with cochlear implants. This finding makes sense when considering the important role that oral language plays in the development of reading skills. Parents of children with cochlear implants can use the information provided by this meta-analysis to facilitate the selection of the best communication method for their child. Implications of using an oral communication method are considered, and suggestions for future research are given.

APPROVED BY THE DIRECTOR OF HONORS THESIS:

_____

Dr. Michaela Ritter
Department of Communication Sciences and Disorders

APPROVED BY THE HONORS PRORGRAM:

_____

Dr. Andrew Wisely, Director

DATE: _____

THE IMPACT OF COMMUNICATION METHODS ON THE READING DEVELOPMENT OF CHILDREN WITH COCHLEAR IMPLANTS

A Thesis Submitted to the Faculty of

Baylor University

In Partial Fulfillment of the Requirement for the

Honors Program

By

Ali Groves

Waco, Texas

May 2015

TABLE OF CONTENTS

CHAPTER ONE

Introduction

Since the invention of neonatal hearing screening, parents have been able to find out very early if their child has a hearing deficit (Decker, Vallotton, & Johnson, 2012; Young, 2002). When a parent discovers that their child has a hearing deficit or is profoundly deaf, one of the concerns they may have is how they will communicate with their child (Young, 2002). There are various options available for parents to consider when choosing a communication method and/or device for their child with a hearing impairment. Parents may choose some type of amplification device for their child to augment the child's hearing abilities, such as a cochlear implant or hearing aid (Gravel & O'Gara, 2003). They may choose a communication method that emphasizes the development of spoken language, or they may select to use one that highlights the use of sign language (Gravel & O'Gara, 2003). Parents must select the best communication method and/or amplification device for their child as quickly as possible since effective communication is vital for a child's healthy cognitive and social development (Decker et al., 2012). However, it is often difficult for parents to make a decision quickly because most children who are born with hearing loss are born to parents who do not have any knowledge about or past experience with deafness (Decker et al., 2012; Young, 2002). The process of gathering information and making a decision can therefore be challenging and perplexing for parents (Decker et al., 2012; Young, 2002).

The purpose of this meta-analysis is to provide comprehensive information to parents of children with cochlear implants that will aid them in the difficult process of determining the best communication method for their child. This chapter will serve as an introduction to the topic. Subsequent chapters will discuss the results of various studies that examine the effect oral communication and manual communication methods have on the reading development of children who are deaf and who also use cochlear implants. Lastly, suggestions for future research will also be provided in effort to bring attention to gaps in the literature and from the research of previous studies.

Approximately 40 % of children who are profoundly deaf in America are now receiving cochlear implants (National Institute on Deafness and Other Communication Disorders (NIDCD), 2012-2016). A cochlear implant (CI) is a device that can restore partial hearing ability for individuals who are profoundly deaf (Loizou, 1999). It is composed of components that are worn externally and internal components that are surgically implanted in the skull and inner ear (Moore & Teagle, 2002). The external portion of the device consists of a microphone, speech processor, transmitter, and power supply (Moore & Teagle, 2002). The microphone, which is worn at the level of the ear, picks up sound and converts it into an electronic signal. This signal is sent to the speech processor, which codes the frequency, timing, and intensity of sound picked up by the microphone. Once the speech processer has converted the signal it is sent to the external transmitter coil, which rests on the outside of the skull, slightly posterior to the ear. The external transmitter coil is normally held in place on

the head by a magnet on the external portion of the device and a corresponding magnet that is a part of the internal receiver-stimulator. The electronic code is sent from the external transmitter to an internal receiver-stimulator, which decodes the signal. Once the signal is decoded it is sent to the electrode array. An electrode array is a small wire-like device that is wound through a snail shaped part of the inner ear called the cochlea (Loizou, 1999). When the electronic signal is sent through the inner ear the auditory nerve is stimulated, making it possible for a child who is profoundly deaf to perceive sound (Loizou, 1999).

Since 1990, cochlear implants have been used in the United States to treat severe to profound sensori-neural hearing loss. With the recent implementation of universal newborn screenings, the number of children identified with hearing loss has significantly increased (Kirk, Pisoni, & Miyamoto, 2000). Since CIs are associated with greater speech, language, and reading achievement, CIs have become an increasingly popular option for profoundly deaf children (NIDCD, 2012-2016). For instance, in the United States there has been about a 25% increase in the proportion of children receiving CIs (NIDCD, 2012-2016). The proportion of children receiving implants is even higher in other countries. In Sweden approximately 90% of children who are born deaf receive at least one implant while many others have been reported to receive two (Svartholm, 2010).

Although cochlear implants are popular, they can often be controversial, and it can be difficult for parents to decide if a CI is right for their child. Since the

invention of the CI, the Deaf community and those individuals who adopt a medical model of deafness have debated the relative merits and demerits of cochlear implants (Hyde & Power, 2006; Lane & Grodin, 1997). Before discussing this rather contentious debate it is important to define the terms 'Deaf community' and 'medical model of deafness.' The Deaf community is made up of deaf individuals who adopt a *cultural* model of deafness. Instead of seeing deafness as a medical condition, the cultural model of deafness conceptualizes deafness as a form of human variation (Lane, 1992; Lane & Grodin, 1997; Sengas & Monaghan, 2002;). The cultural model of deafness recognizes the Deaf community as a minority group and celebrates its unique art, history, social structure, attitudes, values, mannerisms, and language (Lane, 1992; Lane & Grodin, 1997).

In contrast to the cultural model of deafness, the *medical* model of deafness arises from the belief that deafness is a tragic medical condition that will likely result in a poor quality of life (Crouch, 1997; Lane, 1992; Sengas & Monaghan, 2002). This perspective usually leads parents and professionals to seek medical interventions for their child. The discourse of the medical model is one of 'fixing an impairment,' with one resolution being a CI (Crouch, 1997). While the medical model of deafness supports cochlear implantation and believes that it can be used to facilitate hearing and provide a "normal" life, members of the Deaf community view CIs as unethical (Hyde & Power, 2006; Lane & Grodin, 1997). The Deaf community does not support CIs because they think a child who is deaf will lose their membership in the deaf community if

they receive a CI (Lane & Grodin, 1997). Members of the Deaf community think that it is unethical to take away a deaf child's membership to the Deaf community because it is where children who are deaf naturally belong (Lane & Grodin, 1997). Furthermore, the act of removing a child who is deaf from the Deaf community is unethical because it threatens the longevity of the Deaf community (Lane & Grodin, 1997). If all children who are deaf receive CIs and do not enter into the Deaf community there will not be a new generation of Deaf adults to carry on the culture and values of the Deaf community. As a result the Deaf community may cease to exist. The Deaf community therefore thinks CIs are unethical because they threaten to dissolve a cultural minority (Lane & Grodin, 1997). These points cause members of the Deaf community to argue against the medical model's support of CIs. However, proponents of the medical model argue that receiving a cochlear implant will give a child who is profoundly deaf the opportunity to join "normal" society and will provide them with a higher quality of life. This debate places parents of children who are profoundly deaf in the middle of controversy (Lane & Grodin, 1997).

If a child does receive a CI, they are most likely to use an oral communication method (Archbold, Nikolopoulos, Tait, Donoghue, Lutman, & Gregory, 2000; Hyde & Punch, 2011). Oral communication (OC) is a broad term used to describe more specific communication methods that focus on the development of spoken language skills (Geers, 2002). There are three primary communication methods that are classified as OC methods: Auditory-Verbal, Auditory-Oral, and Cued Speech (Geers, 2002). The goal of the Auditory-Verbal

method is for a child who is deaf to develop spoken language by using their residual hearing (Gravel & O'Gara, 2003). The child's use of their residual hearing is the sole means by which they are allowed to develop spoken language; during learning activities they are not allowed to rely on lip reading or look at the speaker's face in order to determine what the speaker is saying (Gravel & O'Gara, 2003). The emphasis on developing spoken language skills is very strict, and children using this communication method are not exposed to the Deaf community or sign language (Gravel & O'Gara, 2003). The Auditory-Oral method is similar to the previous method because it has the same goal, but it allows the use of speechreading, facial expressions, and naturally occurring gestures in order to facilitate the development of spoken language (Gravel & O'Gara, 2003). The last communication method included under the umbrella term OC is Cued Speech. Cued Speech is made up of eight different hand shapes that are placed in four different locations on the speaker's face to represent consonants and vowels in a visual way (Gravel & O'Gara, 2003). These visual signals help children with hearing loss distinguish individual speech sounds that would otherwise be ambiguous (Gravel & O'Gara, 2003). The ability to distinguish speech sounds helps children with hearing loss learn spoken language and helps improve their speechreading skills (Gravel & O'Gara, 2003).

Children with CIs are generally expected to use OC methods (Archbold et al., 2000; Hyde & Punch, 2011). However, it is debated whether OC methods are indeed the best and most ethical communication method for CI users (Archbold et al., 2000). Other types of communication methods that children who are deaf

may use are manual communication (MC) methods. Manual Communication (MC) methods incorporate the use of sign language as part of their communication approach. There are three primary MC methods: Manually Coded English, Total Communication, and sign language.

Manually Coded English (MCE) "is a visual representation of the spoken English language" (Gravel & O'Gara, 2003, p. 247). It is not a genuine language but a contrived signing system that was created to teach children who are deaf how to read English orthography (Hoffmeister, 2000). It uses signs from natural sign language and borrows from the rules of spoken English in order to accomplish this goal (Gravel & O'Gara, 2003; Sengas & Monaghan, 2002). Because MCE follows the rules of spoken English, a person can theoretically sign MCE while simultaneously speaking English. When MCE is used in combination with spoken English it is called total communication (TC) or simultaneous communication (Geers, 2002; Gravel & O'Gara, 2003; Lynas, 2005). Alternatively, TC can refer to a philosophy of communication that advocates for children who are deaf to use whatever combination of communication methods (manual, oral, written) that will benefit them the most (Hawkins & Brawner, 1997; Hyde & Power, 1991). However, it is more common for the term TC to refer to a specific method of communication that combines a signing system, such as MCE, and spoken English.

TC was a very popular communication method in the United States in the 1970s and 1980s (Lynas, 2005). However more recently professionals have found that TC is hard to practice and hard for children who are deaf to

understand (Lynas, 2005). This finding has led several professionals and researchers to conclude that it is not the best communication method for children who are deaf (Lynas, 2005). Yet, the use of TC is still common and parents may consider this communication method for their child.

Another MC method parents may consider for their child is sign language. Sign language is a genuine language, meaning it has all of the defining characteristics that other recognized languages have (Baker & Baker, 1997; Gravel & O'Gara, 2003; Sengas & Monaghan, 2002; Stokoe, 1980). It is not merely a manually coded version of spoken English, as MCE is, but is rather a unique language with its own set of rules (Gravel & O'Gara, 2003). Like other languages around the world, these rules change from country to country, and different sign languages are used around the globe (Sengas & Monaghan, 2002). For instance, British Sign Language is used in Britain, and Nicaraguan Sign Language is used in Nicuragua. American Sign Language (ASL) is used in America, and is especially used by members of the Deaf community (Gravel & O'Gara, 2003, p. 244).

It is important for parents to consider each communication method and how it will affect their child's reading development because research suggests that the communication method CI users adopt will affect their ability to read (Conor and Zwolan, 2004). Although most children with CIs will be expected to use an OC method, it is not guaranteed that OC methods will enable CI users to be academically successful, particularly in reading. Although some evidence suggests that CIs and the development of oral language skills benefit CI users'

reading development (Desjardin, Ambrose, & Eisenberg, 2009; Geers, 2003; Geers and Hayes, 2011; Johnson & Goswami, 2010; Moog, 2002; Spencer, Gantz, & Knutson, 2004; Spencer & Olsen, 2008; Spencer, Tomblin, & Gantz, 1997; Tomblin, Spencer, & Gantz, 2000; Vermeulen, Van Bon, Schreuder, Knoors, & Snik, 2007), there is considerable variability among CI users' reading achievement, and there is no guarantee that OC methods will enable CI users reading at an acceptable level (Conor & Zwolan, 2004; Geers, 2003; Geers & Hayes, 2011; Harris & Terlektsi, 2010; James, Rajput, Brinton, & Goswami, 2008; Marschark, Rhoten, & Fabich, 2007; Punch & Hyde, 2010; Spencer, Baker, & Tomblin, 2003; Spencer & Olsen, 2008; Thoutenhoofd, 2006; Vermeulen et al., 2007; Weisi, Rexaei, Rashedi, Heidari, Valadbeigi, & Ebrahmim-Pour, 2013). Additionally, many children with hearing loss who do not have CIs have shown low education achievement, specifically in reading, when using OC methods. These children's inadequate reading skills make some professionals skeptical that CI users' reading development will be benefited most by OC methods (Lynas, 2005). This variability and uncertainty of OC methods makes it important for parents to consider the effect MC methods have on reading. Many studies have shown that sign language has helped children without CIs learn how to read (Harris and Beech 1998; Hermans, Knoors, Ormel, & Verhoeben, 2008; Hoffemesiter, 2000; Padden and Ramsey, 2000; Strong and Prinz, 1997), so MC methods may also help CI users read. Parents of children with CIs should therefore consider both OC and MC methods so they can be sure they are choosing the communication method that will benefit their child's reading achievement most.

It is important that parents make this consideration because most children who are deaf graduate from high school with a third or fourth grade reading level (Qi & Mitchell, 2012). With reading skills at this level children with hearing loss are at risk for social, personal, and economic limitations (Chard, Pilulski, & Templeton, 2000). Because children with hearing loss are at a greater risk for experiencing these difficulties it is crucial for parents of children with CIs to understand how the different communication methods available will affect their child's reading development.

However, it is challenging to determine how OC and MC methods affect the reading achievement of CI users due to the many variables involved in the reading process. Connor & Zwolan (2004) found that age of onset of deafness, pre-implant residual hearing, age of implantation, family characteristics, type of device, vocabulary, and socioeconomic status all influence the reading comprehension skills of CI users. Geers (2002) similarly found that child, family, implant, and educational characteristics affect the reading skills of CI users. The impact of family characteristics on CI users' reading achievement is also supported by Desjardin et al. (2009). Desjardin and colleagues (2009) found that the facilitative language techniques mothers use when reading with their child, such as asking open-ended questions and recasting, affect their child's ability to read. Additionally, there is a large body of research showing that phonological awareness and oral language skills play a crucial role in determining a child's ability to read (Dillon, de Jong, & Pisoni, 2011; Geers & Hayes, 2011; Harris & Terlektsi, 2010; Johnson& Goswami, 2010). It is therefore

a complicated matter to study the effect of communication methods, and their impact on the reading success of CI users.

It is also difficult for parents to access and understand the information they need to make a fully informed decision. To better understand how OC methods and MC methods may affect the reading achievement of their child, parents are likely to turn to professionals for advice (Decker et al. 2012; Young, 2002). However, research suggests that professionals may be biased towards a particular communication method and may not always provide parents with the objective and comprehensive information they need to make an informed decision (Decker et al, 2012; Young, 2002). Whether consciously or unconsciously, professionals tend to promote the communication method that aligns with the model of deafness they hold—i.e., cultural or medical models of deafness (Decker et al., 2012). The medical model of deafness tends to lead professionals to promote OC methods because they promote "normal" functioning (Decker et al., 2012; Young, 2002). Alternatively, because the cultural model of deafness values the use of sign language (Decker et al., 2012; Young, 2002), professionals that embrace a cultural model of deafness are more likely to advocate for MC methods. When professionals present this sort of bias they lead parents to make "crucial choices about how to bring up their deaf child without realizing the full range of options that are available to them" (Young, 2002, p. 4). It is therefore important that parents have access to unbiased and comprehensive information so they can make an informed decision about the communication method their child should use (Hintermair & Albertini, 2005;

Hyde & Power, 2006; Young, 2002). In an effort to provide parents of CI users with a resource of comprehensive information, this meta-analysis examines the effect of selected communication methods on reading achievement. Specifically, this research explores the effect that OC methods and MC methods have on the reading development of children with CIs and provides specific information regarding the expected reading achievement outcomes of CI users choosing to use one of these communication methods.

CHAPTER TWO

Total Communication and Oral Communication Methods

Introduction

Historically children who are deaf have difficulty learning how to read (Qi & Mitchell, 2012). A large body of converging evidence indicates that children with a reading impairment experience difficulty with oral language, particularly in the area of phonology (e.g., Boada & Pennington, 2006; Gallon, Harris, & van der Lely, 2007; Larrivee & Catts, 1999; Liberman, Shankweiler, & Liberman, 1989; Lyon, Shaywitz, & Shaywitz, 2003; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Rosen & Manganari, 2001; Snowling, 2001; Soroli, Szenkovits, & Ramus, 2010; Torgesen, Rashotte & Wagner, 1994; Wagner, & Torgesen, 1987). Oral language and phonological development are contingent upon successful auditory input during a constrained early period of language acquisition (e.g. McConkey Robbins, Burton Koch, Osberger, Zimmerman-Phillips & Kishon-Rabin, 2004; Sharma, Dorman & Spahr, 2002**).** Children who are deaf are particularly vulnerable for failing to acquire the phonological processing skills, which directly affect other oral language skills (e.g., semantics, morphology, syntax, and pragmatics) that are needed to become skilled readers (Anderson & Lyxell, 1999; Harris & Marschark, 2011; Lyon et al., 2003).

Over the past several decades there has been considerable evidence demonstrating the relationship among oral language, phonological processing, and reading skills in children with severe to profound sensori-neural hearing losses

(Boynton, 1995; Friel-Patti & Finitzo, 1990; Hansson, Forsberg, Löfqvist, Mäki-Torkko, & Sahlén, 2004; Hanson, Goodell, & Perfetti, 1991; Mody, Studdert-Kennedy, & Brady, 1997). Thus, it is critical to have a greater understanding of the literacy skills in children who are deaf with a CI in order to elucidate the best practices for facilitating their reading abilities.

Oral Language and Reading Ability

Researchers have identified the reading outcomes for children who are deaf to be typically arrested around third or fourth grade (Allen, 1986; Conrad, 1979; Lewis, 1996; Moog & Geers, 1985; Qi & Mitchell, 2012; Trybus & Karchmer, 1977; Wolf & Allen, 1984). Because of their limited access to oral language and phonological processing skills, reading outcomes have been severely hampered. Oral language plays a crucial role in the reading process because children can use oral language to develop a mental map that enables them to decode and comprehend print. This mental map is called the mental lexicon. Kamhi and Catts (2005a) define the mental lexicon as the individual's knowledge of vocabulary, phonology, semantics, morphology, syntax, and pragmatics. Children use their mental lexicon to decipher and understand print. For example, children can recognize and comprehend a written word they have never seen before by sounding it out and connecting the sounds of the written word to a vocabulary word stored in their mental lexicon. They can also use knowledge about syntax that they have stored in their mental lexicon to help them understand the grammatical structure of print since there is a correspondence between the syntax of an oral language and its written form. These examples illustrate how critical oral language is to the reading process itself.

One of the oral language components that is critical to becoming a successful reader is phonological awareness. Although phonological awareness has only recently passed its nascent stage, the preponderance of scientific studies have identified repeatedly, that phonological awareness is not only a crucial component in the reading process, but it is also highly predictive of later reading achievement and has a reciprocal relationship with reading (Castiglioni-Spalton & Ehri, 2003; Hogan, Catts, & Little, 2005). According to Briscoe, Bishop, and Norbury (2001), phonological awareness is "the ability to detect rhyme and alliteration; to segment words into smaller units, such as syllables and phonemes; to synthesize separated phonemes into words; and to understand that words are made up of sounds that can be represented by written symbols or letters" (p. 349). A subcategory of phonological awareness, phonemic awareness, refers to the understanding that words are composed of phonemes or sounds that can be separated and manipulated (Ehri et al., 2001; Torgesen, Al Otaiba, & Grek, 2005).

Investigators have linked the level of phonological/phonemic awareness attainment in children with and without severe hearing loss and those children who are deaf with CIs to later difficulties with reading achievement (Geers, 2003; Geers, 2007; Lyon, Shaywitz, & Shaywitz, 2003) and have shown it to be one of the most stable indicators of later reading achievement (Hogan, Catts, & Little, 2005). Additionally, deficient phonological/phonemic awareness has been found to lead to difficulties in the acquisition of word decoding, which negatively impacts reading comprehension and fluency (Lyon et al. 2003; Stanovich, 2000). When the reader is using most of his or her cognitive resources for decoding, most likely there are few

resources that can be allocated to reading comprehension (NRP, 2000). Research indicates that the more sensitive a child is to the phonological structure of words (e.g. syllables, phonemes), the more successful decoder and reader he or she will become (Otaiba, Puranik, Ziolkowski, & Montgomery, 2009). Consequently, children who are deaf and who do not have access to phonological awareness and oral language will have more difficulty decoding and comprehending print than normal hearing peers who have access to this knowledge.

Cochlear Implant users, Oral Language, and Reading Ability

With the invention of cochlear implants (CIs) children who are deaf now have the ability to access oral language and phonological awareness to a greater extent than they could with older amplification technology. Several studies show that this change has led children with CIs to develop oral language and phonological awareness skills and that the development of these skills are associated with improved reading skills (Ambrose et al., 2012; Geers, 2003; Geers, 2007; Johnson & Goswami, 2010; Spencer, Baker, and Tomblin, 2003; Spencer and Oleson, 2008; Tomblin, Spencer, and Gantz, 2000; Vermeulen et al., 2007). For instance, Tomblin, Spencer, and Gantz (2000) found that CI users are able to obtain oral language skills that exceed their deaf peers without implants and approach the levels of normal hearing students. They also found that CI users graduating from high school had reading comprehension skills that were considered average to above average. This is an incredible achievement considering the decades of research that has shown children who are deaf graduate from high school with a fourth grade reading level or lower (Allen, 1986; Conrad, 1979; Lewis, 1996; Moog & Geers, 1985; Qi & Mitchell, 2012;

Trybus & Karchmer, 1977; Wolf & Allen, 1984). Tomblin and his colleagues (2000) suggest that this success is directly related to the participants' improved oral language and phonological awareness skills. This research shows that children with CIs have the potential to develop phonological and oral language skills, and they have the ability to read at levels equal to their hearing peers.

However, it is important to note that not all studies suggest that CI users will show such marked achievment in reading. Several studies show that CI users are not reading at age appropriate levels (Conor & Zwolan, 2004; Geers, 2003; Geers & Hayes, 2011; Harris & Terlektsi, 2010; James, Rajput, Brinton, & Goswami, 2008; Marschark, Rhoten, & Fabich, 2007; Punch & Hyde, 2010; Specner & Olsen, 2008; Vermeulen et al. 2007; Weisi et al., 2013). Research suggests that a possible cause for this variation is the communication method used by the CI user (Connor & Zwolan 2004; Geers, 2002). It is logical that a child's communication method would affect their reading achievement because children must use the knowledge they have of a first language to learn how to read and write, and OC or MC methods will give children different language foundations. One of these methods may provide CI users with a better language foundation, which potentially could enhance later reading abilities (Mayer and Leigh, 2010). For example, research indicates that a child using an oral communication (OC) method will develop an understanding of the syntax involved in oral language and will be able to use this knowledge when learning how to read. Comparatively a child using sign language will develop a different understanding of syntax because sign language does not follow the same structure as oral language (Baker and Baker, 1997; Stoke 1980). Because the syntax of oral

language matches the syntax of its written form, the child using an OC method may have an advantage when learning to read. Such an advantage may cause the variation observed between CI users' reading achievement. Since research has clearly suggested that one communication method may have advantages over another, it is important to consider how different communication methods affect CI users' reading development.

One specific MC method that parents of CI users commonly consider and have their child use is total communication (TC). TC refers to a philosophy of communication that enables children who are deaf to use a combination of communication methods—manual, oral, or written—that will benefit them the most (Hawkins & Brawner, 1997; Hyde & Power, 1991), or more specifically the term can refer to the simultaneous use of a signing system and speech (Geers, 2002; Gravel & O'Gara, 2003).

Based on the discussion in the previous paragraphs, a person may assume that OC methods would benefit CI users' reading development more than TC would because OC methods focus more on the development of oral language skills than TC does. However, some research suggests that the use of manual communication may benefit CI users oral language acquisition and academic achievement (Hyde and Punch, 2011). The manual component of TC may support CI users' development of oral language skills to a greater extent than the OC method (Hyde and Punch, 2011). Additionally, research has shown that many children with CIs use TC as their primary form of communication (Christiansen and Leigh, 2002; Geers, Spehar, and Sedey, 2002; Hyde and Punch, 2011). For instance, Christiansen and Leigh (2002)

found that of the 439 CI users that participated in their study, 47% of them used TC. These findings suggest TC may benefit CI users reading development and that a significant amount of children with CIs prefer TC as their communication method of choice. Consequently, it is critical to examine OC methods in comparison to TC in order to determine the advantages and/or disadvantages of each.

Examination of Communication Methods

Many studies show that OC, rather than TC, better allows cochlear implant users to achieve a higher level of reading ability. One such study is Geers (2002). This study was part of a larger study titled "Cochlear Implants and Education of the Deaf child" that was funded by the U.S. National Institutes of Health and was initiated by the Center for Applied Research in Childhood Deafness at the Central Institute for the Deaf. To conduct this study a summer camp in St. Louis was organized and held. Children attended the camp with one of their parents for three days, and all of their expenses were paid. At the camp children engaged in testing for two hours each morning, and in the afternoon they participated in planned entertainment activities. Data was collected on a variety of variables, including the participants' auditory, speech, language, and reading abilities. This data was collected and analyzed in order to determine the significance of these variables on CI users' reading achievement.

Geers (2002) also examined how the participants' primary communication method affected their reading achievement. To examine this relationship, Geers (2002) selected a subsample of participants (136 participants out of a total of 181

participants). This subsample was selected so the study sample would be as homogenous as possible. The CI users who were included in the Geers (2002) study were a) eight to nine years of age, b) experienced onset of deafness before age three, and c) were implanted before age five.

To determine what communication method the participants used, Geers (2002) used a rating scale that was designed to reflect how much each child's education program relied on OC or MC methods. Six different communication methods were identified and each method was assigned a number score. Education programs that used mostly sign, speech and sign, or speech with limited sign were assigned a score of one, two, and three respectively. Together these methods were classified as total communication (TC) methods. Cued speech, auditory-oral, and auditory-verbal methods were assigned a score of four, five, and six respectively, and together they were classified as oral communication (OC) methods. Because children with CIs may change the communication method they use from year to year, the communication methods that each participated used the three years following implantation and the year they completed before attending the summer camp were recorded. After using this scoring system to assign numerical values to the communication methods each participant used, the participants' scores were averaged to reflect the type of communication method they used most often. Geers (2002) reported that about half of the participants (N= 67) attended schools that used OC programs and the other half (N=69) attended schools that used TC programs.

After collecting this data the participants reading skills were tested. The two subtests from the Peabody Individual Achievement Test-Revised (Dunn &

Markwardt, 1989) were used to assess the participants' reading recognition and comprehension skills. The Word Attack subtest from the Woodcock Reading Mastery Test (Woodcock, 1987) was used to determine the participants' phonic and structural analysis skills. In addition to these tests, Geers (2002) created two tasks to assess the participants' phonological coding skills.

Geers (2002) then used a variety of statistical analysis tools to analyze the results from these tests. Through this analysis, Geers (2002) found that participants attending OC programs were "better able to use the information provided by the implant to hear, speak, and read" than students attending TC programs (p. 181). This finding suggests that OC methods will benefit CI users' reading skills more than TC.

In a retrospective study of data provided by the cochlear implant camp described in Geers (2002), Geers & Brenner (2004) studied the affect CI users' communication method had on their reading achievement using a different perspective. In this later study Geers & Brenner (2004) compared the test results of CI users who consistently used the same communication method (OC or TC) and CI users who changed communication method at least once to determine if communication method prior to and following cochlear implantation affected the participants' test results. All of the participants that were studied at the implant camp (N=181) were included in Geers & Brenner (2004). The participants were all a) eight to nine years of age, b) had received their implant by the age of five years, and c) had four to six years of use with their cochlear implant. The participants' communication methods were recorded using the same rating scale and method described previously in the review of Geers (2002). Geers and Brenner (2004) reported that the participants

were divided fairly evenly between OC and TC settings, with 92 children having spent the majority of their education attending OC settings and 89 having spent the majority of their time in TC settings (Geers & Brenner, 2003).

Geers and Brenner (2004) used the same battery of tests that Geers (2002) used to test the participants' reading skills. Analysis of the test results showed that CI users who consistently used OC outperformed CI users who consistently used TC. They also found that participants who moved from TC to OC did better than participants that moved from OC to TC. These results suggest that CI users who use OC will have better reading skills than CI users who rely on TC.

A more current study by Geers and Hayes (2011) also shows that OC facilitates a higher level of reading achievement in CI users than TC. Geers & Hayes (2011) studied the reading, writing, and phonological skills of deaf students with CIs in order to determine the literacy skills of CI users. Although the focus of this study is not exclusively limited to reading it is included in this review because it documents important findings regarding the relationship of TC and CI users' reading success. Included in the study were 112 students who were between the ages of fifteen and eighteen years of age and had received their implants as preschoolers. These participants had participated in a previous study (Geers, 2003) and were now being reexamined in order to determine if there were any changes in the students' abilities to read. At the time of testing all the participants had at least ten years of experience with their CI. The majority of the participants in this study used OC (N=85) and a smaller number used TC (N=25) as their primary method of communication.

One of the goals of Geers and Hayes (2011) was to determine how demographic characteristics affect the literacy achievement of CI users. Included under the category of demographic characteristics was the participants' use or nonuse of "sign enhancement" (Geers & Hayes, 2011, p. 53S). The term 'sign enhancement' refers to the participants' reliance on sign language during the administration of the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn 1981). In order to determine the effect sign enhancement had on the literacy success of the participants, the researchers first calculated the participants' reading skills using multiple tests. The Peabody Individual Achievement Test (PIAT)—Revised (Dunn & Markwardt, 1989) was used to test the participants' reading recognition and comprehension skills. The researchers also administered the test of reading comprehension (TORC; Brown et al., 1995) to assess the participants' silent reading comprehension. Additionally the researchers created a picture spelling test to assess the writing skills of the participants, and each participant wrote an essay that was evaluated using the National Technical Institute for the Deaf's scoring method (Schley & Albertini, 2005) in order to determine their writing skills. Together the results of these studies were used to determine the literacy success of the participants.

After administering these tests, Geers and Hayes (2011) found that 17% of the participants in their study read below a 4th grade reading level, 36% of the participants read above the 9th grade reading level, and 46% of the participants had shown progress over the school years but read at levels that where behind their hearing peers. The researchers then determined how much of the variance observed among the participants literacy success could be accounted for by child, family, and

implant characteristics. During this process the researchers discovered that child, family, and implant characteristics accounted for 19.8% of the variance in the participants'' literacy outcomes. Included in this finding was the more specific discovery that participants who had a high IQ and "whose receptive vocabulary was not enhanced by addition of sign language obtained the highest literacy levels in high school" (Geers & Hayes, 2011, p. 57S). Because reading comprehension and recognition skills of the participants were included in the term "literacy," this finding suggests that OC may benefit the reading development of CI users more than TC.

Lastly, research conducted by Moog (2002) further demonstrates that OC methods help CI users read at levels comparable to their hearing peers. Moog (2002) reviewed the speech, language, and reading skills of CI users who attended the Moog Center for Deaf Education. This school follows an intensive oral program that focuses on spoken language and reading development. Moog (2002) studied 17 children from the school who were between the ages of five and eleven years of age. The participants involved in the study started to receive oral education services at the age of two and half years of age, and continued to receive these services after they were implanted, around the age of four years.

Moog assessed the children's vocabulary and reading comprehension skills. Children younger than eight years of age were evaluated using the Gates MacGinitie Reading Test (Gates & MacGinite, 1989) and children older than eight years of age were tested using the Stanford Achievement Test (ninth edition). The results of testing showed that 12 out of 17 students scored at an age-appropriate reading level for both vocabulary and reading comprehension. Moog concluded that these results

suggest that high quality oral education makes it possible for CI users to develop reading comprehension levels equivalent to their hearing aged peers.

In contrast to these studies, which suggest that OC methods are most benefical, the investigation conducted by Connor and Zwolan (2004) suggests that OC does not benefit CI users to a greater degree than TC. Connor & Zwolan (2004) studied the effect many variables have on CI users' reading achievement. Three variables studied by these researchers included a) the participants' communication method, b) reading comprehension, and c) pre- and post-implant vocabulary. To study these variables, Connor & Zwolan (2004) examined 91 CI users who were on average around 11 years of age. The participants of the study were divided into two groups based on the communication method they used before receiving a CI. Children who used any form of manual communication were placed in the group labeled TC for total communication. Children who used only spoken language were placed in the group labeled OC for oral communication. On average the participants continued to use the same communication method after they received their CI. To test the participants' reading comprehension skills, Connor and Zwolan (2004) administered the Passage Comprehension subtest of the Woodcock Reading Mastery Test—Revised (WRMT; Woodcock, 1987). To assess the participants' pre- and post-implant vocabulary, Connor and Zwolan (2004) administered the Picture Vocabulary test of the Woodcock-Johnson Test of Cognitive Ability (Woodcock & Mather, 1989) and the Expressive One-Word Picture Test (EOWPVT; Gardner, 1990). Both of these vocabulary tests required that the participants identify pictures through signed or spoken responses.

Analysis of the test results showed that the participants' pre-implant communication method was correlated with their pre-implant vocabulary. The results also indicated that the participant's pre- and post-implant vocabulary was correlated with his/her reading comprehension scores. Connor and Zwolan (2004) also found that the participants in the TC group tended to have higher pre-implant vocabulary. However, they also found that the participants' pre-implant communication method did not have a significant effect on their reading comprehension. At first glance, this later finding seems surprising considering that TC was associated with better pre-implant vocabulary, and pre-implant vocabulary was correlated with better reading comprehension. However, while these findings may suggest an indirect relationship between TC and reading, it does not mean that the use of TC directly leads to better reading comprehension. In fact, Connor and Zwolan (2004) found that neither TC nor OC had a direct or significant effect on the participants reading skills. This means that although there was a relationship between TC and vocabulary it did not give TC users a significant advantage over OC users. Instead there were other variables, such as age at implantation and overall language competence, which had a larger impact on CI users' ability to read. These findings led Connor and Zwolan (2004) to conclude that, in regards to CI users' reading achievement, it does not matter if they use OC or TC, as long as they have consistent access to a good language role model at an early age.

The findings of Connor and Zwolan (2004) contrast with the discoveries of the articles previously reviewed in this section; they suggest that CI users' use of TC or OC does not predict later reading success. Conversely, the results of Geers (2003),

Geers & Brenner (2004), Geers & Hayers (2011), and Moog (2002) suggest that OC benefits CI users' ability to read at a higher level than TC. It is important for CI users and/or parents of CI users to consider these findings when determining which communication method will benefit the CI user the most in his or her endeavor to become a successful reader.

CHAPTER THREE

Sign Language and the Revised Bilingual Approach

Sign Language and Reading Ability

People who understand that reading depends heavily on oral language and code-related reading skills may hypothesize that the reading skills of children with hearing loss will not benefit from using sign language because sign language does not correlate in a systematic way with oral language (Goldin-Meadow & Mayberry, 2001). However many research articles show that children with hearing loss have used sign language and become successful readers.

For instance, Harris and Beech (1998) studied how oral communication (OC), manual communication (MC), and phonological awareness correlated with the reading progress of 24 children who were severely or profoundly deaf. The participants' single-word reading comprehension, phonological awareness, oral language ability, sign language ability (signed English or British Sign Language), and language comprehension were tested.

After obtaining the results from testing the researchers analyzed the results of the four best readers. These four children had reading scores comparable to their normal hearing peers. Two of these children spoke English well and did not sign. These two children had high scores on the phonological awareness and language comprehension tests. The other two children had parents who were deaf and were very good signers. These two children had high scores on the language comprehension tests, but not on the phonological awareness tests. Although they did

not have strong phonological awareness, the second pair of children was still able to read at level comparable to their hearing peers. These results suggest that children who are deaf "may become successful readers by more than one route" and that children who use sign language can develop normal reading skills (Harris & Beech, 1998, p. 214).

Many other studies also suggest that sign language benefits the reading skills of children who are deaf (Hermans, Knoors, Ormel, & Verhoeben, 2008 for review). Padden and Ramsey (2000) is one such study. Padden and Ramsey (2000) studied 31 children that used either ASL or total communication (TC) in order to determine the relationship between sign language and reading. The researchers assessed the participants' reading comprehension through the Stanford Achievement Test (SAT)—Hearing Impaired. The researchers also administered three tests to assess the participants' ASL skills. Two of these tests, the Verb Agreement Production test and the Sentence Order Comprehension test were developed by Supalla et al. (in press), and the third test, an imitation task, was developed by Padden and Ramsey (2000). Additionally, Padden and Ramsey (2000) developed two tests to assess the participants' associative skills. Associative skills refer to a person's ability to associate a sign with its English counterpart. By studying the participants' associative skills the researchers were better able to determine the effect sign language had on the participants' ability to understand written English.

The first associative skills test was a fingerspelling test. This test required participants to view a signed sentence that had one fingerspelled word in it, and then identify its English counterpart by writing the fingerspelled word. The second

associative skills test assessed the participants' ability to connect initialized signs with English words. Initialized signs are signs taken from ASL that are slightly adapted to incorporate the starting letter of the English word. Similar to the first test, each participant was asked to write down the English word associated with the initialized sign.

From these assessments the researchers found that the participants' ASL skills, associative skills, and reading comprehension skills were all positively correlated. More specifically they noticed that the participants who scored highest on the reading comprehension test also had better associative skills. This later finding suggests that the use of initialized signs and fingerspelled words specifically may help children who are deaf become better readers.

In addition to the two studies reviewed previously, there are also studies that show that children who are deaf and have parents who are deaf (CDPD) perform better on reading tests because they have superior signing abilities. One example of such a study is Strong and Prinz (1997). Strong and Prinz (1997) were interested in determining the relationship between ASL skill and English literacy. They were also interested in determining if CDPD had an advantage over children who were deaf and had hearing parents. To study these relationships the researchers tested the ASL abilities and English literacy abilities of 160 children with hearing loss. Each participant's ASL production abilities were tested using a classifier production test and a sign narrative test developed by Strong and Prinz (1997). The researchers also developed four tests to test the participants ASL comprehension. These tests included a story comprehension test, a classifier comprehension tests, a time marker test, and a

map marker test (Strong and Prinz, 1997). The participants' English literacy abilities were tested using selected and revised subtests from the Woodcock-Johnson Psychoeducational Test Battery, revised version (Woodcock and Mather, 1989; 1990) and the Test of Written Language (Hammill & Larsen, 1996). After the test results were obtained the researchers divided participants into three groups based on their ability to sign: low, medium, and high ability. They also divided participants into groups by age and by the hearing status of their mother. They then studied the relationships between these groups.

Results from this data show that participants who had medium or high ASL skills performed better on literacy tasks than participants with low ASL skills. This finding suggests that there is correlation between a deaf child's ASL skill and English literacy. The researchers considered many ways in which this relationship may work. First they considered intervening variables that could be the cause of this correlation, such as school setting or the participant's degree of deafness. However the researchers strove to control such intervening variables throughout the study, which makes it unlikely that such a hypothesis would be true. They also considered the hypothesis that English literacy may promote ASL skill instead of ASL skill promoting English literacy. However, they concluded that this relationship was not plausible for the population being studied. This lead Strong and Prinz (1997) to conclude that ASL may help children who are deaf become successful readers.

Another noteworthy finding of Strong and Prinz (1997) is that the participants with deaf parents outperformed children with hearing parents on the ASL skills and literacy tests. The researchers were interested in determining what caused the

children with deaf parents to outperform their peers. Analysis of the data they collected lead Strong and Prinz (1997) to conclude "the advantage of being from a deaf family is likely to result largely from fluency in ASL" (p. 45). This finding, supports the notion that ASL may help children who are deaf be successful readers.

Hoffemeister (2000) supports the findings of Strong and Prinz (1997). Hoffemeister (2000) compared the ASL skills and reading skills of children who were deaf and had intense exposure to ASL to children who were deaf and had less exposure to ASL. To test the participants' ASL skills Hoffemesiter (2000) created three ASL tasks: the ASL synonyms, antonyms, and plurals-quantifiers tasks. To test the participants' reading comprehension Hoffemesiter (2000) used a version of the Stanford Achievement Test (SAT-HI) normed for children who are deaf. He found that children who had more intense exposure to ASL had better reading comprehension scores compared to children who had little exposure to ASL. This finding in addition to the findings of Harris & Beech (1998), Padden and Ramsey (2000), and Strong and Prinz (1997) suggest that ASL supports the reading development of children who are deaf.

Bilingual-Bicultural Education

Research findings documenting the positive affects of sign language on reading have contributed to the development of bilingual or bilingual-bicultural education for children who are deaf (Strong & Prinz, 1997; LaSasso and Lollis, 2003). In bilingual education settings, children who are deaf learn sign language as a first language and then use their knowledge of sign language to learn how to read and write (Mayer & Leigh, 2010). This educational model is based on the theory of

linguistic interdependence, which was developed by Cummins (1989 & 1991) (see Mayer & Leigh, 2010 for review). This theory states that people can learn a first language and then use their knowledge of their first language to learn a second language. In bilingual education settings for children who are deaf this translates into using sign language as a first language and then learning to read and write as a second language. This model is currently a popular model used to educate children who are deaf and do not have cochlear implants (CIs) (Knoors & Marshark 2012; LaSasso & Lollis, 2003; Mayer & Leigh, 2010).

Comparatively, bilingual education is not a very popular option for children with CIs because most parents of children with CIs want their child to develop oral language (Hyde, Punch, & Komesarooff, 2010; Leigh, 2008; Mayer & Leigh, 2010). Bilingual education and sign language tend to be used as a last resort for children with CIs who do not successfully develop oral language (Leigh, 2008). However several scholarly articles suggest that sign language in a remodeled bilingual educational setting may benefit CI users' reading achievement (Dammeyer, 2014; Knoors & Marschark, 2012; Mayer & Leigh, 2010; Svartholm, 2010). In these revised bilingual educational settings CI users would focus on the development of both oral language and sign language. This acceptance of both OC and MC is referred to as the "both/and method" of communication, which "advocates neither sign language and deaf culture at all costs nor hearing-oriented education and oral language integration at all costs" (Hintermair & Albertini, 2005, p. 190). Instead it recognizes both OC methods and sign language are valuable and may benefit CI users

reading achievement. In this paper this method will be referred to as the revised-bilingual approach.

Currently the majority of scholarly articles that support the revised-bilingual approach provide theoretical support rather than empirical evidence for it. Nevertheless these articles provide parents with important information about the potential benefits the revised-bilingual approach could have on their child's reading achievement, and parents will want to consider this information when they are making a decision about the communication method their child should use. The remainder of this chapter is therefore devoted to reviewing all of the articles that advocate for the revised-bilingual approach and could be found through Baylor University's electronic database, interlibrary service, and print library.

Examination of Revised-Bilingual Approach

There are several studies that consider the theoretical benefits that OC and sign language may have on CI users' reading achievement. One such study is Mayer & Leigh (2010), which discuss the benefits sign language could have on the academic achievement of CI users in revised-bilingual education settings. In this discussion Mayer & Leigh (2010) first explain the challenges of applying the theory of linguistic interdependence to current bilingual settings for children who are deaf. Following this explanation they make suggestions for how to remodel bilingual education so that it embraces both OC and sign language in a way that would benefit CI users' reading and academic achievement.

Mayer & Leigh (2010) explain that the application of the theory of linguistic interdependence to a bilingual education setting for children who are deaf poses two

main challenges. The first challenge arises from the theory's requirement that proficiency in a first language (L1) must occur before it can be used to acquire knowledge of a second language (L2). In current bilingual education settings for children who are deaf it is expected that L1 will be sign language. However children who are deaf struggle to develop proficiency in sign language because they do not normally have access to proficient sign language models. Generally children who are deaf are born to hearing parents who do not have any sign language skills and therefore cannot serve as language models for their child. Without an acceptable language model it is difficult for children to learn sign language as L1, and consequently it will be difficult to learn L2.

The second challenge of applying this theory to current bilingual models for children who are deaf is that children must have adequate exposure to the oral form of L2 before they can learn to read and write the printed form of L2. It is debated how much understanding children must have of the oral form of L2 before they can develop an understanding of the printed from, but Mayer & Leigh (2010) make it clear that there is some level of proficiency required. This poses a challenge to children who are deaf because they are expected to learn the printed form of an oral language they do not have access to. As a result children who are deaf and in current bilingual educational settings will probably have a difficult time learning how to read.

Although these challenges make it difficult for children who are deaf to become successful readers, children with CIs may benefit from a bilingual approach if changes are made to current bilingual education models. Mayer & Leigh (2010) argue that in order for CI users to succeed L1 should be an oral language and sign

language should be learned as L2. Mayer & Leigh explain that this change is appropriate for CI users because they have access to oral language through their CI and the ability to develop sufficient oral language skills. This revision to the bilingual approach would solve both of the challenges Mayer & Leigh (2010) outlined in their explanation and discussion on the theory of linguistic interdependence. It solves the first challenge—developing proficiency in L1—because children with CIs have the ability to develop oral language proficiency. Additionally it solves the second challenge—the struggle to learn a written language without knowledge of its oral form—because CI users would have the knowledge of oral language they need.

Mayer & Leigh (2010) also argue that CI users' academic achievement would benefit from the use of sign language. Specifically they argue that sign language should be used with oral language in the revised-bilingual approach. By this Mayer & Leigh (2010) do not necessarily mean that revised-bilingual settings should follow a TC philosophy in which MCE is used simultaneously with spoken English. Instead they think a contact sign language may be most beneficial to CI users. This type of signing is similar to TC because it uses signs from natural sign language while mouthing the English words that correspond with the signs. However it is different from TC because it uses a combination of syntactic structures from oral language and sign language instead of relying on the full structure of the oral language like MCE does. This combination of oral language and sign language is a natural way the Deaf community has adapted sign language to link it to written language. Because

members of the Deaf community have found this type of signing to be helpful, it may be a form of sign language that can aid CI users' reading development.

Knoors & Marschark (2012) make a similar argument to support the revised-bilingual approach. They concur that although oral language is likely to be CI users' L1 there is also a role for sign language in their lives. Specifically, and in agreement with Mayer & Leigh (2010), they believe that oral language should be taught as L1 and sign language should be taught as a L2 in revised-bilingual education settings for CI users. They argue that this change would give CI users the opportunity to develop their oral language skills and that learning sign language as a second language would support there oral language development. Although Knoors & Marschark do not discuss the benefits this change could have on CI users' acquisition of reading skills, it is reasonable to assume that this change would benefit CI users' reading development because it would develop their oral language skills, which a crucial component of the reading process.

Svartholm (2010) also provides similar rational to support the use of a revised-bilingual approach with the hope that this approach will help CI users become better readers. In his discussion Svartholm (2010) focuses on research from Sweden. Svartholm (2010) explains that there is not a lot of research from Sweden that gives empirical insight into the effect sign language has on the reading or academic achievement of CI users, but parents of CI users and government agencies have communicated that there are major benefits. These benefits, one of which is increased language development, have the potential to help CI users succeed

academically in a variety of subject areas, including reading. CI users could experience these benefits in a revised-bilingual approach.

Svartholm, (2010), Knoors & Marschark (2012), and Mayer & Leigh (2010) are therefore in agreement and provide rationale that supports the use of a revised-bilingual approach to help CI users develop into skilled readers. In further support of this argument, Dammeyer (2014) provides empirical evidence for the bilingual approach. Dammeyer (2014) evaluated the literacy skills of CI users and non-users in Scandinavian bilingual education settings. There were 331 participants included in the study, and 28% of the participants had CIs. On average the participants were around the age of 11 years old and had received their implant around the age of six years old. Another distinguishing characteristic of this sample is that 24% of the participants had additional disabilities. Dammeyer (2014) did not report what proportion of CI users, if any, was among the group of participants that had additional disabilities.

The literacy skills of the participants were determined through teacher evaluations. Each participant's teacher reported the grade level that their student's literacy skills were equivalent to. If a participant was no more than one year behind in school they were classified as having no delay in literacy skills. If they were more than one year behind they were considered to have delayed literacy skills. Out of all 331 participants 45% showed no delay in literacy skills and 55% showed a delay.

Dammeyer (2014) explains that although it may seem that a high percentage of the participants had delayed literacy skills, this number is actually lower than reports by Traxler (2000), who reported that 90% of children studied were not reading

at an acceptable level. Dammeyer (2014) states that the improvement he observed may be a result of the participants using both sign language and OC methods in bilingual education settings. This statement suggests that a revised-bilingual approach may benefit CI users reading development.

In summary, this review of the available literature suggests that CI users' reading development may benefit from the use of sign language in a revised-bilingual approach. However, because most of these studies are theoretical in their approach, rather than empirical, additional research is needed before the affects of a revised-bilingual approach on the reading development of CI users are clear.

CHAPTER 4

Discussion and Conclusion

Historically deaf children have struggled to learn how to read (Qi & Mitchell, 2012), but with the invention of newborn hearing screenings and cochlear implants (CIs) children who are profoundly deaf now have the ability to access oral language and develop phonological awareness (Ambrose et al., 2012; Geers, 2003; Geers, 2007; Johnson & Goswami, 2010; Spencer and Oleson, 2008; Tomblin, Spencer, and Gantz, 2000; Vermeulen et al., 2007), enabling them to read at the same level as their normal hearing peers (Desjardin, Ambrose, & Eisenberg, 2009; Geers, 2003; Geers and Hayes, 2011; Johnson & Goswami, 2010; Moog, 2002; Spencer, Gantz, & Knutson, 2004; Spencer & Olsen, 2008; Spencer, Tomblin, & Gantz, 1997; Tomblin, Spencer, & Gantz, 2000; Vermeulen, Van Bon, Schreuder, Knoors, & Snik, 2007). However not all children with CIs are reading at levels comparable to their hearing peers (Conor & Zwolan, 2004; Harris & Terlektsi, 2010; Punch & Hyde, 2010; Spencer & Olsen, 2008; Thoutenhoofd, 2006; Vermeulen et al., 2007; Marschark et al., 2007; Weisi, Rexaei, Rashedi, Heidari, Valadbeigi, & Ebrahmim-Pour, 2013). One cause of this variation may be CI users' communication method of choice. Because reading is an important skill for children to develop, it is essential to know which communication method is most likely to foster CI users' reading development and enable them to be a successful reader. This meta-analysis suggests that oral communication (OC), rather than MC methods, are most likely to increase CI users' reading achievement.

A large body of research suggests that the use of OC benefits CI users more than total communication (TC) (Geers, 2003; Geers & Brenner, 2004; Geers & Hayers, 2011). This finding makes sense in light of the large body of research that shows that TC is difficult to practice and difficult to understand (Lynas, 2005; Svartholm, 2010). TC is difficult to practice because it uses a "signed form of English that takes twice as long as the spoken form to articulate" (Lynas, 2005, p. 202). This delay between speaking and signing makes it difficult for people to sign and speak at the same time (Lynas, 2005). It also causes distortions in both the speech and sign systems, making TC difficult to understand (Lynas, 2005; Svartholm, 2010). As a result TC does not help children who are deaf (including children without implants) achieve greater linguistic and intellectual achievement (Lynas, 2005; Svartholm, 2010). Conversely, TC undermines the acquisition of language and literacy skills (Lynas, 2005). In light of these findings, it is not surprising that research findings by Geers (2003), Geers & Brenner (2004), and Geers & Hayers (2011) indicate hat OC methods benefit CI users' reading development more than TC methods.

In comparison to TC, the impact of sign language on CI users' reading achievement may be more promising. Several studies show that sign language helps children who are deaf and who do not have CIs learn how to read (Hermans et al., 2008, Harris and Beech, 1998; Padden & Ramsey, 2000; Strong and Prinz, 1997; Hoffemister, 2000). Because research shows that children with hearing loss who do not use a CI benefit from sign language, it is possible that sign language may help children with CIs learn how to read. Additionally, research provides theoretical

support for the use of sign language and oral language in a bilingual setting (Dammeyer, 2014; Knoors & Marschark, 2012; Mayer & Leigh, 2010; Svartholm, 2010). It is possible that this revised-bilingual approach to communication may benefit CI users' reading achievement by removing barriers that currently hinder CI users in bilingual settings from developing appropriate literacy skills (Knoors & Marschark, 2012; Mayer & Leigh, 2010). This communication method may also benefit CI users by fostering their language development, which would in turn benefit their reading skills (Knoors & Marschark, 2012; Svartholm, 2010). Furthermore, sign language may serve as a direct support while CI users are learning to read. For example, sign language may serve as a visual aid and help CI users understand the link between printed words with spoken words (Mayer & Leigh, 2010). However, while this research provides sound rationale for the revised-bilingual approach, additional empirical research is needed before it can be concluded that this communication method is most likely to benefit CI users' reading development.

It is logical that OC methods are most likely to benefit CI users reading development due to the large body of research showing that oral language plays a central role in reading development for normal hearing children (Kamhi & Catts, 2005a). Oral language makes it possible for normal hearing children to develop phonological awareness, which is the underpinning for learning how to decode print (Kamhi & Catts, 2005a, 2005b). Oral language also gives normal hearing children access to the mental lexicon that is needed to comprehend print (Kamhi & Catts, 2005a). Because oral language plays such a crucial role in reading, it is not surprising that research continues to provide evidence that CI users who use OC methods are

better readers than those who use other communication methods. It is likely that by focusing on oral language development, CI users are more likely than MC users to develop the skills needed to become good readers due to their increased knowledge base in oral language (Ambrose et al., 2012; Geers, 2002; Geers, 2003; Geers, 2007; Geers & Hayes, 2011; Moog, 2002; Johnson & Goswami, 2010; Spencer and Oleson, 2008; Tomblin, Spencer, and Gantz, 2000; Vermeulen et al., 2007).

Although the use of an OC method seems promising for most CI users, it is important to recognize that not all CI users will be successful using OC methods, and certain CI users may benefit more from the use of MC methods (Knoors and Marshark, 2012; Leigh, 2008; Mayer and Leigh, 2010). It is important to identify these children at an early age since oral language and phonological processing skills are critical to reading development during the early preschool years (e.g. McConkey Robbins, Burton Koch, Osberger, Zimmerman-Phillips & Kishon-Rabin, 2004; Sharma, Dorman & Spahr, 2002**)**. If CI users miss out on this critical period their ability to read will be negatively affected (Boada & Pennington, 2006; Gallon, Harris, & van der Lely, 2007; Larrivee & Catts, 1999; Leigh, 2008 Liberman, Shankweiler, & Liberman, 1989; Lyon, Shaywitz, & Shaywitz, 2003; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Rosen & Manganari, 2001; Snowling, 2001; Soroli, Szenkovits, & Ramus, 2010; Torgesen, Rashotte & Wagner, 1994; Wagner, & Torgesen, 1987). It is therefore extremely important that such individuals be identified as early as possible so they can access early intervention services, explore alternative communication methods, and develop a strong language base during the critical period of development (Knoors and Marshark, 2012; Leigh, 2008; Mayer and

Leigh, 2010). In order to identify these children, future researchers needs to identify risk factors that indicate that a CI user will not be successful using a OC method. Different risk factors may include type of hearing loss, specific neuropathies, and additional disabilities (Leigh, 2008). Determining potential risk factors such as these will help professionals identify CI users who may struggle using OC methods at an early age and connect them with support services so they do not miss out on the critical period of development (Leigh, 2008).

In addition to these efforts, researchers need to determine the best ways for CI users to access MC methods so CI users who struggle to use OC methods can develop a strong language foundation using MC methods (Knoors and Marschark, 2012; Svartholm, 2010). This information would help parents, most of whom do not have past experience with MC methods, use the best practices available to teach MC methods to their child (Decker et al., 2012). If researchers can identify the best approaches for learning MC methods, there is a greater likelihood that CI users struggling to use OC methods will be able to develop adequate language skills. It is important that CI users develop these language skills because their language skills will affect their reading skills.

In addition to this focused research, there are many other areas that deserve further attention. Future research should also consider additional variables that affect the reading achievement of CI users. Although this meta-analysis shows that OC benefits CI users' reading development, there was also considerable variability observed among the participants' reading success. For instance, Geers and Hayes (2011) reported that only 36% of the participants were reading at an acceptable level,

and the remainder of the participants showed varying levels of reading success. There are many factors that may account for this variability (Connor & Zwolan, 2004; Desjardin et al., (2009); Dillon, de Jong, & Pisoni, 2011; Geers, 2002; Geers & Hayes, 2011; Harris & Terlektsi, 2010; Johnson & Goswami, 2010). Particular variables that affect CI users' reading achievement and need further study are age of implantation, device characteristics, and educational setting. Future research should closely examine these variables and seek to determine what supports will best help CI users read at levels comparable to or better than the general population.

When researching the different variables that affect CI users' reading achievement particular attention should also be given to studying the use of sign language and oral language in bilingual settings to determine if this communication method benefits CI users (Dammeyer, 2014; Knoors & Marschark, 2012; Leigh, 2008; Mayer & Leigh, 2010; Svartholm, 2010). Leigh (2008) gives specific recommendations that are particularly noteworthy for future researchers to consider. Leigh (2008) recommends that such studies distinguish between (1) children enrolled in bilingual settings because they have achieved *limited success* with OC methods and (2) children who have *succeeded* in OC methods but are nevertheless pursuing sign language as an alternative form of communication. It is important to distinguish group one from group two because group one will not accurately show how the use of *both* sign language and oral language affect CI users' reading achievement. Instead group one will only have the potential to show how sign language affects CI users reading development. Moreover, group one may not even accurately reflect the affect of sign language on CI users' reading achievement because the participants may have

initially used OC methods, showed little success with OC methods, and as a result missed out on the critical period of language development. Missing out on this crucial period may confound the results of the study and make it difficult to determine the effects of sign language on CI users' development. It is therefore important for future studies to distinguish between groups one and two.

In addition to studying these groups, Leigh (2008) also recommends that future studies compare the achievement of (1) CI users in bilingual settings and (2) CI users in settings that only use OC methods in order to determine which communication approach leads to the most favorable outcome.

When conducting such studies, future researchers should avoid the use of unrepresentative samples, small sample size, and lack of control groups. For instance, Moog (2002) examined the literacy achievement of 17 students, which is a relatively small sample size. A small sample size can be problematic because the sample may not be representative of the entire population of interest. If the sample is not representative, the results of the study will not generalize to the population at large and will therefore be less valuable. In addition to considering limitations such as these, future researchers should refer to Marschark, Rhoten, and Fabich (2007) for a discussion about common confounding variables and methodological shortcomings that researchers need to be aware of. Marschark and colleagues (2007) conducted a meta-analysis of research studying CI users' reading achievement and found that researchers need better methodological controls. Specifically, future researchers need to control for oral language skills before and after hearing loss and before and after cochlear implantation (Marschark et al., 2007). Future researchers also need to

control for participants' socioeconomic status, parental hearing status, early intervention experience, educational placement, and other factors that are known to affect CI users' reading achievement (Marschark et al., 2007). Lastly, they recommend that future researchers try and include inconsistent CI users in their studies because this may give parents and professionals a more accurate picture of the outcomes they can expect from cochlear implantation.

As parents use the information provided by this meta-analysis to select a communication method for their child they should be aware of several implications. First, parents should remember that the information provided relates specifically to children with CIs and the conclusions here should not be generalized to children who are deaf and do not use implants. Parents should also be aware that this information is meant to serve as an aid in the decision-making process rather than an exclusive resource. In addition to the information provided by this meta-analysis, parents should consider the effect different communication methods have on other areas of their child's development. For example, parents should consider how OC and MC methods affect their child's emotional and social development. By considering other areas of their child's development, parents will be able to make a well-informed decision regarding which communication method is best for their child.

If parents do decide that they want their child to use an OC method they should be aware of the time and effort necessary to support their child's development of oral language (Leigh, 2008; Moore and Teagle, 2002; Punch and Hyde, 2010; Spencer and Marschark, 2003). Parents will have to support their child's oral language development because CIs do not fully restore hearing (Loizou, 1999;

Marschark et al., 2007; Moore and Teagle, 2002; Punch and Hyde, 2010), and without full access to auditory information CI users will have a more difficult time developing oral language than their normal hearing peers. As a result, parents of children with CIs will have to intentionally foster their child's oral language development through therapy, practice, and additional supports (Leigh, 2008; Moore and Teagle, 2002; Punch and Hyde, 2010; Spencer and Marschark, 2003). It is important that parents are aware of this, so they can provide their child with the services they need to successfully use OC methods.

Parents who decide that an OC method is best for their child should also monitor their child's progress closely and be open to changing educational environments, service centers, or communication methods if their child is not showing success with OC methods. It is critical that parents monitor their child's progress carefully otherwise they may be at risk for missing out on the critical period of language development, which may adversely affect their child's reading development (Kahmi & Catts, 2005a, 2005b).

In conclusion, the information provided in this meta-analysis can help parents of children with CIs determine which communication method is best for their child's reading development. This meta-analysis suggests that OC methods will benefit CI users' reading development more than MC methods (Geers, 2003; Geers & Brenner, 2004; Geers & Hayers, 2011; Moog 2002). In fact, research suggests that the use of OC methods with CI users can result in reading achievement equivalent to hearing peers (Ambrose et al., 2012; Desjardin, Ambrose, & Eisenberg, 2009; Geers, 2003; Geers and Hayes, 2011; Moog, 2002; Spencer, Baker, and Tomblin, 2003; Tomblin,

Spencer, and Gantz, 2000; Vermeulen et al., 2007). Before the invention of CIs, OC methods failed to produce this positive outcome for the majority of deaf children (Lynas, 2005). Yet, with new CI technology profoundly deaf children can now use OC methods to successfully develop oral language skills and achieve a higher level of reading (Ambrose et al., 2012; Desjardin, Ambrose, & Eisenberg, 2009; Geers, 2003; Geers, 2007; Geers & Brenner, 2004; Geers and Hayes, 2011; Johnson & Goswami, 2010; Marschark et al., 2007; Moog, 2002; Spencer and Oleson, 2008; Tomblin, Spencer, and Gantz, 2000; Vermeulen et al., 2007). The potential for CI users to achieve such high reading success is remarkable in light of the large body of research showing that historically most children who are deaf graduate from high school with a fourth grade reading level (Qi & Mitchell, 2012). It therefore seems that with the invention of the cochlear implant, OC methods are now a viable option for children who are profoundly deaf and are likely to place CI users on a trajectory towards greater academic success.

REFERENCES

Allen, T. (1986). Patterns of academic achievement among hearing impaired students: 1974 and 1983. In A. Schildroth and M. Karchmer (Eds.), *Deaf children in America* (pp. 161-206). Boston, MA: College-Hill Press.

Anderson, U., & Lyxell, B. (1999). Phonological deterioration in adults with an acquired severe hearing impairment. A deterioration in long-term memory or working memory? *Scandinavian Audiology 28*, 241-247.

Archbold, S. M., Nikolopoulos, T. P., Tait, M., & O'Donoghue, G. M., Lutman, M.E., Gregory, S. (2000). Approach to communication, speech perception and intelligibility after pediatric cochlear implantation. *British Journal of Audiology*, *34*,(4) 257-264.

Baker, S., & Baker, K. (1997). Educating children who are deaf or hard of hearing:Bilingual-bicultural education. ERIC Clearinghouse on Disabilities and Gifted Education (www.eric.ed.gov)

Boada, R., Pennington, B. F. (2006). Deficient implicit phonological representations in children with dyslexia. *Journal of Experimental Child Psychololgy, 95*, 153–93.

Boynton, R. S. (1995). "The New Intellectuals," *Atlantic Monthly*, 54-70.

Briscoe, J., Bishop, D. V. M., & Norbury, C. F. (2001). Phonological processing, language, and literacy: A comparison of children with mild-to-moderate sensorineural hearing loss and those with specific language impairment. *Journal of Child Psychology and Psychiatry, 42,* 329-340.

Brown, V. L., Hammill, D. D., Wiederholt, J. L. (1995). *Test of Reading Comprehension* (3rd ed.). Austin, TX: Pro-Ed.

Castiglioni-Spalton, M. & Ehri, L. (2003). Phonemic awareness instruction: Contribution of articulatory segmentation to novice beginners' reading and writing. *Scientific Studies of Reading, 7*, 25-52.

Christiansen, J. B., & Leigh, I. (Eds.). (2002). *Cochlear implants in children: Ethics and choices*. Gallaudet University Press.

Chard, D. J., Pikulski, J.J., & Templeton, S. (2000). From phonemic awareness to fluency: Effective decoding instruction in a research-based reading program. Boston: Houghton Mifflin.

Conrad, R. (1979). *The deaf school child.* London: Harper & Row.

Connor, C. M., & Zwolan, T. A. (2004). Examining multiple sources of influence on the reading comprehension skills of children who use cochlear implants. *Journal of Speech, Language & Hearing Research, 47*(3), 509–526. doi:10.1044/1092-4388(2004/040)

Crouch, R. A. (1997). Letting the deaf be deaf: Reconsidering the use of cochlear implants in prelingually deaf children. *Hastings Center Report, 27*(4), 14-21.

Dammeyer, J. (2014). Literacy skills among deaf and hard of hearing students and students with cochlear implants in bilingual/bicultural education. *Deafness & Education International*.

Decker, K. B., Vallotton, C. D., & Johnson, H.A. (2012). Parents communication decision for children with hearloss: Sources of information and influence. *American Annals of the Deaf, 157*(4), 326-339. Delage, H., & Tuller, L. (2007). Language development and mild-to-moderate hearing loss: does language normalize with age? *Journal of Speech, Language, and Hearing Research, 50,* 1300-1313.

DesJardin, J. L., Ambrose, S.E, & Eisenberg, L.S. (2009). "Literacy skills in children with cochlear implants: The importance of early oral language and joint storybook reading." *Journal of Deaf Studies and Deaf Education, 14*(1) 22-43.

Dillon, C. M., de Jong, K., & Pisoni, D. B. (2011). Phonological awareness, reading skills, and vocabulary knowledge in children who use cochlear implants. *Journal of Deaf Studies and Deaf Education, 17*(2), 205-226.

Dunn, L. M. & Markwardt, F. C. (1989). *Peabody Individual Achievement Test-Revised.* Circle Pines, MN: American Guidance Service.

Ehri, L., & Wilce, L. (1987). Cipher versus cue reading: An experiment in decoding acquisition. *Journal of Educational Psychology, 79,* 3–13.

Friel-Patti, S., & Finitzo, T. (1990). Language learning in a prospective study of otitis media with effusion in the first two years of life. *Journal of Speech Hearing Research, 33,* 188-94.

Gallon, N., Harris. J., & van der Lely, H. K. J. (2007). Non-word repetition: An investigation of phonological complexity in children with Grammatical SLI. *Clinical Linguistics and Phonetics, 21,* 435-455.

Gardner, M. F. (1990). *Expressive One-Word Picture Vocabulary Test (EOWPVT-R).* East Aurora, NY: Slosson Educational Publications.

Gates, A. J., MacGinite W. H. (1989). *Gates MacGinite Reading Test.* (3rd ed.) Chicago, Ill: Riverside Publishing.

Geers, A. E. (2002). Factors affecting the development of speech, language, and literacy in children with early cochlear implantation. *Language, Speech & Hearing Services in Schools, 33*(3), 172–183.

Geers, A.E. (2003). Predictors of reading skill development in children with early cochlear implantation. *Ear & Hearing, 24*(Suppl.), 59S-68S.

Geers, A. E. (2007). Factors associated with reading development in children with cochlear implants. *Perspectives on hearing and hearing disorders in childhood (Online), 17,* 17-20.

Geers, A., & Brenner, C. (2003). Background and educational characteristics of prelingually deaf children implanted by five years of age. *Ear and hearing,24*(1), 2S-14S.

Geers, A. E., & Brenner, C. (2004, November). Educational intervention and outcomes of early cochlear implantation. In *International Congress Series* (Vol. 1273, pp. 405-408). Elsevier.

Geers, A. E., & Hayes, H. (2011). Reading, writing, and phonological processing skills of adolescents with 10 or more years of cochlear implant experience. *Ear and hearing, 32*(1), 49S.

Geers A., Spehar, B., & Sedey, A. (2002). Use of speech by children from total communication programs who wear cochlear implants. *American Journal of Speech-Language Pathology, 11,* 50-58.

Goldin-Meadow, S., Mayberry, R. I. (2001). How do profoundly deaf children learn to read?. *Learning Disabilities Research & Practice, 16*(4), 222-229.

Gravel, J.S., & O'Gara J. (2003) Communication options for children with hearing loss. *Mental Retardation and Developmental Disabilites Research Reviews 9,* 243-251.

Hammill, D. D., & Larsen, S. C. (1996). *Test of written language*. Pro-ed.

Hanson, V. L., Goodell, E. W., & Perfetti, C. A. (1991). Tongue twister effects in the silent reading of hearing and deaf college students. *Journal of Memory and Language, 30,* 319–330.

Hansson, K., Forsberg, J., Lofqvist, A., Maki-Torkko, E., & Sahlén, B. (2004). Working memory and novel word learning in children with hearing impairment and children with specific language impairment. *International Journal of Language and Communication Disorders, 39*, 401–422.

Harris, M., & Beech, J. R. (1998). Implicit phonological awareness and early reading development in prelingually deaf children. *Journal of Deaf Studies and Deaf Education*, *3*(3), 205-216.

Harris, M. & Marschark, M. (2011). Literacy in the classroom and beyond. *Journal of Deaf Studies and Deaf Education, 16,* 1.

Harris, M., & Terlektsi, E. (2010). Reading and spelling abilities of deaf adolescents with cochlear implants and hearing aids. *Journal of Deaf Studies and Deaf Education*, *16*(1), 24-34.

Hawkins L., & Brawner., J. (1997) Educating children who are deaf or hard of hearing: Total communication. ERIC Clearinghouse on Disabilities and Gifted Education (www.eric.ed.gov)

Hermans, D., Knoors, H., Ormel, E., & Verhoeven, L. (2008). The relationship between the reading and signing skills of deaf children in bilingual education programs. *Journal of Deaf Studies and Deaf Education*, enn009.

Hintermair, M., & Albertini, J. (2005) Ethics, deafness, and new medical technologies. *Journal of Deaf Studies and Deaf Education, 10*(2), 184-192.

Hoffmeister, R. J. (2000). A piece of the puzzle: ASL and reading comprehension in deaf children. *Language acquisition by eye*, 143-163.

Hogan, T. P., Catts, H., & Little, T. (2005). The relationship between phonological awareness and reading: Implications for the assessment of phonological awareness. *Language, Speech, and Hearing Services in the Schools, 36,* 285-293.

Hyde, M. B., & Power, D. J. (1991). Teachers' use of simultaneous communication: Effects on the signed and spoken components. *American Annals of the Deaf, 136*(5), 381-387.

Hyde, M., & Power, D. (2006). Some ethical dimensions of cochlear implantation for deaf children and their families. *Journal of Deaf Studies and Deaf Education*, *11*(1), 102-111.

Hyde, M., & Punch, R. (2011). The modes of communication used by children with cochlear implants and role of sign in their lives. *American annals of the deaf, 155*(5), 535-549.

Hyde, M., Punch, R., & Komesaroff, L. (2010). A comparison of the anticipated benefits and received outcomes of pediatric cochlear implantation: parental perspectives. *American Annals of the Deaf, 155*(3), 322-338.

James, D., Rajput, K., Brinton, J., & Goswami, U. (2008). Phonological awareness, vocabulary, and word reading in children who use cochlear implants: Does age of implantation explain individual variability in performance outcomes and growth. *Journal of Deaf Studies and Deaf Education, 13*(1), 117-137.

Johnson, C., & Goswami, U. (2010). Phonological awareness, vocabulary, and reading in deaf children with cochlear implants. *Journal of Speech, Language & Hearing Research, 53*(2), 237–261.

Kamhi, A., & Catts, H. (2005a). Language and reading: Convergences and divergences. *Language and reading disabilities*, *2*, 1-25.

Kamhi, A., & Catts, H. (2005b). Assessment and Instruction for Phonemic Awareness and Word Recognition Skills. *Language and reading disabilities*, *2*, 127-156.

Knoors, H., & Marschark, M. (2012). Language planning for the 21st century: Revisiting bilingual language policy for deaf children. *Journal of deaf studies and deaf education*, ens018.

Lane, H. L. (1992). *The mask of benevolence: Disabling the deaf community*. New York: Knopf.

Lane, H., & Grodin, M. (1997). Ethical issues in cochlear implant surgery: An exploration into disease, disability, and the best interests of the child. *Kennedy Institute of Ethics Journal, 7*(3), 231-251.

Larrivee, L. & Catts, H. (1999). Early reading achievement in children with expressive phonological disorders. *American Journal of Speech-Language Pathology, 8,* 118-128.

LaSasso, C., & Lollis, J. (2003). Survey of residential and day schools for deaf students in the United States that identify themselves as bilingual-bicultural programs. *Journal of Deaf Studies and Deaf Education*, *8*(1), 79-91.

Leigh, G. (2008). Changing parameters in deafness and deaf education. *Deaf Cognition: Foundations and Outcomes: Foundations and Outcomes*, 24.

Lynas, W. (2005). Controversies in the education of deaf children. *Current Paediatrics*, *15*(3), 200-206.

Lewis, S. (1996). The reading achievement of a group of severely and profoundly hearing-impaired school leavers educated within an natural aural approach. *Journal of the British Association of Teachers of the Deaf, 20,* 1–7.

Liberman, I. Y., Shankweiler, D., & Liberman, A. M. (1989). The alphabetic principle and learning to read. In D. Shankweiler & I. Y. Lieberman (Eds.), *Phonology and Reading Disability: Solving the Reading Puzzle* (pp. 1-33). Ann Arbor: University of Michigan Press.

Loizou, P. C. (1999). Introduction to cochlear implants. *Engineering in Medicine and Biology Magazine, IEEE, 18*(1), 32-42.

Lyon, G. R., Shaywitz, S. E. & Shaywitz, B. A. (2003). A definition of dyslexia. *Annals of Dyslexia, 53,* 1-14.

Marschark, M., Rhoten, C., & Fabich, M. (2007). Effects of cochlear implants on children's reading and academic achievement. *Journal of Deaf Studies & Deaf Education*, *12*(3), 269–282.

Mayer, C., & Leigh, G. (2010). The changing context for sign bilingual education programs: Issues in language and the development of literacy. *International Journal of Bilingual Education and Bilingualism, 13*(2), 175-186.

McConkey Robbins, A., Burton Koch, D., Osberger, M. J., Zimmerman-Phillips, S. & KishonRabin, L. (2004). Effect of age of cochlear implantation on auditory skill development in infants and toddlers. *Otolaryngology—Head and Neck Surgery, 130,* 570-574.

Mody, M., Studdert-Kennedy, M., & Brady, S. (1997). Speech perception deficits in poor readers: Auditory processing or phonological coding? *Journal of Experimental Child Psychology, 64,* 199-231.

Moog, J. S. (2002). Changing expectations for children with cochlear implants. *Annals of Otology, Rhinology & Laryngology*, *111*, 138.

Moog, J., & Geers, A. (1985). EPIC: A program to accelerate academic progress in profoundly hearing-impaired children. *Volta Review, 87,* 259-277.

Moore, J. A., & Teagle, H. F. (2002). An introduction to cochlear implant technology, activation, and programming. *Language, Speech, and Hearing Services in Schools*, *33*(3), 153-161.

Moores, D. F. (1987). *Educating the deaf: psychology, principles, and practices*. Boston: Houghton Mifflin.

National Institute on Deafness and Other Communication Disorders. (2012-2016). National strategic research plan. NIH Publication no. 12-3711. Washington, DC: US Department of Health and Human Services. http://www.nidcd.nih.gov/staticresources/about/plans/strategic/2012-2016NIDCDStrategicPlan.pdf

National Reading Panel (NRP). (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instructions.* Washington, DC: U.S. Government Printing Office.

Otaiba, S., Puranik, C. S., Ziolkowski, R. A., & Montgomery, T. M. (2009). Effectiveness of early phonological awareness interventions for students with speech or language impairments. *The Journal of special education*, *43*(2), 107-128.

Padden, C., & Ramsey, C. (2000). American Sign Language and reading ability in deaf children. *Language acquisition by eye*, *1*, 65-89.

Punch, R., & Hyde, M. (2010). Children with cochlear implants in Australia: Educational settings, supports, and outcomes. *Journal of Deaf Studies and Deaf Education*, enq019.

Qi, S., & Mitchell, R. E. (2012). Large-scale academic achievement testing of deaf and hard-of-hearing students: Past, present, and future. *Journal of Deaf Studies and Deaf Education*, *17*(1), 1-18.

Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest Monograph, 2*, 31-74.

Rosen, S., & Manganari, E. (2001). Is there a relationship between speech and nonspeech auditory processing in children with dyslexia? *Journal of Speech, Language, and Hearing Ressearch, 44*, 720-736.

Schley, S., & Albertini, J. (2005). Assessing the writing of deaf college students: Reevaluating a direct assessment of writing. *Journal of Deaf Studies and Deaf Education, 10,* 96-104.

Senghas, R. J., & Monaghan, L. (2002). Signs of their times: Deaf communities and the culture of language. *Annual Review of Anthropology*, 69-97.

Sharma, A., Dorman, M. F. & Spahr, A. (2002). A sensitive period for the development of the central auditory system in children with cochlear implants. *Ear and Hearing, 23,* 532-539.

Snowling, M. J. (2001). From language to reading and dyslexia. *Dyslexia, 7*, 37-46.

Soroli, E., Szenkovits, G., & Ramus, F. (2010). Exploring dyslexics' phonological deficit III Foreign speech perception and production. *Dyslexia, 16,* 318-340.

Spencer, L. J., Barker, B. A., & Tomblin, J. B. (2003). Exploring the language and literacy outcomes of pediatric cochlear implant users. *Ear & Hearing*, 24, 236-247.

Spencer, L. J., Gantz, B. J., & Knutson, J. F. (2004). Outcomes and achievement of students who grew up with access to cochlear implants. *The Laryngoscope, 114*(9), 1576-1581.

Spencer, L. J., Oleson, J. J. (2008). Early listening and speaking skills predict later reading proficiency in pediatric cochlear implant users. *Ear and Hearing, 29(2),* 270-280.

Spencer, L. J., Tomblin, J. B., & Gantz. B. J. (1997). Reading skills in children with multichannel cochlear-implant experience. *Volta Review, 99*, 193-202.

Stanovich, K. E., (2000). *Progress in understanding reading: Scientific foundations and new frontiers*. New York: Guilford Press.

Stokoe, William C. "Sign language structure." *Annual Review of Anthropology*(1980): 365-390.

Strong, M., & Prinz, P. M. (1997). A study of the relationship between American Sign Language and English literacy. *Journal of Deaf Studies and Deaf Education*, *2*(1), 37-46

Supalla, T., Newport, E., Singleton, J., Supalla, S., Metlay, D., & Coulter, G. (in press). *Test battery for American Sign Language morphology and syntax*. San Diego, CA: Dawn Sign Press.

Svartholm, K. (2010). Bilingual education for deaf children in Sweden. *International Journal of Bilingual Education and Bilingualism*, *13*(2), 159-174.

Thoutenhoofd, E. (2006). Cochlear implanted pupils in Scottish schools: 4-year school attainment data (2000–2004). *Journal of Deaf Studies and Deaf Education*, *11*(2), 171-188.

Tomblin, J. B., Spencer, L. J., & Gantz, B.J. (2000). Language and reading acquisition in children with and without cochlear implant. *Advances in Otorhinolaryngology*, 57, 300-304.

Torgesen, J. K., Rashotte, C. A., & Wagner, R. K. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities, 27*, 276–286.

Traxler, C. B. (2000). The Stanford Achievement Test: National norming and performance standards for deaf and hard-of-hearing students. *Journal of deaf studies and deaf education*, *5*(4), 337-348.

Trybus, R., & Karchmer, M. (1977). School achievement scores of hearing impaired children: National data on achievement status and growth patterns. *American Annals of the Deaf, 122,* 62-69.

Vermeulen, A. M., Van Bon, W., Schreuder, R., Knoors, H., & Snik, A. (2007). Reading comprehension of deaf children with cochlear implants. *Journal of Deaf Studies & Deaf Education*, *12*(3), 283–302.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processes*. Austin, TX: PRO-ED Publishing, Inc.

Weisi, F., Rezaei, M., Rashedi, V., Heidari, A., Valadbeigi, A., & Ebrahimi-Pour, M. (2013). Comparison of reading skills between children with cochlear implants and children with typical hearing in Iran. *International Journal of Pediatric Ptorhinolaryngology, 77,* 1317-1321.

Wiederholt, J. L., & Bryant, B. R. (1992). *Gray oral reading test, third edition (GORT-3).* Austin, TX: Pro-Ed.

Wolf, S. & Allen, T. (1984). A 5-year follow-up of reading comprehension achievement of hearing-impaired students in special education programs. *The Journal of Special Education, 18,* 161-176.

Woodcock, R. W. (1987). *Woodcock Reading Mastery Tests–Revised*. Circle Pines, MN: American Guidance Service.

Woodcock, R.W., & Mather, N. (1989). *Woodcock-Johnson Test of Cognitive Ability.* Allen TX: DLM Teaching Resources.

Woodcock, R.W., & Mather, N. (1989, 1990). *Woodcock-Johnson Psycho-Educational Battery--Revised.* Allen TX: DLM Teaching Resources.

Young, A. (2002). Factors affecting communication choice in the first year of life–assessing and understanding an on-going experience. *Deafness & Education International*, *4*(1), 2-11.