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The Relationship of the Language Skills Required for Reading and Speech Reading Skills for Children with Hearing Impairment

Christine McLoone
University of Tennessee - Knoxville

To the Graduate Council:

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Ilsa Schwarz, Major Professor

We have read this thesis and recommend its acceptance:

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THE RELATIONSHIP OF LANGUAGE SKILLS REQUIRED FOR READING AND SPEECH READING SKILLS FOR CHILDREN WITH HEARING IMPAIRMENT

A Thesis
Presented for the
Master of Arts
Degree
University of Tennessee, Knoxville

Christine McLoone
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ABSTRACT

Currently there is no model of the development of reading skills currently exists for children with hearing impairments. Using the framework of a commonly excepted model of reading for children with typical hearing researchers have sought to determine how children with hearing impairments develop reading skills. The purpose of this is study was to examine a possible link between two components of reading development, speech reading and language. Participants consisted of 5 school aged children with severe to profound hearing loss with cochlear implants or hearing aids. These children were administered the CELF-4 and a department created speech reading test. Results indicated that children with poor language scores had the best speech reading scores while the child with good language scores had poor speech reading score. Performance on tasks examining syntax proved to be crucial to performance on speech reading tasks.

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CHAPTER ONE: INTRODUCTION

Hearing Loss

Hearing loss is either congenital or acquired. Congenital hearing loss is a loss that an individual is born with, often due to syndrome diagnosis, genetics, or maternal drug use (Yost, 2000). It is the number one birth defect in the United States. At present three or four of every 1,000 newborns exhibit some degree of hearing loss (Yost, 2000). In contrast, acquired hearing loss is a loss that develops or is acquired as the child grows. Etiologies range from exposure to oto-toxic drugs to tumors to neurological deficits (Yost, 2000). Current estimates place the number of children younger then 18 with hearing loss at approximately 1.4 million (Yost, 2000).

Hearing loss can be further characterized by the part of the ear that is affected (Yost, 2000). The ear is divided into three portions, outer, middle, and inner, and all three portions must be healthy and in proper order for individuals to hear well. If the outer and middle portions of the ear are not working properly the result is a conductive hearing loss. A conductive hearing loss is typically less severe then the other forms of hearing loss as it is often characterized by a mild hearing loss that is consistent across all frequencies (pitch of sounds) tested. A conductive hearing loss can be treated medically, surgically, or with amplification equipment.

When just the inner ear is affected, the type of hearing loss is classified as sensorineural (Yost, 2000). With a sensorineural hearing loss the hair cells, the sensory organ of the ear that line the cochlea, are damaged and no longer functioning correctly. Hair cells are frequency specific, therefore there will only be losses in the frequency that is specific to the hair cells that are damaged. Hearing losses associated with a sensorineural loss can range from mild, difficulty hearing whispered conversation, to profound, inability to hear any sound (Yost, 2000). Currently, the only method of management of sensorineural hearing loss is to provide amplification via a hearing aid or a cochlear implant (Yost, 2000). However, not all individuals have success using hearing aids due to the inability to amplify sounds enough or the excessive distortion of sound (Yost, 2000).

Another type of hearing loss is referred to as a mixed hearing loss. When there is damage to all parts of the ear it is termed a mixed hearing loss. A mixed loss is a hearing loss that is both conductive and sensorineural.

Amplification and Cochlear Implants

As previously stated, the devices available to manage a hearing loss are either a hearing aid or a cochlear implant. Both devices work to amplify the sound received but they work very differently. The more common method that is used to manage hearing loss is to fit the individual with a hearing aid (Yost, 2000). A hearing aid, depending upon the model, is worn on the body, behind the ear with an ear mold or dome that fits down in the ear canal, or inside the ear. All hearing

aids consist of three basic parts, a microphone, a receiver, and an amplifier. The microphone picks up the signal and sends it to the amplifier which amplifies the sound. The amplifier then sends the amplified sound to the receiver which sends the sound into the ear (Yost, 2000).

When a hearing aid is not amplifying the signal enough for the individual who wears it, there is another option. This option, a cochlear implant, a relatively new method to mange only severe to profound hearing losses and is explored only after individuals fail to have success with hearing aids (Schow & Nebonne, 2002). Cochlear implants consist of three parts as well: a microphone worn near the ear is responsible for picking up the signal (sound), the sound is then transferred to a speech processor which is worn externally, often on a belt or backpack. The speech processor changes the acoustic signal into an electric signal and transports that signal to a receiver that has been implanted into the temporal bone in the head. The receiver acts as the inner ear and sends the sound into the brain (Schow & Nebonne, 2002). A team of professionals including an otolaryngologist, audiologist, and speech-language pathologist are involved in the process of determining eligibility and successfully using the cochlear implant. In order for the implant to be successful, intensive speech language therapy is required (Schow & Nebonne, 2002).

Speech Reading

Even with amplification children with hearing impairment may miss auditory information. Some individuals with hearing impairments use speech reading to help compensate for what is not being received through auditory means due to a poor signal (Kaplan, 1985).

History of Speech Reading

Records indicate that children who have hearing loss have been taught speech and language since the sixteenth century and it is believed that speech reading although not directly taught was learned as a byproduct of the speech and language training (Jeffers & Barley, 1971). The first known direct methods of teaching speech reading as well as the first speech reading curriculum were established in the late nineteenth century (Jeffers & Barley, 1971).

In 1843, the Massachusetts Board of Education secretary Horace Mann, returned from Germany where he observed instructors teaching children to speak and understand through oral methods. He began to advocate for its introduction into the curriculum for individuals with hearing impairments in the United States (Jeffers & Barley, 1971). Although the proposal was initially met with positive reaction, plans for an oral school did not go forward for another twenty years. It wasn't until October, 1867, that two individuals and three influential families, advocating on behalf of their children who lost their hearing after a bout with scarlet fever, established the State supported Clarke School. This school named

for it main benefactor, John Clarke, opened in Northampton, Massachusetts (Jeffers & Barley, 1971). After two years, had passed, a second oral school, the Horace Mann School, opened in Boston, and Sarah Fuller was named principal. Both schools consisted of faculties who were without formal training in the oral methods they were teaching. In 1869, Fuller attended a lecture presented by Alexander Melville Bell discussing the phonetic alphabet he had developed based on the position and shape of articulators. An intrigued Fuller requested a conference for the entire faculty of the Boston School and Melville Bell obliged, sending his son Alexander Graham Bell on his behalf (Jeffers & Barley, 1971).

The Boston school was as much responsible for shaping Alexander Graham Bell's beliefs about deaf education as he was for shaping their curriculum. Prior to his arrival at the school, he doubted the practicality of speech reading arguing that the majority of the sounds being taught were not readily visible (Jeffers & Barley, 1971). The speech reading abilities the hearing impaired students at the school demonstrated changed his position about speech reading and led directly to the development of the curriculum he taught at his School of Vocal Physiology. It was not until 1870, when the public became aware of the possibility of speech reading, that the skill of speech reading was separated from articulation teaching (Jeffers & Barley, 1971). The classes requested by the public, were taught by Sarah Fuller and Mary True. Their work was continued by Lillie Eginton Warren, who in 1903 patented the method of "teaching the reading of facial expressions that occur in speaking" (Jeffers & Barley, 1971 p. 86). She taught this method at

her Warren School of Expression Reading. Over the course of the next century, various teachers adapted Warren's methods and created their own schools and coursework designed to teach adults and children strategies to make them successful speech readers (Jeffers & Barley, 1971).

Practice of Speech Reading

When speaking, the articulators of speech; the mouth, lips, and jaw, makes certain movements needed to form phonemes (Ross, 1998; Harris & Moreno, 2006; Kyle & Harris, 2006). For some sounds the movements are visually different and the individual "reading" the sounds is able to associate the mouth movement with that specific sound. Therefore, every time those movements are seen it is presumed the same sound is being produced. However, some phonemes are not visually different. Sounds that differ in only placement or only in voicing cannot be differentiated because a back placement cannot be "seen" nor can the vibration of the vocal folds. It is estimated that only 30-40% of Standard American English sounds are visible (Ross, 1998).

It is possible that speech reading and residual hearing work in conjunction with each other to overcome the lack of visibility of some sounds. Some sounds that are easily seen are the sounds that are most difficult to hear, conversely sounds that are the most difficult to see are easily heard (Ross, 1998). However, hearing acuity is not a predictor of speech reading (Kyle & Harris, 2006). Research thus far has not determined why some individuals excel at speech reading and while

other struggle. It is recognized that the speaker and situation play a role in the success a speech reader will have, because an unobstructed view of the articulators and face to face communication in a well lit environment will make it easier to see the articulators (Ross, 1998). It has also been suggested, but not proven, that having strong background knowledge in language enables the individual to predict components of the message helps facilitate speech reading (Ross, 1998).

Language and Literacy Development of Children with Hearing Impairment

It is projected that the cost of dealing with hearing loss when diagnosed at birth can reach as much as 1 million dollars (http://www.hearingloss.org/advocacy/HC12.asp). This cost results from the purchase of amplification devices, the up keep of amplification devices including batteries, and the significant cost of learning to communicate, whether the education be oral, sign or both. According to the National Dissemination Center for Children with Disabilities (http://www.nichcy.org/pubs/factshe/fs3txt.htm), data from the 2000-2001 school year showed 1.3% of children receiving services in the school system under the Individuals with Disabilities Education Act (IDEA) Part B have a primary certification of hearing loss. The actual number of children in the educational system with hearing loss is presumably even higher then 1.3% due to children with hearing impairments being served under other classifications (http://www.asha.org/public/hearing/disorders/children.htm).

These children have special needs that need to be met in the classroom including the use of amplification devices and speech and/or language therapy.

Children with hearing impairments face many challenges throughout their school careers. These struggles range from forming social relationships to achieving academic success. Within the elementary and secondary years, one area of particular difficulty is language arts. It is rare that children with hearing losses achieve age appropriate higher level reading skills (Harris & Moreno, 2004).

Sadly, the data regarding the reading development of children with hearing loss has not changed significantly despite the changes in amplification technology and the development of new treatment approaches. Gallaudet University's Research institute (GRI) reported in 1992 that on average, 17 and 18 year olds who are deaf achieved only a fourth grade reading level; only 3% achieved skills equivalent to the skills of a same age peer with typical hearing while a staggering 30% of children who are deaf leave school with no functional reading skills. These data are similar to the data Furth reported in 1966 (Marschark, Lang, & Albertini, 2002; Kelly, 1995; Traxler, 2000). However, some changes have been noted in children who have received cochlear implants as Spencer, Tomblin, & Gantz (1997) found when researching the reading performance of children between the ages of 6.75 and 17.4 who had received their implants between 2 and 9 years of age. Their results indicated that 23% of participants were reading at or above age level, 18 % showed less then one year delay in reading skills, 27% were between

1-2.5 years behind in reading ability, and 32% of the subjects were more then 30 months delayed.

Models of Reading Development

One approach to dealing with the difficulties children with hearing impairment have in learning to read is to assess and treat those areas of deficits that inhibit reading development. To do this, a model of reading acquisition is necessary, with component knowledge or skills outlined. Gough (1986), Chall (1983), and Adams (1990) have all developed models of reading acquisition. However all have been based upon the reading development process in typically developing children. If a child with a hearing impairment is able to acquire reading ability differently, perhaps by using strengths in one area to override a weakness in another, the components of a model for hearing impaired readers may be different or differently weighted than in the models currently being used.

Unfortunately, there has not been an abundance of research in this area. Studies that have been done often have problems that make it difficult to determine if the results can be generalized across all children with hearing impairment, particularly when amplification approaches, communication modes, and instructional practices differ so widely (Harris & Moreno 2004).

If a model of reading development could be created for children with hearing impairment, educators would be able to assess each child's speech and language

needs and develop a treatment plan to address those needs. Specifically, an accurate model of reading development for children with hearing impairments would allow speech-language pathologists to directly target those components of reading acquisition that are most important for children with hearing impairment to master as they develop literacy skills.

Research has shown that there are a number of general language skills necessary for the development of reading. It has been suggested that for children with hearing impairment, speech reading ability may serve as a foundation for some of these skills (Harris and Moreno, 2004, 2006; Harris & Beech, 1998). In order to more closely investigate the individual components needed in a model for literacy acquisition in children with hearing impairment, the relationship of speech reading to components of general language ability, both receptive and expressive have been selected for study. Based upon previous research, it appears that speech reading ability may be a useful indicator of receptive and expressive language development. This study looks to determine if a relationship is indeed present. The specific question asked in this study was:

1. Is there a relationship between the speech reading skills and language skills of children with severe to profound hearing impairment who use oral communication?

CHAPTER TWO: REVIEW OF THE LITERATURE

A Model of Reading Development for Children with Hearing Impairment

A logical starting point of investigation into a model of reading acquisition for children with hearing impairment begins with a widely accepted model of reading development, The Simple View of Reading, developed by Gough & Tunmer (1986). This model, based upon the path to reading used by typically developing children divides reading into a pair of main categories, decoding and comprehension (Hoover & Gough, 2007). However, there are a variety of component skills that make up these categories that children must learn before they become successful readers.

According to this model, decoding refers to the individual's ability to break down the message being delivered. In the English language the messages can be delivered either systematically, referred to as cipher knowledge or unsystematically, referred to as lexical knowledge, and proficient readers must be able to decode both. It is cipher knowledge that allows individuals to see words they have never before been exposed to and connect meaning to the units of the sound (Hoover & Gough, 2007). Conversely, lexical knowledge is the knowledge that allows individuals to realize there are exceptions to the system and what they are. To achieve these two knowledge bases a variety of other components must be mastered. Cipher knowledge is developed through phonological awareness, defined as the ability to manipulate the speech sounds of a language, and

knowledge of the alphabet, described as knowing that there is a structure between written and spoken words. Lexical knowledge is established by the understanding the alphabet and concepts about print, and understanding that the words that are printed do indeed have meaning.

Language comprehension refers to the individual's ability to understand the meaning of spoken language. Two forms of knowledge are needed to fully grasp language comprehension, background knowledge and linguistic knowledge Background knowledge is the knowledge of basic, ordinary rules of the working of language. Linguistic knowledge deals with the less practical more specific components of language; phonology (sounds), semantics (words and different parts of words), and syntax (rules and structure of language.) The components of this model are displayed in Figure 1.

Of all the areas described in the Simple View of Reading, none have proven to be more critical than phonological coding, also referred to as phonological awareness (Kyle & Harris, 2006). Phonological awareness refers to the sounds that make up words, and how aware one is regarding how sounds can be assembled to make one word then the same sounds can be reassembled in a different order to make a new word with a new meaning (Kyle & Harris, 2006). A phonological code in reading is the ability to take the letters that make up the words and identify the sounds that those letters represent (Harris & Beech, 1998).

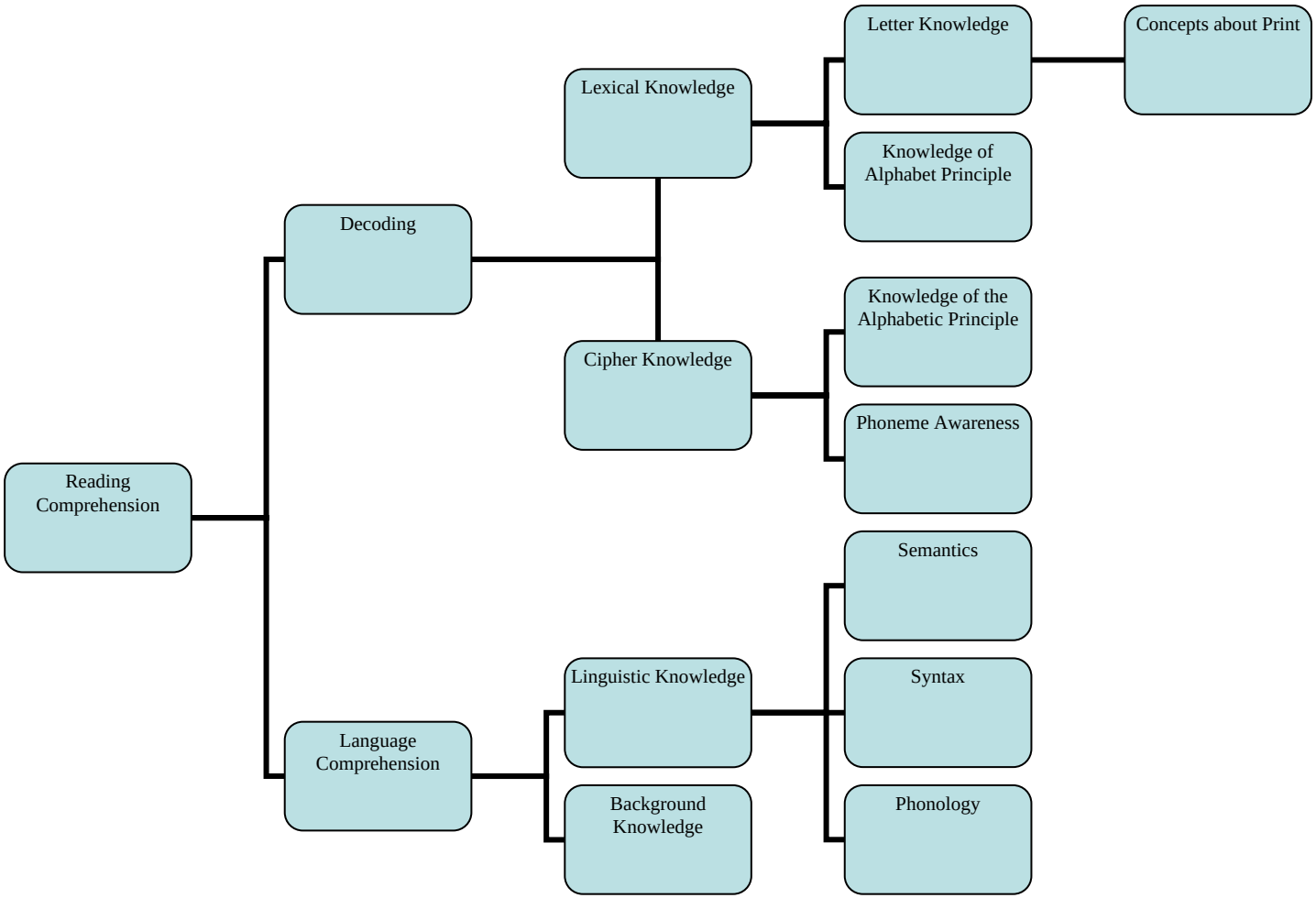

Figure 1. The Simple View of Reading

When considering a model of reading acquisition for children with hearing impairment, all of the components in the simple view of reading may prove important. It is well recognized that the development of language skills including syntax, morphology, semantics and phonology are interdependent (Panagos & Prelock, 1982) and that at least some level of language skill is prerequisite to reading (Hoover & Gough, 2007). However, logic would indicate that children who do not receive the same auditory information as children with normal hearing may require some additional strategies or processes to help them develop good literacy skills. The acquisition of phonological awareness skills in particular, is hindered by the absence of good auditory models. For this reason, some investigators have suggested that speech reading may assist the hearing impaired child to understand the phonology of a language and help provide the phonological foundation needed to read (Harris & Moreno, 2004, 2006; Kyle & Harris, 2006).

Components of Reading Development for Children with Hearing Impairment

Dodd (1998) conducted a longitudinal study to investigate why some children who are trained in "simultaneous" communication, also known as total communication, develop good oral and written language skills and some do not. Sixteen children, most with bilateral severe, severe-profound, or profound hearing loss were tested over the course of 3 years. They were administered the Visual Motor Integration Test (Beery, 1989) to measure non-verbal cognitive development, the Reynell Developmental Receptive Language Scales (Reynell,

1977) and the Peabody Picture Vocabulary Test-3 (Dunn & Dunn, 1997) to assess language comprehension. Expressive language was measured by calculating the Mean Length of Utterance (MLU.) Phonology was investigated by analyzing phonemes missing and consonants correct. Lastly, they investigated lip reading.

As a longitudinal study, there was some attrition over the course of the investigation and the following results are based on the scores of 11 participants. Dodd (1998) found poor linguistic skills across all participants. Results show that the language deficits were not related to intellectual ability. Rather, poor performance on language tests showed a relationship to lip reading ability. Even though assessing the variability of lip reading ability as "enormous", the group of good lip readers (4 participants) had less of an overall language delay than the group designated as poor lip readers (7 participants). Both groups demonstrated the same degree of delay in vocabulary measures. To check reliability, groups were reassembled according to degree of hearing loss. Analysis of these data showed no statistical significance in any area. Results from this study indicate that early lip reading skills are an indicator of future spoken and signed language skills. For this reason, lip reading may be a useful prognostic tool for determining both phonological and syntactic development.

Like most studies with children who are hearing impaired, the subject pool was limited. All children were taught using a total communication approach and only four children were designated as good lip readers. Even though this study did a

very good job of describing individual participants, the inclusion of children with a background in only total communication, coupled with the limited number of children in each group make the results difficult to generalize across the entire population of children with hearing impairment.

Harris and Beech (1998) investigated components of reading in a longitudinal study designed to look at phonological awareness and reading development in children who were hearing impaired. In their study, twenty-four children with prelingual severe/profound hearing loss and a typically developing sample of eighty-five children matched for nonverbal IQ and reading scores were tested. Areas investigated included implicit phonological awareness, oral ability, familiarity with British sign language, and fingerspelling. Groups consisted of children between the ages of 4 years 2 months and 6 years 2 months, who were beginning readers, had a limited vocabulary and could not recognize many letters of the alphabet. Some of the children with hearing impairment had exposure to British Sign Language (BSL.)

Tasks the children had to execute in this study included a single word reading task which involved selecting a word that corresponded to a picture. Implicit phonological awareness was tested by presenting pictures to the children via line drawing; one picture was presented, and the name of the picture was said or signed. The children were then shown two additional pictures and asked which of those two matched the sound in a specified position, either the initial, middle, and

final position, of the word. Next, a letter orientation task was administered. Children were asked to arrange letters in the correct position on a magnetic board. Two handed British fingerspelling ability was tested by having children fingerspell their name, the alphabet, and individual letters. The number of correctly formed letters was calculated to determine a score. Signing ability was assessed and children were classified into three groups based on the number of signs they knew and their ability to connect them. Oral ability was determined by classifying the articulation of the subjects as very good, average, and poor. Finally, language comprehension was assessed by administering the verbal comprehension subtest of the British Abilities Scales in Sign English.

Results showed that language comprehension was positively related to signing and fingerspelling but not with oral skills. Reading was not correlated with fingerspelling but instead with rime, the part of the syllable that contains the vowel and what follows it, and onset, the initial consonant of the syllable, awareness. Signing and fingerspelling were also correlated with each other and negatively correlated with oral skills and implicit phonological awareness. As expected, the children who were deaf did not perform nearly as well on the implicit phonological awareness task as did the children with normal hearing. Phonological awareness and oral ability were significantly correlated. What is interesting is that at the 2 year reevaluation, oral skills and implicit phonological awareness were significantly correlated with reading progress but language comprehension no longer was.

In their discussion, Harris and Beech suggest the high correlations between scores of the children who were deaf on the implicit phonological awareness task and the oral skills task (correlated at .71) may indicate an overlap of skills. Importantly, they suggest that the scores may have been related to strong speech reading skills that allowed the child to recognize the letters of the speaker's lips as the test item was being administered. Campbell (1990) and others have suggested that a phonological code is developed through reading lip patterns used to make sounds. In this study, no testing was done to determine the speech reading abilities of the children who scored well on the implicit phonological awareness task.

In a similar study, Harris and Moreno (2004) investigated the ability of children who are deaf to use phonological coding. They compared the abilities of children who were deaf to the abilities of the chronological age (CA) and reading age (RA) matched typically developing peers across a variety of tasks. Children were divided into six groups, three groups of 7-8 year olds and three groups of 13-14 year olds. Each group had approximately thirty children in it. Children with hearing impairments had nonverbal IQ's above 85 and 85 dB hearing in their better ear. Most of the children in this study used Total Communication, consisting of spoken and signed English, in their classroom settings. The goal of this research was to determine how much the children relied on phonological coding to complete certain language tasks, including short term recall of pictures, orthographic awareness, and a picture spelling test.

The first task of the investigation, short term recall of pictures, used four different sets of pictures to evaluate reliance on phonological coding. The first three sets consisted of pictures that were either visually similar or had names that sounded similar. The fourth set of pictures had no similarities and was used as a control. The children were required to name the pictures in the order in which they were presented. The results showed that the children with hearing impairments did not differ from reading age matched controls but were poorer than chronological age matched controls. This result would indicate that children who are deaf do not use phonological coding to recall the different items names that are all similar sounding names.

On the second task, orthographic awareness, the children in this study were required to differentiate between strings of letters that were "legal" or occurred in the English language and "illegal" or could not occur in the English language. Results showed the children who were deaf had similar performances when compared to children with typical hearing of the same chronological and reading age. On the third task, a picture spelling test, children were shown a line drawing and asked to spell the word the picture illustrated. This was the only task in which deaf children performed differently than their hearing peers. The children who had a hearing loss had a higher number of words they did not attempt to spell and a lower number of phonetic errors. Overall, these results indicate deaf children rely very little on phonological coding when reading. The authors

summarize the major finding of this study by suggesting that the challenge lies in finding alternative ways for children who are hearing impaired to learn to read.

In 2006, Harris and Moreno selected 18 subjects from the cohort of 7-8 year old hearing impaired children in their original study in 2004. They divided the 18 subjects into two groups of nine, grouping them by reading ability. Children who were placed in the good reader group "were reading within 10 months of their chronological age" (Harris & Moreno, 2006, p.192) Children in the poor reader group were reading "at least 15 months below chronological age" (Harris & Moreno, 2006, p.192.) In this study, five children in the good readers group and 1 child in the poor readers group declared British sign language as their first language. The researchers sought to determine if the good readers demonstrated strength in any of the same skills sets. If good reader's demonstrated unique strengths and poor readers showed weaknesses in those same areas, those particular areas may be indicators of reading ability. In particular, the authors wanted to determine if speech reading could be used to develop a phonological code and if so, whether the good readers would be better at speech reading than the poor readers.

Language skills assessed by Harris & Moreno (2006) included reading comprehension, spelling, and orthographic awareness. The spelling test and the orthographic awareness tests were the same as were administered in the 2004 study. The single word reading test used in 2004 was again used in addition to

the Neale analysis of reading ability. In addition to language skills, Harris and Moreno investigated speech reading by administering a test of their creation based on the work of Geers (1994). The test consisted of five blocks of pictures. A female speaker silently pronounced the name of an object depicted in a set of pictures presented to the examinee. 10 stimuli were presented in each of the 5 blocks. The words in each block were classified according to number of syllable, onset, and rime. In the first block, all three components were the same, while the second block consisted of words with the same number of syllables (2) but different onset and rime. Blocks 3, 4, and 5 were more difficult as all words were only one syllable. Additionally, the words in block 3 had the same onset but different rime patterns while items in blocks 4 and 5 had the inverse, differing in onset but having the same rime. The examinee had to point to the picture representing the word being spoken. Phase two of the test consisted of presenting simple questions and commands.

Of the areas investigated, good readers demonstrated better spelling and reading comprehension scores then their counterparts. Analysis of their errors revealed that the good readers used phonological codes and demonstrated syllable awareness while the profile of the poor readers' errors did not suggest either was present in their language repertoire. Analysis also showed a statistically significant correlation between speech reading and good reading ability. However, 2 of the 9 poor readers achieved similar speech reading scores to those

of the good readers. The other skill investigated in this study, speech intelligibility, showed no correlation with reading skill.

Although further investigation is needed, these results suggest that speech reading helps develop a phonological code that may lead to good reading skills in children with hearing impairments. Unfortunately, this study did not investigate other language variables that may have provided more information about the various skills children used when learning to read.

Recently, Kyle and Harris (2006) examined correlates and predictors of reading and spelling achievement in 7- 8 year old school children who were deaf and hearing of the same reading age. Of the children who had hearing impairments, all had severe to profound hearing loss, achieved a score of at least 85 on a nonverbal intelligence assessment, and were prelingually deaf. Data were collected from the children's performance on a wide variety of assessments. These included: single word reading, word recognition, sentence comprehension, a spelling test that required them to write down the name of the object of varying syllable lengths, a phonological awareness activity to match onset and rhyme, short-term memory activity that required them to remember the sequence that pictures were presented, non-verbal intelligence, and speech reading. The speech reading was tested using the procedure described by Harris and Moreno (2006) as adapted from Geers (1994). Correlations were significant for speech reading and nonverbal IQ, reading single words, sentence comprehension and phonological awareness.

Vocabulary was also significantly correlated with single word reading, sentence comprehension, and phonological awareness.

Analysis showed that after accounting for nonverbal intelligence, the only activities that predicted reading abilities were medium associations with speech reading and productive vocabulary. What this study does not provide is sufficient information about the importance of language components other than vocabulary. The single word reading and sentence comprehension tasks used in this study were used as measures of reading. It may be that the sentence comprehension task was tapping into syntactic, morphological, and semantic skills that caused the significant correlations with speech reading and vocabulary. It is also interesting that phonological awareness, a skill known to be critical for reading development was not correlated with any of the other tasks.

Summary

Skills that comprise the decoding and comprehension categories required for typically hearing children to develop good reading skills have been the focus of previous studies of children with hearing impairments. Investigators have tested skills such as speech reading (Harris & Moreno, 2006; Kyle & Harris, 2006,) phonological awareness (Harris & Moreno 2004, 2006), fingerspelling (Harris & Beech, 1998), vocabulary (Kyle & Harris, 2006), short term memory (Harris & Moreno 2004), and speech intelligibility (Harris & Moreno, 2006) in attempts to find the language components necessary to develop good readers.

Results of those studies have indicated that speech reading has shown a positive relationship with reading and language skills. Even though the samples have not been large and vary on a number of dimensions, children with hearing loss who speech read seem to have better reading and language skills then their counterparts who do not have good speech reading skills (Harris & Moreno, 2006; Kyle & Harris, 2006). It is suggested that this is because the skills such as initial sound recognition and rhyming abilities developed in speech reading as well as the over all articulatory gestures and motor movements, help develop a phonological code (Harris & Beech, 1998). While this may be true, what the research has not demonstrated is how speech reading skills are independent of or related to language abilities. The lack of any correlation between phonological awareness and speech reading in the Kyle and Harris (2006) study is one indication of this problem.

Although Harris & Moreno (2006) found that speech reading was important to good reading, no other language variables were assessed so there is no way of knowing if some language skill may be critical to the development of speech reading. As Dodd, McIntosh, and Woodhouse (1998) indicated when describing the participants in their 1998 study, “The variability in lipreading ability was enormous and it would be interesting to know why children differ so (p. 241.) When researchers are able to describe the components of reading development for

children with hearing impairment, and explain how the components are acquired, educational plans for literacy instruction should be radically improved.

CHAPTER THREE: METHODS

Participants

Five children between the ages of 5:0 and 9:0 with hearing loss were selected from the caseload at Children Hearing Services (CHS) at the University of Tennessee. All were residents of or around the Knoxville, Tennessee area. The participants demonstrated no other disabilities in the areas of sensory integration, physical, neurological or learning difficulties as determined by observation, parent report, and previous assessments.

Children were recruited through notification of Ms. Velvet Buehler, the coordinator of the Children Hearing Services and subsequent notification of case managers of individual participants from their current caseloads at the Children's Hearing Services at the University of Tennessee.

Initially, 10 children were selected for participation. Due to various reasons that include absences from therapy, failure to respond to the request to participate, and the inability to achieve a baseline score of CELF 4, only 5 children were available for testing. Of the five children, 3 females and 2 males, only one of the males wore a hearing aid. The other children wore cochlear implants. (See Table 1.)

Table 1. Demographics of Participants.

	AGE	GENDER	HEARING IMPAIRMENT	ETIOLOGY	HA OR CI-TYPE OF DEVICE	DATE IMPLANTED HEARING AGE
P1	7.2	Female	Profound	Congenital	CI- Unilateral Nucleus 24 Contour, Cochlear Nucleus Freedom speech processor.	Turned on 06/03; Hearing age 4.4
P2	7.7	Male	Severe-profound	Auditory Neuropathy	CI- Unilateral Advance Bionics, Harmony Speech Processor	Turned on 10/03; Hearing age 3.9
P3	8.5	Female	Severe-profound	Acquired, diagnosed in 2003. Exact etiology unknown.	CI- Unilateral Nucleus 24 Contour, Cochlear Nucleus Freedom speech processor.	Turned on 12/04; Hearing age 2.8
P4	8.5	Female	Severe-profound	Acquired, diagnosed in 2003. Exact etiology unknown.	CI- Unilateral Nucleus 24 Contour, Cochlear Nucleus Freedom speech processor.	Turned on 12/04; Hearing age 2.8
P5	7.11	Male	Mild-severe	Congenital	HA- Biaural PicoForte 2P2	Aided since 10 months old

Participant Description

Participant 1 was a 7 year 1 month old, female with a cochlear implant. Her implant, a Nucleus 24 Contour with a Cochlear Nucleus Freedom processor was turned on in June of 2003. She has been enrolled in therapy at CHS since 2004. Prior to her enrollment she was receiving speech language therapy services at another out patient clinic beginning in 2002.

Participant 2 was a 7 year 7 month old male who has worn a cochlear implant for four years. His implant is an Advanced Bionics with a Harmony Speech Processor and was turned on in October of 2003. He has not received any speech language therapy prior to his enrollment at CHS in 2003.

Participant 3, the identical twin of participant 4, was an 8 year 5 month old female who has worn a cochlear implant for 3 years. She acquired her hearing loss at approximately 3.5 years of age. She wears Nucleus 24 Contour turned on in December of 2004 and uses a Cochlear Nucleus Freedom processor. She has been receiving services at CHS since 2003.

Participant 4, the identical twin of participant 3, was 8 years 5 month old female who has worn a cochlear implant for 3 years. She acquired her hearing loss at approximately 3.5 years of age. She wears Nucleus 24 Contour turned on in December of 2004 and uses a Cochlear Nucleus Freedom processor. She has been receiving services at CHS since 2003.

Participant 5 was an 8 year 2 month old male who wears a Binaural PicoForte 2P2 hearing aid. He has been aided and seen at CHS since he was 10 months of age.

Materials

The assessment battery consisted of two tests. First, the standardized Clinical Evaluation of Language Fundamentals-4 (Semel, Wiig, & Secord, 2003), a test of expressive and receptive language was used. The CELF-4 is normed on children ages 5.0-21.11, to test a variety of language skills. The test administration in terms of start item and subtests administered is dependent on the age of the subject.

All subjects were tested with the test form designed for children between 5 and 8:11. The subtests administered to the children included: Concepts and Following Directions, Word Structure, Recalling Sentences, Formulated Sentences, Word Classes- Receptive, Word Classes-Total, and Sentence Structure. A scaled score, on a scale of one being the lowest possible and 19 being the highest, is assigned based on the number of items correctly answered. Subtests that target related underlying skills are grouped together to calculate a standard score in main areas of language. These are: Core Language, Receptive Language, and Expressive Language. The Core Language score was calculated by adding the scores achieved on the Concepts and Following Directions, Word Structure, Recalling Sentences, and Formulating Sentences subtest. The Receptive Language score

was calculated by adding the scores achieved on the Concepts and Following Directions, Word Classes- Receptive, and Sentence Structure subtests. Finally, the Expressive Language score is comprised by adding the scores achieved on the Word Structure, Recalling Sentences, and Sentence Structure subtests.

The second test, to measure speech reading ability, was created in the University of Tennessee Department of Audiology & Speech Pathology based upon a research protocol published by Geers (1994) which was also the basis for the speech reading test created by Harris and Moreno (2006) and repeated by Kyle and Harris (2006). The version of the speech reading test used here was created by a master's degree student at the University of Tennessee and recorded on DVD and VHS. In this test, a female graduate student who spoke Standard American English spoke words and sentences that were presented to the children with the sound turned off. Ten words in each of five blocks were presented eight seconds apart. The children were provided with a card displaying pictures. The children were told to look at the women when she spoke the word and then point to the picture that illustrated what she said. For the sixth block, the children were given a picture of a teddy bear and were told the women was going to tell them to point to something on the bear. Lastly, in block seven, the subjects were given a box containing toys and told to watch the women and follow the directions regarding what to do with the toys.

Procedure

The participants were assessed individually in a therapy room in the Children Hearing Services program at the University of Tennessee. Testing was administered by a graduate student clinician with at least fifty hours experience in a clinical practicum and supervised by a speech language pathologist (SLP) licensed by the American Speech and Hearing Association (ASHA). In a few cases, when the participant had been administered one of the tests within the year, the test from the clinical file was used. When both tests were administered, the assessment battery lasted approximately one to two hours depending on the child's performance on the standardized test. Administration was broken down in either one or two sittings depending on the child's ability and time constraints of the family. Parental consent was obtained before each child was tested.

CHAPTER FOUR: RESULTS

The purpose of this study was to determine the relationship between speech reading skills and language skills known to be components of reading development. Should a link be found, it would provide information regarding the process of language acquisition for children with hearing impairment. The study controlled for age, degree of hearing impairment, and to some extent the language abilities of the subjects as they had to be able to achieve a score on the CELF – 4.

Table 2 and Figure 2 depict the participants Core Language standard scores and percentile rank, Receptive Language standard score and percentile rank, and Expressive Language standard score and percentile rank as well as their performance on speech reading test, broken down by performance on word tasks, performance sentence tasks, and overall performance. (For scaled scores see Table 3 and Figure 3.)

Individual Description of Results

Participant 1 achieved poor language scores on the CELF – 4 and poor scores on all portions of the speech reading test. Her subtest scores were: Concepts and Directions 1, Word Structure 1, Recalling Sentences 1, Formulating Sentences 1, Word Classes-Receptive 9, and Sentence Structure 8. The scaled scores of the subtest were calculated to determine a standard score and percentile rank in three main areas of language. The standard score for Core Language skills was 40,

Table 2. Standard Scores on CELF-4, Percentile Rank of CELF- 4, and Percent Correct on Speech Reading test (word, sentences, and overall performance.)

	CELF 4 Core Language standard score	CELF 4 Core Language percentile rank	CELF 4 Receptive Language standard score	CELF 4 Receptive Language percentile rank	CELF 4 Expressive Language standard score	CELF 4 Expressive Language percentile rank	Speech Reading Word percent correct	Speech Reading Sentences percent correct	Speech Reading Words and Sentence percent correct
P1	40	<0.1	75	5	45	<0.1	38	25	36
P2	40	<0.1	65	<0.1	45	<0.1	52	0	41
P3	40	<0.1	69	2	45	<0.1	62	33	56
P4	40	<0.1	55	<0.1	45	<0.1	64	42	60
P5	98	45	99	47	101	53	38	0	31

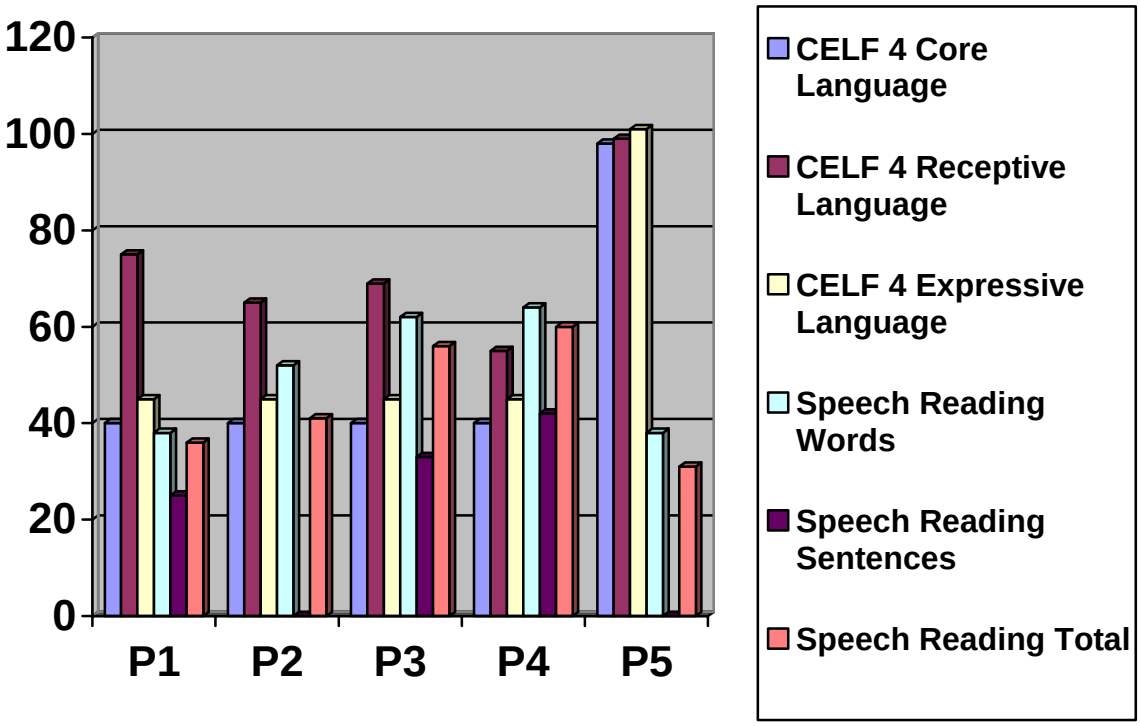

Figure 2. Standard Scores achieved on CELF – 4 and percent correct achieved on Speech Reading test.

Table 3. Scaled Scores on CELF – 4

	Concepts and Directions (scaled score)	Word Structure (scaled score)	Recalling Sentences (scaled score)	Formulating Sentences (scaled score)	Word Classes Receptive (scaled score)	Sentence Structure (scaled score)
P1	1	1	1	1	9	8
P2	1	1	1	1	10	2
P3	1	1	1	1	13	1
P4	1	1	1	1	6	1
P5	8	6	16	9	13	9

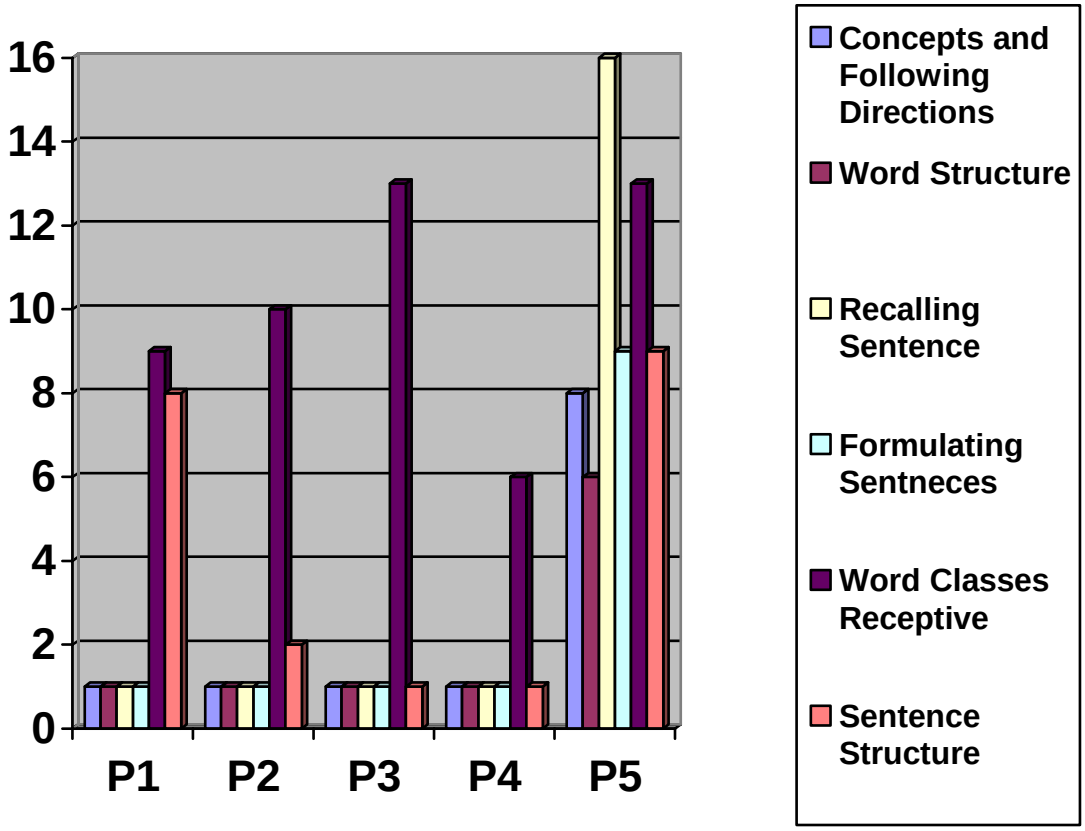

Figure 3. Participant's Scaled Scores on individual subtests of CELF – 4.

earning a percentile rank of <0.1. The standard score for Receptive Language skills was 75, earning a percentile rank of 5. The standard score for Expressive Language skills was 45, earning a percentile rank of <0.1.

Participant 2 achieved poor scores on all sections of the CELF-4. He achieved good scores on the word portion of the speech reading test and poor scores on the sentence, and word and sentence portion of the speech reading test. His CELF-4 subtest scores were: Concepts and Directions 1, Word Structure 1, Recalling Sentences 1, Formulating Sentences 1, Word Classes-Receptive 10, and Sentence Structure 2. The scaled scores of the subtest were calculated to determine a standard score and percentile rank in three main areas of languages. The standard score for Core Language skills was 40, earning a percentile rank of <0.1. The standard score for Receptive Language skills was 65, earning a percentile rank of <0.1. The standard score for Expressive Language skills was 45, earning a percentile rank of <0.1.

Participant 3 demonstrated significantly below average scores on the CELF- 4 and good scores on the word and word and sentence portion on the speech reading test. Her CELF-4 subtest scores were: Concepts and Directions 1, Word Structure 1, Recalling Sentences 1, Formulating Sentences 1, Word Classes-Receptive 13, and Sentence Structure 1. The scaled scores of the subtest were calculated to determine a standard score and percentile rank in three main areas of languages. The standard score for Core Language skills was 40, earning a percentile rank of

<0.1. The standard score for Receptive Language skills was 69, earning a percentile rank of 2 and the standard score for Expressive Language skills was 45, earning a percentile rank of <0.1.

Participant 4 demonstrated the same overall score profile as her twin, participant 3. She achieved a similar score pattern on the CELF-4 and slightly better scores on all portions of the speech reading test. Her subtest scores were: Concepts and Directions 1, Word Structure 1, Recalling Sentences 1, Formulating Sentences 1, Word Classes-Receptive 6, and Sentence Structure 1. The scaled scores of the subtest were calculated to determine a standard score and percentile rank in three main areas of languages. The standard score for the Core Language skills section was 40, earning a percentile rank of <0.1. The standard score for Receptive Language skills was 55, earning a percentile rank of <0.1 and the standard score for Expressive Language skills was 45, earning a percentile rank of <0.1.

Participant 5 achieved the highest scores on the CELF-4 and low scores on all portions of the speech reading test. His CELF-4 subtest scores were: Concepts and Directions 8, Word Structure 6, Recalling Sentences 16, Formulating Sentences 9, Word Classes-Receptive 13, and Sentence Structure 9. The scaled scores of the subtest were calculated to determine a standard score and percentile rank in three main areas of languages. The standard score for the Core Language skills section was 98, earning a percentile rank of 45. The standard score for Receptive Language skills was 99, earning a percentile rank of 47, and the

standard score for Expressive Language skills was 101, earning a percentile rank of 53.

CHAPTER FOUR: DISCUSSION

The results of previous studies that have investigated the relationship of speech reading to language and reading have concluded that speech reading plays a role in developing good reading skills. The studies have also demonstrated a positive relationship between speech reading and language ability. Unfortunately, these studies have often mixed children with and without signing background, children who used either aids or implants without describing the specific subjects, and children with language levels that were not controlled. As a result, it is important for additional research too be carried out in the area of speech reading with well defined populations. By doing this, over time, a true picture of how speech reading may be related to language acquisition and reading development will be clear.

Results from this study

When the results from all children on the language subtests are evaluated, children with the overall poorer scores on the CELF-4 showed better receptive language skills then expressive language skills. This is not surprising as this is a typical profile for children with language delays. Among themselves, the children with cochlear implants showed the strongest performance in the area of vocabulary as evidenced by scores on the Word Classes Receptive subtest of the CELF-4. In this subtest, children were asked to point to the pictures of two objects

(out of a set of three or four items) that go together. Two of the participants (1 and 2) also achieved scores of 8 and 9 on the Sentence Structure subtest, a subtest that evaluates knowledge of syntax. To evaluate syntax in this subtest, the children were shown an easel with four pictures and told: “Point to he is climbing and she is swinging” or “Point to the girls are dressed for the game.” All children scored well below the mean across all subtests. Participant 5, the only child who wore hearing aids, was the only participant able to achieve scaled scores above 1 on all subtests of the CELF-4.

When speech reading tasks are viewed relative to the CELF-4 subtests, an interesting profile emerges. Participants 1 and 5 performed poorly on the speech reading tasks with scores of 38% correct each on the Word section and scores of 25%and 0% respectively on the Sentences section. However, both scored above 7 on the Sentence Structure subtest and above 8 on the Word Classes subtest of the CELF-4. In contrast, participants 2, 3, and 4 performed above 50% on the word portion of the speech reading task. They also demonstrated comparable scores to participants 1 and 5 on the Word Classes Receptive subtest but had standard scores of only 1 or 2 on the Sentence Structure subtest of the CELF-4. This information may suggest that speech reading skills develop to support understanding when syntactic knowledge is poor. In other words, when vocabulary knowledge is similar, children with weak syntax will develop better speech reading skills in order to support their understanding.

Behavioral observation lends some support this theory. For example, Participant 4, when administered the speech reading test would repeat aloud what she thought the women on the screen said. Often the word the child said was a nonsense word that had the same rhythm as one of the pictures she was to choose from. She repeated what she thought she read off the lips, listened to the rhythm of the names of the picture options, found similarities, and consistently achieved over half correct in each block of single word presentations. Using her vocabulary skills she was able to match the nonsense word to one of the pictures. She did not perform as strongly on the sentence portion of the test, possibly suggesting that there was too much input, and that her vocabulary knowledge coupled with speech reading ability was insufficient for connected speech.

The performance of Participant 2, Participant 3, and Participant 4 indicates that all are still attempting to acquire basic language skills. Even though the children may show some ability in the area of vocabulary, it is limited. Their performance on the subtests of the CELF-4 demonstrates that while they have some command over components of language, which allowed them to get a minimum number of items correct, they have not mastered all the necessary language skills that are likely to underpin good reading skills. An additional behavioral observation supports this. When completing the Concepts and Directions subtest of the CELF –4, Participant 2 was able to point to the correct pictures, demonstrating that he had the necessary basic vocabulary; however, he did not get the items correct because he did not understand all the concepts required. A number of the

questions take the following form: **"**Point to the black shoe after you point to the small house." Participant 2 got this and the questions like this incorrect because of lack of knowledge regarding the meaning of the word "after" in this sentence. Instead he pointed to both items at the same time.

It has been suggested that children with hearing impairments develop phonological codes differently then children with normal hearing (Harris & Beech 1998.) All of the subjects who performed above average on the word portion of the speech reading task have not developed the speech reading ability needed to overcome what are most likely to be a combination of semantic and syntactic deficits when speech reading is required for connected speech. If the results of this study are replicated, the conundrum is whether to actively teach speech reading to assist in understanding or to facilitate syntactic development in the expectation that good speech reading skills will not be necessary if syntax is good.

While previous studies have indicated a relationship between speech reading and some language skills, Kyle & Harris (2006) have reported only a "minimal" correlation. One issue that needs to be considered for further research is that of the test being administered. Almost every research project on this topic has administered a different language and speech reading test. It is possible that the instructions as well as the stimuli presented affect the outcome of the results. The example given earlier of Participant 2, who did not understand the test directions, even though the vocabulary being tested was known, indicates that different tests

may show different results. In this case, a single word receptive test may have shown a different level of vocabulary knowledge. As a result, larger samples are going to be needed in order for a true picture to emerge.

From this subject pool it is difficult to say if findings can be used to support the results of previous studies. Dodd, McIntosh & Woodhouse (1998) found that lipreading scores showed positive correlations with nonphonological language measures, including assessments of language comprehension. However, syntax was not directly measured in this study. This study also needs to be replicated with older children who are able to demonstrate more sophisticated language skills. Additionally, as the only child wearing a hearing aid, Participant 5 may be unusual. It is not know if his performance was related to being the only hearing aid user, or unique to him. What this study did find was that the three subjects who had the poorest syntax scores had the best single word speech reading scores. What this suggests is that there may be some link between syntactic knowledge and speech reading. A replication would help to see if the inverse relationship found between syntax and speech reading is consistent. Replication of this study with the same subjects when the children are older would also be intriguing to see if there is a change in the test results. How speech reading will eventually relate to language skills and eventual reading ability is a topic of great interest and requires a great deal of additional study.

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VITA

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