Development of Vocabulary and Phonological Skills in Children with Normal Hearing and Cochlear Implants

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Abstract

Problem Statement: Children with hearing loss experience both degraded sensory inputs and diminished experiences with language, making language learning difficult. Two important kinds of language structure are vocabulary and word-internal phonemes. For children with normal hearing, the lexical restructuring model is usually posited as explaining the relationship between the acquisition of these two levels of language structure. According to this model, children's earliest vocabularies consist of whole word units, rather than sequences of phonemes as adult vocabularies do. As the child's vocabulary grows and their auditory attention to acoustic details in the speech signal improves, they begin to attend to those acoustic details that define phonemes. Thus, vocabulary and phonemic acquisition progress in a scaffolded manner, each supporting the development of the other. But does that happen for children with hearing loss who lack both experience and refined acoustic representations? If so, what is the primary direction of influence? And finally, does literacy acquisition support the development of either vocabulary or phonemic structure to a significant extent? These were the questions addresses in this study. Upon reviewing the available literature, we predicted that phonological skills would most strongly influence vocabulary development for children with cochlear implants (CIs)

Participants: Children from a longitudinal study of language acquisition participated. Twenty-eight of these children had normal hearing (NH), and 28 had severe-to-profound hearing loss and used CIs. Otherwise, these children were well matched on age and socioeconomic status, two factors that account for language abilities.

Methods: Data on vocabulary skills, phonemic awareness, and word reading were collected from these children when they were 14 years of age. Data collected at younger ages from these children and others in the same longitudinal study were also used. Cross-lagged correlational analyses were performed to investigate patterns of significant impact among variables.

Results: Outcomes showed significant relationships only at young ages. Although there were some cross-lagged relationships between vocabulary and phonemic acquisition, the onset of literacy accounted for a lot of the development in both vocabulary and phonemic structure observed for these deaf children with CIs in those early elementary grades.

Conclusion: Early literacy activities can significantly impact language acquisition for deaf children who have CIs.

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Introduction

The first 3 years of a child's life are tremendously important for speech and language development. Significant language delays are experienced by those who are deaf or hard of hearing, as they do not have access to sound in their environment. Before cochlear implants (CIs) became available and more widely used, speech perception for those with a hearing loss was exceedingly difficult. Those with a severe-profound hearing loss often relied on other forms of communication. Some chose and still choose to use sign language as their main form of communication, while others relied on lip reading, amplification of sound from hearing aids, contextual clues, and body language. Today, with the help of the CI and early hearing screenings and interventions, children with a severe-profound hearing loss are able to use oral communication, allowing them to develop speech perception abilities, improving oral language outcomes. This better prepares children with CIs to have the ability to catch up to their same-aged normal hearing (NH) peers (Lund, 2015). But do some deficits remain and is the language-learning process the same for children with CIs as for their NH peers? The goal of this study was to address these questions for one aspect of language learning and vocabulary development.

Review of the Literature

Universal newborn hearing screening (UNHS) and Early Hearing Detection and Intervention (EHDI) guidelines were established to help accelerate the diagnosis and treatment of children with hearing loss. Until recently, the average age for identification of a hearing impairment was 2 ½ years of age. In 1993 the National Institute of Health (NIH) recommended that newborns must receive a hearing screening prior to being discharged from the hospital. Prior to the NIH stating the necessity for screenings only infants born with high-risk factors for hearing loss were usually the only ones receiving hearing screenings. This resulted in over half of newborns with an undetected hearing loss being sent home each year. With these guidelines in place, the number of children with hearing loss who go untreated has decreased. With the help of these programs it has been possible for children to receive early treatment and to develop oral language skills similar to their same-aged NH peers (Yoshianga-Itami et al., 2017).

In the past, testing one's hearing abilities could only be done with behavioral measures. Auditory brainstem response (ABR) and otoacoustic emissions (OAEs) are two physiological measures that are able to test hearing abilities in newborns. Tests for both ABRs and OAEs are noninvasive and are typically performed when the infant is asleep or quietly resting. Using physiological measures to test hearing abilities allows newborns to be screened right away for the possibility of a hearing loss before they are discharged from the hospital (ASHA). With this early detection ability, newborns with hearing loss have the potential to receive proper intervention after they are diagnosed, making it possible to access sound in their environment.

EHDI guidelines consist of three recommendations that must be followed in order for early detection procedures to be maximally effective. Newborns must receive a hearing screening by 1 month of age, a diagnosis of an actual hearing loss by 3 months of age, and intervention for that hearing loss by 6 months of age. These guidelines are also known as the EHDI 1-3-6 policy (Yoshianga-Itano et al., 2017).

Age of Cochlear Implantation

In the year 2000, the US Food and Drug Administration approved the use of cochlear implants for children as young as 12 months of age. A CI provides a sense of sound to someone with a profound hearing loss by bypassing the damaged parts of the cochlea and directly stimulating the auditory nerve, which allows the brain to recognize these signals as sounds. With newborn hearing screenings, the expectation for children with CI has been raised for participating in activities such as attending regular schooling. Nonetheless, before children receive CIs they experience a period of auditory deprivation, limiting their access to spoken language. This period of auditory deprivation puts them at risk for significant language acquisition delays when compared to their same-aged NH peers. Most researchers currently agree that receiving a CI before 2 years of age is considered early implantation, whereas receiving a CI after 2 years of age is late implantation. Children who receive implantation early show faster growth rates in vocabulary than those receiving implantation later (Walker & McGregor, 2013). Beyond that, we do not know much about vocabulary development in children with CIs, or how that development differs from that of NH.

Word Learning Process

The word learning process consists of three key components: fast mapping, extension, and retention. A word is fast mapped after a few exposures when one is able to connect a word to its referent. Besides proper nouns, all words can be put into categories, so correctly being able to determine the category for a word is considered extension. When the word is actually held in memory it is considered retention. Walker and McGregor wanted to investigate the word learning process in children with CIs. For the study, they recruited children from the Midwest who attended private deaf oral education schools. Of these children, there were 15 boys and nine girls, all of whom had CIs and were between the ages of 3;6 and 6;9 at the time of their participation. 47 children with NH also participated in this study: 24 were age-matched and 23 were vocabulary-matched. Each participant was tested over two one-hour sessions, at least 24 hours apart. All participants were presented with familiar and novel objects, and the presenter of the experiment labeled the objects three times with the target word. These objects were used to test comprehension, retention, and extension for the children. Uncued and cued production testing were used to determine the child's ability to correctly label the objects. Results showed that children with CIs had roughly the same results as their same-aged NH peers for fast mapping and extension; for retention, however, children with CIs demonstrated weaker results (Walker & McGregor, 2013). These results suggest that children with CIs are just as capable as children with normal hearing when it comes to learning new words and understanding their appropriate uses, but have difficulty retaining them in the lexicon.

Relationship between vocabulary and phonological development

There is a bi-directional relationship between vocabulary development and phonological acquisition, meaning phonological abilities influence vocabulary acquisition, and the structure of the lexicon is shown to influence phonological knowledge. Phonological structure generally refers to a level of structure that is internal to the word. It can include syllables, onsets, and rimes, or individual phonemes. Lexical characteristics that can influence the development of vocabulary and phonology are word frequency, which is the number of times a word arises in a language, and neighborhood density, which is all the words that are rendered distinct by the deletion, addition, or substitution of one phoneme. In the mental lexicon, words are presumably arranged based on phonological similarity, forming dense and sparse neighborhoods. For example, the word *cat* has a dense lexical neighborhood because it includes many neighbors such as *hat, sat, cap, car, cut,* etc., whereas the word *these* has a sparse neighborhood containing relatively few neighbors such as *tease* and *ease*. (Storkel & Morrisette, 2002).

The development of the mental lexicon is thought to require both the opportunity to hear words often so they can become familiar, and the ability to recognize word-internal structure so those words can be represented in a salient manner. Both factors are essential, if words are to be acquired and stored in a long-term lexicon. Without ample opportunity to hear a variety of words, the lexicon cannot grow. But if a child is never able to recover word-internal phonological structure, it will be hard for the child to adequately discriminate among words with similar structures, such as those in dense neighborhoods. It also would be hard for the child to store words in the long-term mental lexicon, as Walker and McGregor (2013) observed from children with CIs.

Developmental psycholinguists generally agree that children's early lexicons are not organized into phonological neighborhoods as well as adults because they do not recognize phonological structure at as detailed a level as adults (Nittrouer, 1992; 2006, Vihman & Velleman, 1989; Walley, 1993). Instead these early lexical representations are more holistic in form, consisting of long-term, gradually changing spectral structure (Nittrouer, Lowenstein, & Packer, 2009; Storkel, 2002). It is generally thought that pressure from a burgeoning lexicon forces the reorganization of items in that lexicon into a more strictly phonological form, and the emergence of these phonologically based neighborhoods. It is equally conceivable, however, that emerging sensitivity to phonological structure – as might arise as a consequence of learning to read an alphabetic orthography – could be responsible for that lexical reorganization, and support rapid growth of the lexicon.

An experiment by Metsala (1997) revealed the influence on word recognition of children not having as much experience as adults with hearing words, and their lexicons not being organized as strictly by phonological structure. In this experiment, Metsala presented a short section of the start of the word (100 ms) and asked adults and children between 7 and 11 years of age what the word was. A little bit more of the word (50ms) was added on each of several subsequent presentations, until the adult or child correctly identified the word. Some words were low-frequency words and some were high-frequency words. Children needed longer word stretches than adults to recognize the words, which meant that children's representations were not as specifically phonemic as the representations of adults. Presumably, children needed those long stretches to recover the kind of global acoustic structure they used to represent the words. This requirement of longer stretches held for both kinds of words, but the age difference was greater for low-frequency words. That finding revealed that children had not had as much experience hearing a lot of words: they were not as familiar with the low-frequency words, and needed especially more of the acoustic signal to recognize those words.

In another experiment by Walley, Smith, and Jusczyk (1986), it was found that children in kindergarten did not discriminate very well between nonword disyllables (CVCV) that differed by fewer than three phonemes. Children in second grade performed better on the discrimination task than the kindergarten children, regardless of how many phonemes distinguished the words in the pair (one, two, or three). That showed that the kindergarten children did not really recognize a difference between words of one phoneme, so would not be able to discriminate very well among words in dense lexical neighborhoods where there are a lot of words differing by one phoneme. Overall, young children appear to represent words by coarse acoustic structure, and use sentence context to disambiguate these words from similar sounding words. This immature lexical characteristic seems to extend fairly long through childhood; at least until 11 years of age.

Present Study

The current study was undertaken to see if the relationship between lexical and phonological acquisition differs for children with CIs, compared to those with normal hearing. Children with hearing loss should be at a disadvantage, both in terms of opportunities to hear new words and the ability to develop sensitivity to phonological structure. Opportunities to hear new words would be constrained because hearing at a distance or when there is even a little bit of background noise is more greatly impaired for listeners who use auditory prostheses, including CIs. The ability to develop sensitivity to phonological structure is impaired because CIs provide only highly degraded spectral structure, which defines many phonemic categories. The question of whether one of these skills (lexical or phonological) drives development in the other to a greater extent in children with CIs has a significant clinical implication: Should clinicians be focusing more on teaching new words or on developing phonological awareness?

Finally, the current study also investigated the potential role of early literacy instruction on the development of either lexical or phonological skills. Children with hearing loss may benefit more than children with NH from exposure to visually presented languages, because that modality is not impaired. The argument against this suggestion is that the alphabet represents phonemic units, so an individual presumably needs to recognize those units in the first place in order to associate visual symbols with them. To test these possibilities, word reading was also used in analyses to evaluate whether it promotes acquisition of vocabulary and/or phonological structure, or if its acquisition is promoted by knowledge with either one or the other of those linguistic structures.

For collecting data on the three measures (i.e., expressive vocabulary, phonemic awareness, and word reading), it may seem as if starting in second grade is too late, but these children had no phonological awareness in kindergarten so starting in second grade seemed best fit. Looking at Cohen' d values between NH and CI children for vocabulary there was a Cohen's d of 1.35, whereas for phonemic awareness there was a Cohen's d of 2.43. This shows that CI children started kindergarten much poorer in phonological awareness, meaning they start kindergarten really poor at recognizing phonemes.

Methods

Participants

Fifty-six children from a longitudinal study of language acquisition participated in this study: 28 of these children had NH, and 28 had a severe-to-profound hearing loss and wore one or two CIs. All children had just completed eighth grade at the time of most recent testing. In addition, data were also collected from these children in second, fourth, and sixth grade. At the time of most recent testing, the mean age of children with NH was 14 years, 2 months and the mean age for children with CIs was 14 years, 6 months. All children were at the same academic level, so the age difference was not considered problematic.

Several criteria needed to be met in order to participate. They had to have no condition other than hearing loss that could result in language disorders, they had to have parents with normal hearing, and they had to come from homes where only English was spoken to them.

These children were well matched on age and socioeconomic status, two factors that account for language abilities. In order to determine if these children were well matched for socioeconomic status, a metric was used. This metric looks at each parent in the home and uses occupational status and highest education level, ranked on a scale from 1 to 8, lowest to highest. For each parent, the scores are then multiplied together, and the highest score received from the parents is used to determine the socioeconomic status (Nittrouer & Burton, 2005). Based on this scale, the means for children with NH were 36 and the means for children with CIs were 33. This difference in socioeconomic status is not statistically significant ($p = .353$). These mean scores indicate that the average family in this study had at least one parent who obtained a four-year university degree.

All children who wore CIs had severe-to-profound hearing losses. The median age for identification of a hearing loss was two months of age. For the age of identification, the median was used rather than the mean because of a few outliers in the data. The children with CIs were born deaf and received a CI at the median age of 14 months. The median was used for this report of data rather than the mean, as well because of a few outliers. For instance, one child received their first CI at 12 years of age, which brought the mean to 23.68 months, so this was our reason for using the median instead. Besides hearing loss, no other disabilities were present in the children for this study. In addition, all participants had a Brief IQ test done. The children with NH had a mean of 107 and the children with CIs had a mean of 105 (p = .570). Both groups were at means for the normative sample, and standard deviations were similar.

Table 1. Mean and median scores for NH and CI groups, including socioeconomic status and brief IQ for eighth grade.

	NH (*N*=28)			**CI (*N* = 28)**		
	Median	Mean	SD	Median	Mean	SD
Socioeconomic status (out of 64)	36	36	13	35	33	11
Brief IQ	106	107	15	175	105	5
Age of identification (months)				2	5	6
Age of first implant (months)				14	24	27

Equipment

A sound-treated booth was used for all testing completed for the collection of data for this study. For all tests given to the participants, audio-video recordings were used to capture the responses. This allowed scoring of tests to be reviewed later by another staff member of the laboratory to ensure accuracy of original scorer. There were three tasks involving phonological sensitivity that were administrated. Stimuli for these tasks were presented in audio-visual format through a computer with a Creative Labs Soundblaster soundcard, in addition to a Roland MA-12C powered speaker. Custom-written software controlled presentation of the stimuli, and recording of responses.

Three subtests of standardized instruments were administered: the word reading subtest of the Wide Range Achievement Test – 4 (WRAT-4; Wilkinson & Robertson, 2007); the Expressive One-Word Picture Vocabulary Test – 4 (EOWPVT-4; Martin & Brownell, 2011); and the Final Consonant Choice (Nittrouer, Shune, & Lowenstein, 2011). For these tasks, all rules regarding when to discontinue testing were followed, but responses were video-audio recorded using a SONY HDR-XR550V video recorder. To ensure good sound quality of all recordings the children wore SONY FM transmitters. All scoring done at time of testing was checked by an independent experimenter at a later time.

Procedures

All procedures were approved by the Institutional Review Board at the University of Florida. All auditory stimuli were presented at 68 dB sound pressure level. Each child who participated in this study came to the laboratory for two consecutive days. A number of tasks were administered to the children in individual test sessions that lasted no more than one hour each. Between each session breaks were given of no less than one hour each.

Outcomes for three measures were examined. The EOWPVT-4 was used to measure vocabulary skills (Martin & Brownell, 2011). Testing expressive vocabulary knowledge rather than receptive vocabulary knowledge assessed a deeper level of word familiarity. For this task, children are shown pictures that are meant to be familiar one at a time and are asked to label each picture. Some pictures had more than one acceptable answer. When a child misses six consecutive items, a ceiling is reached. All testing was audio-video recorded with equipment in a sound booth. The person administrating the test scored data initially, but to ensure the accuracy of scoring, another member of the laboratory staff watched the videos and scored the tests. After, scores were compared with the original data collected to confirm all scoring. In addition to the

EOWPVT-4, the reading subtest of the WRAT-4, was used to test the basic-word reading ability for all participants and was a basic metric of language proficiency. (Wilkinson & Robertson, 2006). For this task, responses were audio-video recorded and scored later by two independent experimenters so that reliability could be checked. Finally, the final consonant choice (FCC) task was used to assess participants' sensitivity to or awareness of phonological structure (Nittrouer, Shune, & Lowenstein, 2011). The FCC consisted of 48 test trails, as well as six practice trials, all recorded by a male talker. A target word was presented during each trial, and the participant had three opportunities to repeat the target correctly. However, most participants repeated all target words correctly with just one opportunity. Next, they saw and heard three words, and had to select the one that ended in the same sound as the target. Testing was stopped after six incorrect responses. In this case, responses were scored once during testing, and again later by an independent observer so reliability could be checked.

Analysis

Cross-lagged correlational analyses were performed to investigate patterns of significant impact among vocabulary development and phonological acquisition. Vocabulary development and phonological acquisition was looked at in second, fourth, sixth, and eighth grade for both groups of CI children and NH children. This technique was used to establish the direction of relationship among the two variables. In addition, word reading was also used in the analyses to evaluate whether it promotes acquisition of vocabulary and/or phonological structure, or of its acquisition is promoted by knowledge with either one or the other of those linguistic structures.

Results

Table 2 shows the means and standard deviations (SD) for both groups of children for the observed measures at second, fourth, sixth, and eighth grade. This included expressive vocabulary, phonemic awareness, and word reading scores. Table 2 also shows results of the independent sample t-test. The independent sample t-test allows the means between two unrelated groups (i.e. NH and CI children) to be compared on the same dependent variable. Data for 28 children with NH and 28 children with CIs were included in the analyses. Group differences were examined before the specific goals of the study were addressed statistically. For the NH group, one child was not tested at fourth grade so the sample size for that group is 27 at fourth grade. For the CI group, two children were not tested at second grade, so the sample size for that group was 26; one child was not tested at fourth grade so the sample size for that group is 27; and two children were not tested in sixth grade so the sample size for that group is 26.

TABLE 2. *Expressive vocabulary, phonemic awareness, and word reading scores for NH and CI groups.*

	NH			CI					
	N	Mean	SD	*N*	Mean	SD	*t*	*p*	*Cohen's d*
Expressive vocabulary									
Second grade	28	95	12.7	26	83	18.4	2.75	**.008**	.743
Fourth grade	27	107	11.2	27	100	17.5	1.74	.087	.474
Sixth grade	28	134	13.6	26	128	16.1	1.57	.122	.427
Eighth grade	28	144	14.6	28	135	16.0	2.30	**.025**	.615
Phonemic awareness									
Second grade	28	71	18.3	26	42	27.2	4.59	**<.001**	1.24
Fourth grade	27	84	10.5	27	60	27.3	4.32	**<.001**	1.17
Sixth grade	28	88	7.8	26	70	19.8	4.35	**<.001**	1.17
Eighth grade	28	90	6.7	28	73	20.4	4.25	**<.001**	1.32
Word reading									
Second grade	28	42	6.5	26	38	7.1	2.10	**.041**	.571
Fourth grade	27	51	5.3	27	47	8.2	1.95	.056	.532
Sixth grade	28	53	6.0	26	48	8.7	2.42	**.019**	.654
Eighth grade	28	54	6.1	28	50	7.0	2.37	**.022**	.632

Results of *t* tests shown between NH and CI groups. Bolded *p* values for those less than or equal to 0.05.

Some impressions can be gathered by looking at Table 2. For all measures, the CI group showed poorer mean scores than the NH group at every test age; however not all differences were statistically significant. The *p* values show that children with CIs performed more poorly on phonemic awareness for all grades. For expressive vocabulary, group differences reached statistically significance in eighth grade, but not in second or fourth. For expressive vocabulary, group differences reached statistical significance in second, sixth, and eighth grade, but narrowly missed it in fourth grade.

At first glance, when raw scores were translated to standard scores it seemed as if children with CIs were performing close to the normative sample for the mean performance for both word reading and expressive vocabulary. However, all children in this study came from middle-class families, with relatively high SES. Based on this, comparing CI children to NH children tested in the study, CI children were almost one SD below NH children for expressive vocabulary, and approximately one-half SD below NH children for word reading.

Next, partial correlations computed between each pair of these three measures for children with NH and those with CIs were performed. To ensure the criteria for normal distributions and homogeneity of variance were met, each of the three potential predictor variables were also examined. Only one measure was found that did not meet these requirements, which were final consonant choice, the task that measured phonological awareness. Arcsine transforms were applied since it was negatively skewed. The arcsine transforms resulted in normal distribution so they were used in further analyses. These partial correlations were run to determine the relationships between vocabulary, phonology, and literacy acquisition in second, fourth, sixth, and eighth grade. To determine the direction of relationship among variables in developmental studies, partial correlation coefficients are often computed, (e.g., Ritchie Bates, &

Plomin, 2015; Sperlich, Mexiner, & Laubrock, 2016). The partial correlation coefficient computed consists of a proposed dependent measure and a proposed predictor variable at both the previous grade and current grade. Variability in the proposed dependent measure associated with performance at the earliest age is controlled (Nittrouer, S., Caldwell-Tarr, A., Low, K. E., & Lowenstein, J. H., 2017).

Figure 1, 2, and 3 all show cross-lagged figures for partial correlation results between the three measures. First, the relationship between expressive vocabulary and final consonant choice were looked at, then the relationship between expressive vocabulary and word reading were looked at, and lastly the relationship between final consonant choice and word reading were looked at. Note that bolded arrows and numbers show relationships that are statistically significant. Dashed arrows and non-bolded numbers are relationships that are not statistically significant.

Figure 1. Cross-lagged figures for results of partial correlations, looking at relationships between expressive vocabulary and final consonant choice in second, fourth, sixth, and eighth grade.

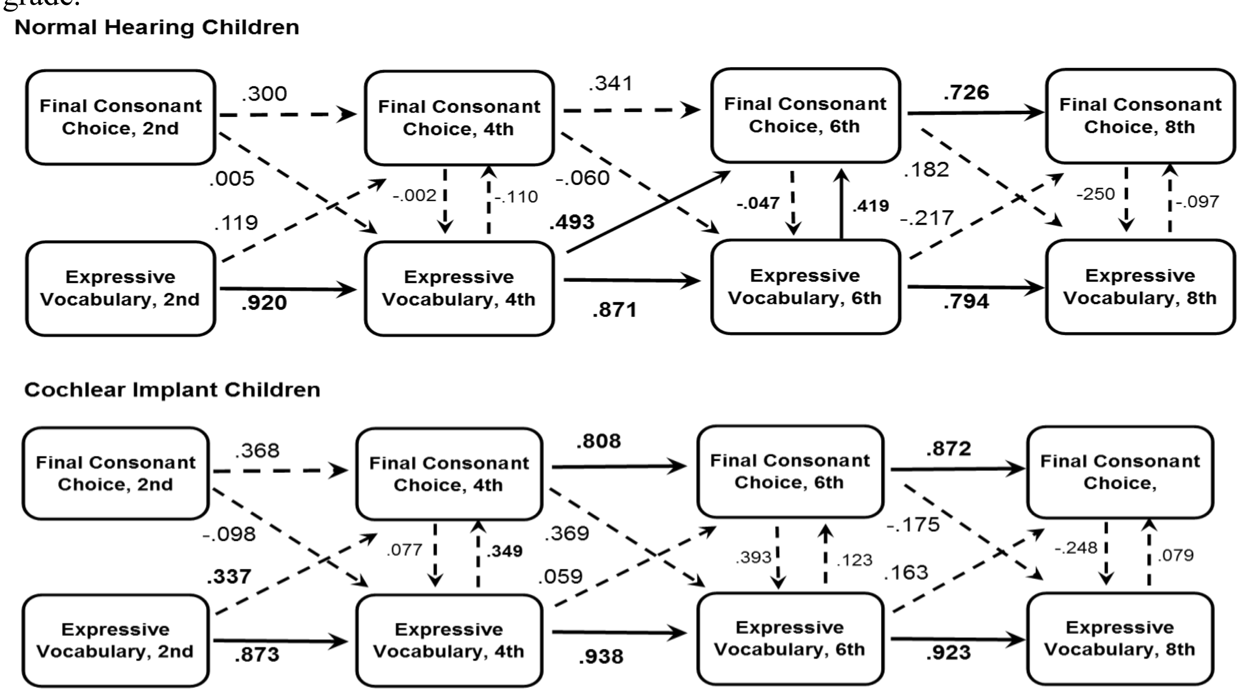


Figure 2. Cross-lagged figures for results of partial correlations, looking at relationships between final consonant choice and word reading skills in second, fourth, sixth, and eighth grade.

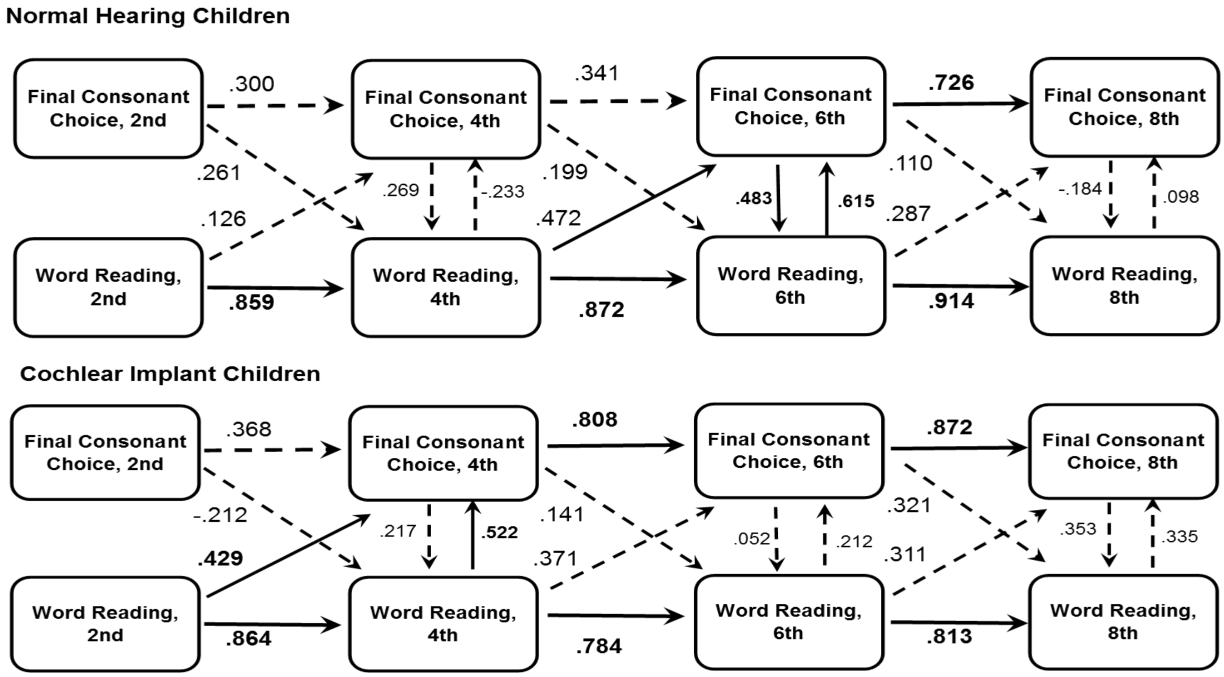
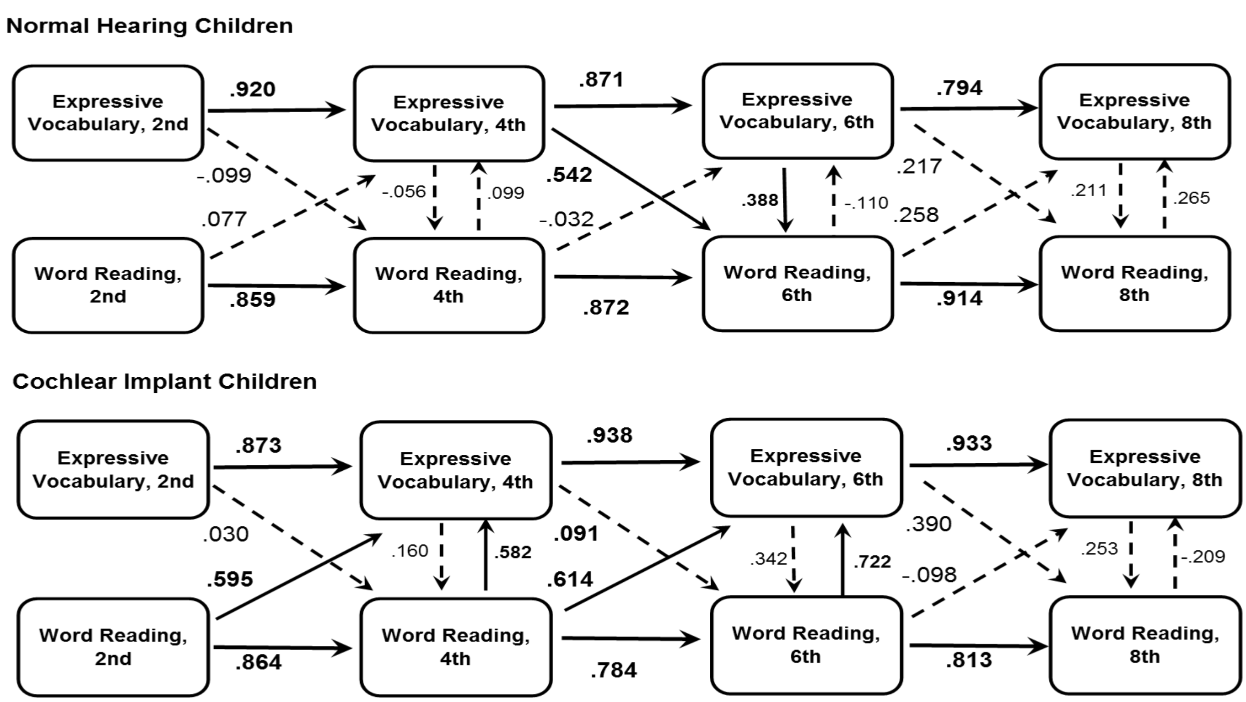


Figure 3. Cross-lagged figures for results of partial correlations, looking at relationships between expressive vocabulary and word reading skills in second, fourth, sixth, and eighth grade.



Partial correlations were also computed for looking at the relationship between these measures from second grade directly to eighth grade. Figure 4, 5, and 6 show the results for these partial correlations with each of the measures.

Figure 4. Cross-lagged figures for results of partial correlations, looking at relationships between expressive vocabulary and final consonant choice from second to eighth grade.

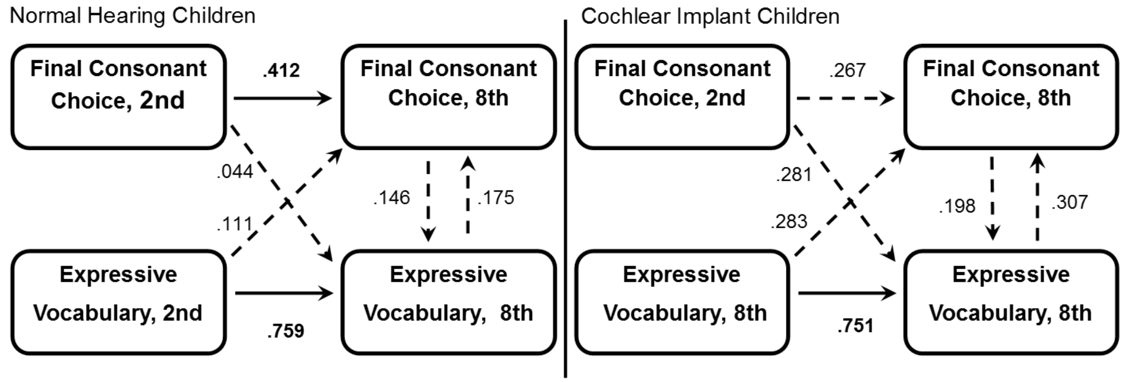


Figure 5. Cross-lagged figures for results of partial correlations, looking at relationships between final consonant choice and word reading skills from second to eighth grade.

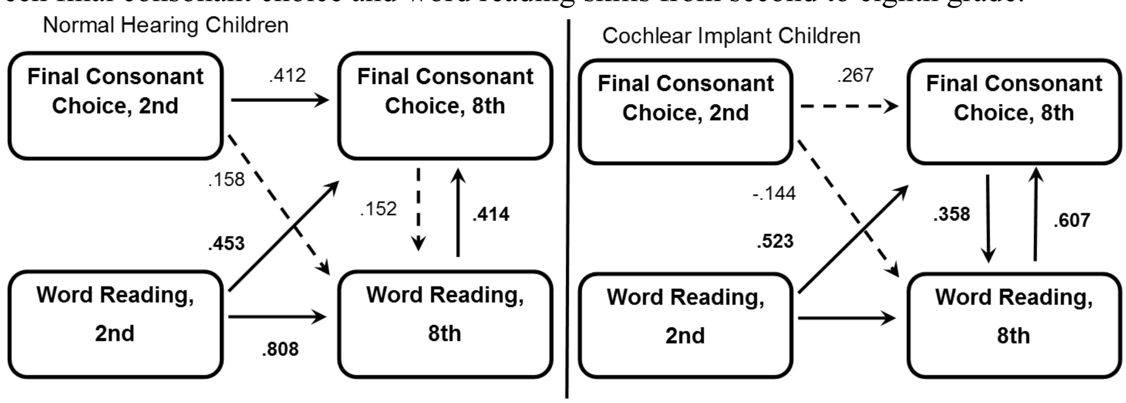
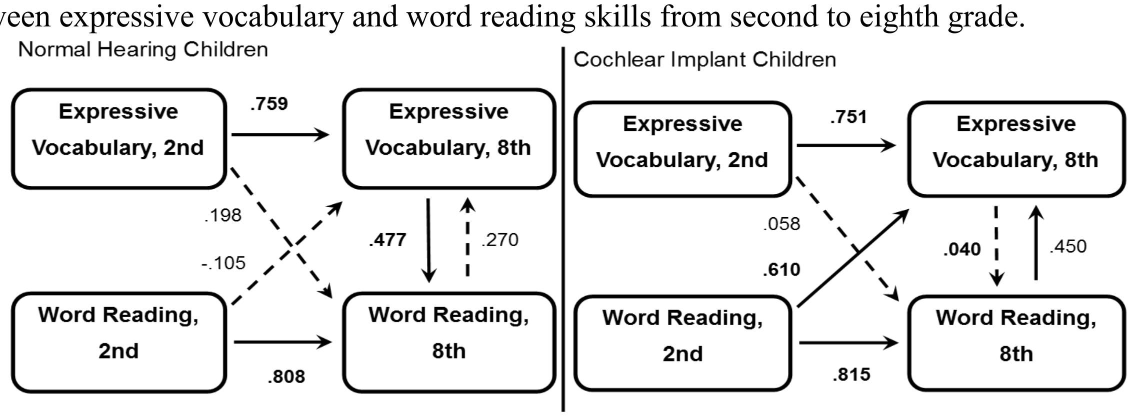


Figure 6. Cross-lagged figures for results of partial correlations, looking at relationships between expressive vocabulary and word reading skills from second to eighth grade.



Discussion and Conclusions

The focus of the present study was to assess if the relationship between vocabulary and phonological acquisition differs for children with CIs when compared to their same-aged, NH peers. Data collected from a longitudinal study of children with hearing loss were used. Using sources found through outside research, the hypothesis was formulated that phonological skills would most strongly influence vocabulary development for children with CIs. By calculating partial correlations, it was shown that the effects from one grade to the next are not as strong as suspected for the relationship between phonological skills and vocabulary knowledge. Instead, a somewhat unexpected finding was that early literacy is important to both the development of vocabulary and phonological sensitivity for children with CIs. This suggests that literacy instruction is very important for CI children.

No evidence was found to support the notion of lexical restructuring for these children, either NH or CIs. It could be that data collection for this study started too late for the NH children because they already had some reasonable sensitivity to phonological structure in second grade, but that is not believed to be the case for children with CIs. Literacy is what seems to have bolstered the development of phonological awareness for these children. On the basis of our analysis, it is appropriate to conclude that word reading supports the emergence of expressive vocabulary and phonemic awareness for children with CIs.

Two major findings can be concluded from this study. First, the model of lexical restructuring does not fit language learning for children with profound hearing loss or cochlear implants. Secondly, children with CIs need some type of crutch or support to learn vocabulary and phonological awareness, and that crutch seems to be literacy instruction. Literacy instruction is absolutely critical for children with CIs, as it promotes rather than follows the development of other language skills. With appropriate testing, treatments, and intervention, early literacy activities can significantly impact language acquisition for these children with CIs. Clinical implications can be made on the findings of this study. It is essential that appropriate diagnostic and intervention methods are developed to help these children so they can flourish in modern society.

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