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Reading comprehension and oral reading fluency of deaf children with cochlear implants

Kasie Gueringer

READING COMPREHENSION AND ORAL READING FLUENCY OF DEAF CHILDREN WITH COCHLEAR IMPLANTS

by

Kasie Gueringer

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Approved by:
Heather Hayes, PhD, Independent Study Advisor

Abstract

This study investigates whether deaf children with cochlear implants have oral reading fluency scores comparable to reading-age matched hearing peers. It also examines the reading comprehension skills of deaf children with cochlear implants.

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Abbreviations

1. Cochlear Implant (CI)
2. Oral Reading Fluency (ORF)
3. Hearing Aid (HA)
4. Curriculum Based Measurement (CBM)
5. Iowa Test of Basic Skills (ITBS)

Background

Traditional models of reading propose that good readers have mastered two important skills: decoding and comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). Children with deficits in word recognition, or decoding, do not struggle with language comprehension. Thus, these children are able to comprehend the text once they receive word-reading interventions (Catts, Adlof, & Weismer, 2006). However, some children who have mastered decoding skills still struggle with reading. *Poor comprehenders* are children who experience difficulties in reading comprehension but have normal abilities in word recognition and phonological processing. It is estimated that approximately 5-10% of school age children fall into this category (Nation & Snowling, 1998). Initially, poor comprehenders go undetected because reading comprehension in the early years is heavily dependent upon word recognition skills. Poor comprehenders struggle to understand the text, even when they have decoded it accurately (Bishop & Adams, 1990). They have difficulty with story comprehension, and inferential questions. Many researchers have attributed these difficulties to deficits in the language domains of semantics and syntax. There is much research investigating poor comprehenders among hearing children, but this topic has yet to be investigated in the special population of deaf children with cochlear implants.

Children who are deaf struggle to master reading skills: The average deaf child graduates from high school reading at a fourth-grade level (Traxler, 2000). Traditionally, deaf children have struggled with the reading skills of decoding and comprehension. However, children who wear advanced cochlear implant (CI) technology presumably have access to spoken language and are able to hear the distinct differences among phonemes better than their deaf peers without CIs (Spencer & Tomblin, 2008). This is an essential component for developing the alphabetic principle, which is necessary for learning how to decode words. Some studies have shown that deaf children with CIs are able to achieve reading levels within the lower end of the average range when compared to hearing peers (Geers, 2003; Geers & Hayes, 2010; Spencer, Barker, & Tomblin, 2003). The advent of cochlear implant technology has allowed these children to make strides in developing reading skills, but a gap in performance still exists.

It has been suggested that deaf children are not at risk for reading failure according to their scores on measures of oral reading fluency (B. Lanfer, personal communication, February 2011). Oral reading fluency (ORF) measures accuracy and fluency while reading text aloud (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Hasbrouck & Tindal, 2006). ORF is measured by asking students to read a passage aloud for one minute, and the number of words read correctly from the passage per minute (WCPM) is the oral reading fluency rate. There is no known research on the oral reading fluency rates of deaf children with cochlear implants. Therefore, it is essential to determine whether deaf children with cochlear implants are good decoders by comparing their oral reading fluency scores to reading-age matched hearing peers.

It is important to remember that good decoding skills alone are not enough to help these children master reading, particularly once the child reaches elementary school, when the text becomes more complex in terms of language structures. Geers (2003) found that overall language competence is most strongly associated with reading outcomes for children who are deaf or hard of hearing. She concluded that it is important to first create a language base to which a child can apply the decoding skills used when learning to read. Phonological processing strategies are bootstrapped onto a child’s vocabulary and word knowledge. However, many children who are deaf or hard of hearing lack the sufficient language skills necessary to comprehend the printed words they read.

Experienced teachers of the deaf have anecdotally reported that deaf children are "word callers" –able to decode words fluently but without comprehension of what they read (B. Lanfer, personal communication, February 2011). This anecdotal report led me to ask the question: Are deaf children with cochlear implants similar to the hearing population of poor comprehenders? In hearing children, there exists a strong relationship between ORF and comprehension for students in the elementary grades (Fuchs et al., 2001; Kuhn & Stahl, 2000). According to the National Reading Panel (2000), fluent readers are able to read text with "speed, accuracy and proper expression" which allows for comprehension of the text. Hosp and Fuchs (2005) found a consistent relationship between reading comprehension and ORF across grades one through four. Even in the later years of elementary, ORF scores have been shown to predict student success on state-mandated reading assessments (McGlinchey & Hixson, 2004; Stage & Jacobsen, 2001). This research study looks at the ORF scores of deaf children as a window into their comprehension skills. Because ORF has yet to be investigated in children with cochlear implants, we must look to the literature on hearing children in order to further explore this relationship.

Vocabulary, phonological awareness, letter-naming fluency, oral reading fluency, and nonsense word reading fluency are early literacy skills that have been shown to predict overall reading performance. However, research confirms that ORF provides the most information about a student's comprehension skills. Kim, Petscher, Schatschneider and Foorman (2010) examined the relationship between emergent and conventional literacy skills and reading comprehension skills. They studied the growth rate of oral reading fluency, vocabulary, phonological awareness, letter-naming fluency and nonsense word fluency from first grade to third grade using the Dynamic Indicators of Basic Early Literacy Skills (DIBELS). They compared these skills with measures of reading comprehension in each of the grades. Their results revealed that ORF, either initial status or growth rate, provided the most information about reading comprehension achievement across all grade levels. These results support the belief that ORF is a higher-level skill that incorporates lower-level skills. It is also interesting to note that the participants in their study had ORF scores in each grade that were well above the DIBELS benchmarks.

Jenkins, Fuchs, Broek, Espin and Deno (2003) further investigated the relationship between oral reading fluency and reading comprehension by looking at performance in context and context-free conditions. When words are presented in context, it is assumed that the reader uses contextual factors as additional information to help decode the words and make sense of the text. When words are presented in a context-free condition, readers must rely on simple word recognition skills or decoding skills (Stanovich, 1980). They measured the context and context-free reading performance of 113 fourth-grade students, expecting that students would have higher rates of ORF in context conditions than in context-free conditions. The researchers randomly selected the students to match a normal distribution based on reading performance. The students read a folktale aloud for one minute and the number of words read correctly and incorrectly was counted. Errors were omissions, insertions, mispronunciations, substitutions, and hesitations of more than three seconds. Self-corrections were not errors. The folktale was configured to approximate a third-grade reading level. The folktale was formatted in three ways: original or *context* format, in a randomized *list* format, and a randomized list arranged in a *paragraph* format without punctuation. For the *list* format, the authors randomly re-ordered the words and organized them in a list. The *paragraph* format included the same number of paragraphs and words per paragraph as the original passage. They also administered the reading comprehension subtest of the Iowa Test of Basic Skills (ITBS). This subtest requires the student to read short passages and answer multiple-choice questions. The authors confirmed that words read in context are read faster than the same words in the context-free formats. The correlations with the ITBS were .83 for context reading fluency and .54 for list fluency. The correlations demonstrate that context fluency is more strongly associated with comprehension than list fluency. The authors suggest that teachers can use oral reading fluency rates as an accurate assessment of overall reading competence.

PURPOSE

Oral Reading Fluency appears to be an appropriate and useful measure of reading comprehension for hearing children. However, there is no research concerning the ORF scores of deaf children. Furthermore, this measure may not be appropriate for deaf children with CIs who may be good decoders but poor comprehenders. Therefore, there were two goals in the present study. First, I investigated whether deaf children with cochlear implants are able to read aloud fluently at a level that is comparable to hearing peers. Deaf students' ORF scores on traditional measures of oral reading fluency were compared to reading-age matched hearing peers. Second, I examined whether children with cochlear implants are reading fluently without comprehension, as suspected by experienced teachers. In order to answer the second question, I based my study on the design used in Jenkins et al (2003). If the participants understand what they are reading to some degree, then they should be faster in the context format than in the list or paragraph formats. If the participants are simply decoding words without comprehension, then they should be equally fluent in all three conditions. This conclusion would suggest that ORF is not a true measure of reading comprehension for all deaf children with cochlear implants.

METHOD

Participants

Eight students met the following criteria for the study: a cochlear implant user, and identified as reading at the first grade reading level by their school director. Because research has found that students' oral reading fluency scores in the first grade are indicative of further struggles with word decoding skills and thus comprehension skills (Kim et al., 2010), I chose to limit my participant sample to this reading level. There were four female and four male participants. The children were native English speakers with no additional diagnosed disabilities as reported by the directors of the schools that the children attended. Students were recruited from two private schools in St. Louis, Missouri where deaf children are taught how to listen and talk. Table 1 shows the individual characteristics of the participants. At the time of the study, the children had been enrolled in an oral school for the deaf for an average of 4.85 years (range 3.17 to 6.92 years). The mean age of the children at the time of testing was 7.46 (range 5.75 to 10 years). The mean age at implant was 2.70 (range 1.08 – 5 years of age). One of the children was adopted and therefore it was unknown if the biological parents have a hearing loss. None of the other children's biological parents were reported to have a hearing loss. Four participants wore bilateral cochlear implants, two participants wore a cochlear implant in one ear and a hearing aid in the opposite ear, and two participants wore only one cochlear implant.

Table 1

Characteristics of Participants

	Age at Test (years)	Age at CI (years)	CI experience (years)	Years in Oral School	Devices
1	6.83	1.08	5.75	6.66	Bilateral CIs
2	6.67	2.75	3.92	3.17	Bilateral CIs
3	6.25	1.08	5.17	6.00	Right: CI Left: none
4	9.00	5.00	4.00	6.92	Right: CI Left: HA
5	7.58	4.92	2.66	3.5	Right: CI Left: HA
6	10.00	2.50	7.50	5.08	Bilateral CIs
7	5.75	1.42	4.33	3.50	Bilateral CIs
8	7.58	2.83	4.75	4.00	Right: CI Left: none

Note: CI= cochlear implant, HA = hearing aid.

Materials

The measure of oral reading fluency was based on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) (Farrell, Hancock, & Smartt, 2006; Good & Kaminski, 2003) ORF subtest. I chose this material because the DIBELS is a widely used assessment tool that identifies students who are at risk for reading failure. This tool has been used in the past with students who are deaf or hard of hearing at an oral school (B. Lanfer, personal communication, February 2011). Students read aloud for one minute from a 212-word first grade passage. The number of words read correctly from the passage was considered the oral reading fluency rate. Following the method used in Jenkins et al. (2003), I formatted the passage in three ways: original or *context* format, in a randomized *list* format, and a randomized list arranged in a *paragraph* format without punctuation (see Appendixes A, B, and C).

Procedures

To administer the assessment, I used the following directions “*Please read this* (point) *out loud. If you get stuck, I will tell you the word so you can keep reading. Do your best reading. Start here* (Test administer pointed to the first word of the passage). *Begin*.” Each student read each format for one minute; the order in which the students read the formats was counterbalanced. Students worked on a puzzle for approximately one minute between each format as a filler task. Errors were analyzed as omissions, mispronunciations, substitutions, and hesitations of more than three seconds. Self-corrections and insertions were not considered errors.

RESULTS

Figure 1 plots the individual oral reading fluency scores of the deaf children in the context condition. According to the DIBELS, any student in first grade who scores below the established benchmark of 40 words read correctly per minute at the end of the year is at-risk for reading failure. Fifty-percent of the deaf participants with cochlear implants were not considered at risk for reading failure according to their oral reading fluency scores.

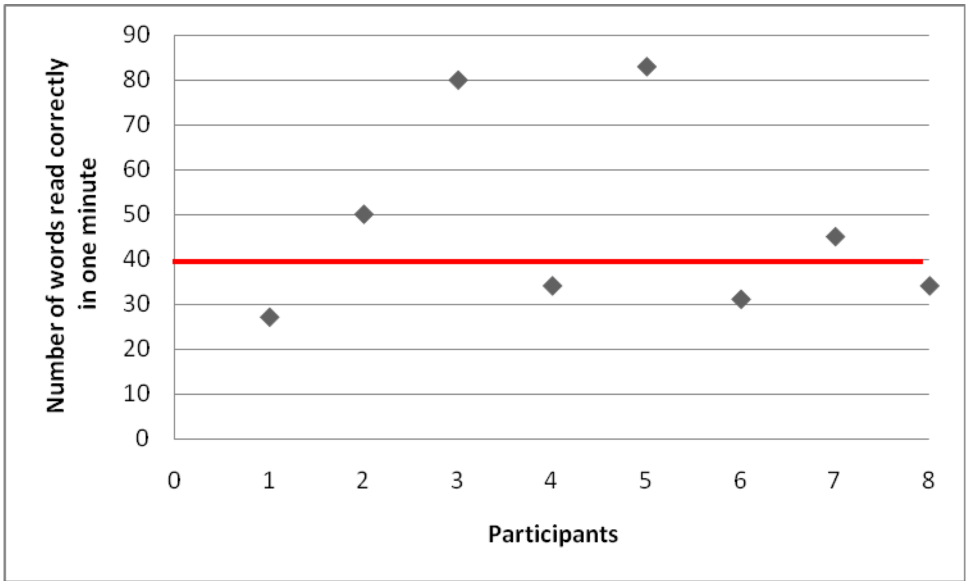

Figure 1. Oral reading fluency scores in the context condition for deaf children with cochlear implants. The red line represents normal oral reading fluency rate for hearing children of the same reading age.

Table 2 shows the individual data from each condition and the mean performance in each condition. On average, participants read the most words correctly per minute in the context condition, followed by the list condition. Participants read the least number of words correctly per minute in the paragraph condition.

Table 2

Individual and mean Oral Reading Fluency scores for each of the three conditions

Participants	**Context Condition**	**List Condition**	**Paragraph Condition**
1	27	41	39
2	50	49	30
3	80	65	51
4	34	26	25
5	83	59	63
6	31	32	22
7	45	47	23
8	34	22	33
Average Performance	48	43	36

Note: Scores indicate number of words read correctly per minute in each of the three conditions.

DISCUSSION

The first goal of the present study was to determine if deaf children with cochlear implants are able to read fluently at a level that is comparable to hearing peers. Mean performance in the context condition shows that, on average, deaf children with cochlear implants have ORF scores comparable to reading-age matched peers. Seventy-five percent of the participants in this study were of first-grade age and reading at grade level. Therefore, this study can be thought of as a “best-case scenario” in which half of the deaf children with cochlear implants were not at risk for reading failure. This result is contrary to the aforementioned research concerning the reading skills of deaf children (Traxler, 2000). In another study investigating the reading performance of 12,536 hearing students, mean ORF scores were well above the established DIBELS benchmarks in first-grade (56 words read correctly per minute) (Kim et al., 2010). When comparing the participants’ scores to these children, the deaf children with cochlear implants are behind their hearing peers. To my knowledge, this study is the first to document the oral reading fluency rate of deaf children with cochlear implants. Further research needs to be completed with a larger population of deaf children with cochlear implants.

The second goal of this study was to determine if deaf children with cochlear implants are decoding fluently with comprehension of the material. Consistent with the findings of Jenkins and colleagues (2003), words read in context should be read faster than the same words in the list condition. To my knowledge, this 2003 study is the only known investigation of this pattern of performance in hearing children. Although Jenkins and colleagues looked at hearing fourth-grade students, it is still reasonable to contrast their data with those of the deaf children in the current study. Mean performance indicates that, on average, deaf children with cochlear implants are reading more words successfully in one minute in the context condition versus list condition. Furthermore, students in the current study read the least number of words correctly in the paragraph condition. As stated previously, if the participants understand what they are reading, they should be faster in the context condition than either of the context-free conditions. Consequently, on average students are comprehending the material.

Because I could not reliably perform statistical comparisons on such a small group, it cannot be determined whether the difference among conditions is statistically or practically significant. However, comparisons among the groups show that hearing children demonstrate greater inhibitory effects in the context-free conditions than in the context condition. Hearing children read 35% fewer words in the list condition than the context condition. Deaf children only read 11% fewer words in the list condition. When comparing the context condition and the paragraph condition, hearing children read 40% fewer words while the deaf children read 26% fewer words. My limited population makes it hard to draw strong conclusions, but it appears as if the ORF rate of hearing children is more greatly affected by the format of the passage than in deaf children who wear cochlear implants.

One limitation to the current study was that I was unable to collect data on reading comprehension skills of the students. Another limitation to my study was the degree of overlap between context and context-free tasks. In other words, did the differences between scores on each condition differ because of the types of words read? Because the participants only read the passages for one minute, the degree of word overlap was minimal. To examine overlap, I compared the first 100 words in each of the three conditions. Overlap between the first 100 words in the list and context was 55% and between context and list was 63%. Future studies should control for frequency and length of words read between all conditions to ensure that differences in performance are not due to differences in word characteristics.

Despite these limitations, the results of this study have important practical implications. Oral reading fluency is an important component of curriculum based measurement (CBM). CBM is a widely-used tool to quickly and effectively gather performance information to facilitate decisions concerning educational placements and determine present levels and goals for Individualized Educational Plans (IEPs) (Deno, 1985, 2003). The DIBELS were developed based on measurement procedures for Curriculum-Based Measurement (CBM). One of the primary functions of the DIBELS is to identify children *as early as possible* who are not likely to read at grade level by the end of the third grade (Farrell et al., 2006). In theory, ORF scores are quick and accurate measures that provide teachers with valuable information about students' overall reading performance. Administering an ORF "test" takes only one minute, can be administered by teachers as a part of the classroom routine, and appears to be a reliable predictor of reading comprehension skills. Thus, it is not surprising that ORF assessments like the DIBELS are very attractive to teachers. However, it is important to know whether the DIBELS is accurately identifying students who are at-risk for reading failure. When looking at the individual participants' performance in the current study, five deaf children did not demonstrate the same pattern of performance as hearing students. These students did not accurately decode words faster in the context condition than in the context-free conditions. In other words, these students appear to be simply decoding words without comprehension. According to the DIBELS benchmark scores for ORF, only three of these five participants would be considered "at-risk" for reading failure and thus receive appropriate interventions. This is noteworthy because the DIBELS is likely failing to identify all deaf students who are in need of appropriate interventions.

Therefore, teachers of deaf children who wear cochlear implants should be careful of the conclusions they draw from the DIBELS. It is not the same conclusion one can draw from most hearing children, in that ORF is a reasonable predictor of reading comprehension. For deaf children, measures of ORF should be paired with traditional measures of reading comprehension. If teachers are using the DIBELS to identify children who are at risk for reading failure, they should pair the ORF measure with the retell fluency (RTF) measure. The RTF assessment was developed to provide a check of the student's comprehension in the ORF assessment.

Overall, the current study contributes to the literature on the reading performance of deaf children with cochlear implants. We now know that deaf children with cochlear implants are able to achieve reading-age-appropriate benchmark oral reading fluency scores, although oral reading fluency may not be a reliable predictor of reading comprehension.

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Appendix A

Context Condition

It has been so cold This winter. The wind blew and blew. It rained and rained. The days have been gray and dark. I had to wear mittens and a hat to school every day. It even snowed twice.

At first winter was fun. Now I'm tired of the cold. It has been too cold and wet to play outside. At school, we sit in the library and read during recess. After school I just stay in the house and play. I don't want to play inside anymore.

But today was nice. The sun was shining brightly even though it was still cold. The wind didn't blow. My friends and I played kick ball at recess. We had to take off our jackets because we were warm. We even got hot and thirsty.

On the way home from school I saw a purple flower on our street. It was blooming in the grass. I told my mother about it. She wanted me to show it to her. She bent down and touched it.

"Come sniff this," she said. It smelled like perfume and sun mixed together. "Spring must be right around the corner," she said. "This is a crocus. It's one of the first flowers of spring."

I can't wait for spring.

Appendix B

List Condition

to	sun	she	shining
tired	anymore	rained	wind
and	inside	show	every
we	and	school	mixed
has	hot	is	street
stay	school	was	cold
cold	from	the	and
library	first	the	wind
crocus	dark	wait	of
in	a	together	blew
my	was	thirsty	about
come	and	this	it
been	for	corner	take
we	I	and	i
home	play	and	snowed
got	must	outside	I
a	she	have	my
recess	it	blow	can't
our	off	spring	today
it	of	down	after
to	had	to	me
play	our	I'm	the
it	i	jackets	flowers
right	it	spring	school
the	because	she	want
at	and	warm	on
gray	twice	didn't	all
i	said	even	on
and	way	mother	to
saw	fun	to	play
wear	in	sniff	said
of	so	days	wet
to	purple	the	just
played	It	bent	sit
this	a	the	it
but	it's	though	sun

we	perfume	the	friends
kick ball	to	nice	been
rained	in	and	winter
even	she	and	brightly
was	first	during	one
flower	wanted	cold	were
it	the	it	be
and	don't	blooming	the
been	around	i	too
her	school	like	has
day	house	still	smelled
mittens	told	cold	now
touched	blew	it	read
was	grass	we	at
I	was	hat	at
the	winter	even	had
spring	the	this	recess

Appendix C

Paragraph Condition

Gray a to around wait flowers be too and winter said twice my her library this today has the had the of and though in for blew school the cold the day to touched it it down together just

Purple didn't right corner the off sun cold first she saw hot it told said a she the every blooming school at rained stay been we even we sit can't in don't warm rained play my but been and now outside I this is and I to all to

Were after spring shining must street come wind we sniff school to because we wear and first flower and school fun was play have kick ball I wanted still it was tired it house has I about our she nice crocus even in it's of

To the mittens mother played the wind one want like grass at I spring way inside I recess blow brightly during days spring it recess jackets had play cold and she and dark from to mixed so I'm wet read

Anymore me smelled even cold it the home was a bent I of it it sun it the and blew snowed take hat this perfume winter been the was show was friends on got on

Our and at and thirsty