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Reading by sound, sign, or spelling

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Abstract

The purpose of this study was to determine if deaf college students used a primary recoding strategy during reading. Subjects were divided into two groups of 15. The first group scored 5-7.5 on the California Reading Test and the other group scored 10.5-12. Their use of recoding strategies was tested through a letter cancellation task and a word recall task. Using the paragraphs from Baker (1984), the subjects were also tested for metacognitive skills during reading. A background survey allowed us to review any unusual cases or to relate findings to background characteristics. Results compared to a hearing control group showed that it is difficult to say that one recoding strategy is used more than another at the post-secondary education level for any group. Recoding strategy is not significantly correlated with reading skill or deafness, but deaf readers who score low on the California Reading Test demonstrate poorer metacognitive reading skill.

Reading by Sound, Sign, or Spelling

Introduction

With an average reading level at only the fourth grade (Marschark, Lang, & Albertini, 2002; Laughton, 1988), deaf high school graduates are not even equipped to read and comprehend most newspapers, which are written for the general public at approximately an eighth grade reading level. This means that the average person who is deaf is "functionally illiterate" upon leaving high school (Marschark, Lang, & Albertini 2002). Unfortunately, even with all the research and changes in educational settings and teaching methods, this has changed little over the years.

Reading, Phonology, and Deaf Issues

It has been shown over and over again by Perfetti & Sandak (2000), Mussleman (2000), and others that phonology, or speech-based recoding, is correlated with better reading skills in students who are hearing. Phonology is the ability to take print, letter by letter, and relate it to its corresponding sound, or the ability to "sound out" unknown words in order to make sense of them. Mussleman (2000) found phonological recoding throughout the reading process. Students who are hearing are taught to read usually after they have acquired the spoken form of their language, albeit English, Spanish, or any other language with a written form. Generally, these students use their knowledge of phonology from the spoken form to aid in the acquisition and comprehension of the printed form (Perfetti & Sandak, 2000). Hirsh-Pasek & Treiman (1982) found three advantages that the use of phonological recoding may bring to the reader who is hearing. They are word identification, comprehension, and memory. It is important to be able to

identify new or unknown words via "sounding out" (Corcoran Nielsen & Luetke-Stahlman, 2002). Suppose a child is reading a book and comes across an unknown word. If this child has learned to speak, and the word is in their repertoire, then having the ability to "sound out" the word will help the child make sense of the print form.

"Sounding out" words can be a problem for the person who is severely to profoundly deaf. Hanson and Fowler (1987) noted "at least two ways in which a reader who is prelingually, profoundly deaf might acquire information about the phonological forms of words"; through alphabetic orthography or "by learning to speak and/or lip-read the language". Not all people who are deaf acquire the proficiency to speak intelligibly. The reason I used the phrase proficiency to speak instead of the term speech was that, according to Conrad (1979), some researchers believe that people who are deaf can acquire an "internal speech". There seems to be a link between articulation, mouth movements no matter how subtle, and language processing during silent reading. Thus, articulation is another way in which deaf people may acquire and/or use phonology. This system is based on mouth movements and may or may not need to include voicing, depending on the research one reads (Mussleman, 2000). It is also noted by Hirsh-Pasek & Treiman (1982) that articulation, use of internal speech, is correlated with less hearing loss and better speech intelligibility.

Phonological recoding may be a useful tool in recoding and even play a critical role in reading. However, it may not be completely sufficient by itself. One person may use various strategies independently or interdependently while reading. We know that students who are hearing tend to use a phonology-based system for learning to read.

What do students who are deaf use? Not all students who are deaf learn to speak. Does this mean that they are unable to learn to read well? Perfetti & Sandak (2000) wrote:

> If phonology – the structure of speech sounds in a spoken language – is a fundamental level of language structure onto which reading is scaffolded … then a child who lacks phonology faces an immediate obstacle in learning to read. (p.35)

Other researchers have studied the various possible recoding strategies used by both deaf and hearing. Although people who are hearing generally rely on phonology, Hamilton & Holzman (1989) have demonstrated the use of sign-based recoding among people who are hearing when the person knew both languages. For example, there were two groups of subjects who were hearing. Both groups were from hearing families. The first group had no second language experience while the second group had second language experience with a form of Signed English. The group with some Signed English experience was able to use the recoding strategy that allowed them to be more successful at the task at hand, therefore, performing better than the other group of subjects who were hearing and had no experience with sign. People who are deaf, on the other hand, seem to use more than one strategy more often. Speech-based, sign-based, articulatory, orthographic, and dactylic (fingerspelling) recoding have all been used and it may depend on the task at hand as to which is utilized (Hamilton & Holzman, 1989; Mussleman, 2000). For example, in the ink-color match condition of a Stroop effect task conducted by Parasnis (1993), in which subjects were required to decide if a white-colored word matched the color of another word (not if the words themselves matched), it

would have been beneficial to use a recoding strategy other than speech-based making it easier to focus attention on the color rather than the word. There are different types of tests for phonological recoding. One type, such as the Stroop effect, tests whether a phonological system or some other system is used. It does not simply test for or against phonological recoding but shows its use only if a difference in performance arises within subjects (Perfetti & Sandak, 2000). On a version of the Stroop task by Leybaert and Alegria (1993), phonological information was only used when required. Parasnis (1993) showed use of phonological recoding by college students who were deaf and interpreters who were hearing, but the subjects who were deaf were better at suppressing lexical information when it benefited them to do so. In other words, they were able to ignore the word, or print, and focus their attention on the color of the print.

Other Factors Important for Reading

Much research has focused on other issues of students who are deaf face when learning to read English. Toscano, McKee, and Lepoutre (1999) have shown that reading ability in college students who are better readers and deaf is correlated with a multitude of factors such as parental involvement, early exposure, and communication. Marshark, Lang, & Albertini (2002) have also stated that parent-child communication is a major factor in child language development which is important for supporting learning to read.

Metacognition. While processing reading, people use different strategies. One strategy that helps people become successful readers is metacognition (Strassman, 1997). Metacognition is thinking about the cognitive task one is performing. While a person reads, they think about what they are reading, the information being processed

from the print. Does it make sense? If not, what is wrong? Do I understand what I am reading? Have I read something about this topic previously? These and more are all things that help us to think about what we are reading and monitor our level of knowledge or comprehension (Strassman, 1997). One problem for readers who are deaf, according to Strassman (1997), is that they have difficulty judging their own level of understanding. A middle school student who is deaf may be reading a book about a topic they had never seen before. When asked by the teacher if they need help they respond no. But later, when asked a direct question about what a certain word or phrase is referring to the student replies by saying they do not know and possibly with a confused look on his/her face.

Recoding Strategies in People Who are Deaf

Sign-based. Sign-based recoding in the deaf has been seen with tasks such as word-list recall. Lichtenstein (1998) and Hamilton & Holzman (1989) used word-recall tasks to test for sign-based recoding in students who are deaf. Words that share parameters of ASL such as movement, handshape, location, and palm orientation are said to be cheremically similar. They have also been called formationally similar by Hanson (1982). CANDY and APPLE share all parameters except for handshape, therefore are cheremically similar. CANDY and ONION are not cheremically similar. Cheremically similar word-lists recalled with less accuracy lead to the conclusion that sign-based recoding was used. If some other code was used, there would have been fewer errors in recalling cheremically similar lists. Word lists can also be modified to test for dactylic (fingerspelling), orthographic, and phonological recoding.

Print-based. Another way the deaf may recode print is orthographically. A variety of studies have been done to test whether a person who is deaf will recode orthographically or phonetically. Orthography deals with spelling in which words contain similar strings of letters such as 'ea' in bear, hear, and tear. As previously mentioned, word-list recall is only one way to do this. Hanson & McGarr (1989) and Parasnis (1996) have done rhyme generation tasks with college students who are deaf and found evidence of both orthographic and phonologic recoding. Deaf subjects in both studies generated more rhymes that were orthographically similar than not.

Speech-based. Now let us consider phonological recoding more in depth. When considering phonological recoding and sign recoding it may be helpful to think about how our brains function. Auditory memory works more sequentially whereas our visual memory is more capable of working simultaneously (Mussleman, 2000). Lichtenstein (1998) found that phonology was correlated with working memory capacity while reading. The use of phonology increases working memory. However, many researchers are finding that a flexible recoding system may work better for reading comprehension than access to only one (Mussleman, 2000). Although phonological recoding has been reported among readers who are hearing and better readers who are deaf, the more options a person has while reading, the more effective they may be at dealing with the task at hand.

Research Questions

Hirsh-Pasek & Treiman (1982) claim that the recoding system(s) used by an individual may change over time. Young children may start with one strategy and with

age and experience may add various techniques or simply switch. The purpose of this study is to assess which recoding strategies used while reading are most associated with better post-secondary readers who are deaf. The research questions asked here are: Do students who are deaf show evidence of speech-based, sign-based or print-based recoding? Do post-secondary students who are deaf use one, or more than one at any given time when they are beyond the stage of learning to read, at the post-secondary level? Is there any association between type(s) of recoding and certain demographic characteristics of post-secondary students? Since the main reason for using recoding strategies is to succeed in reading, this study will examine the association between reading scores and speech-based, sign-based, and print-based recoding. Upon discovering which recoding strategies better readers use and their background, future researchers may use these findings to look at early intervention programs and teaching techniques to see if they may be improved within a specific dynamic or more generally.

Method

Subjects

Thirty students who are deaf, enrolled in a post-secondary school for the deaf/hard-of-hearing, receiving support services, who had taken the California Reading Test upon entering the school, and who scored in the upper and lower percentage on that test were invited to participate in the study. The first thirty to respond were selected and categorized into two groups without subject knowledge. Fifteen subjects, 11 male and 4 female, obtained California Reading Test scores within the top 20 percent of scores for

all students at the school (hereinafter referred to as HiDeaf) and the other 15 subjects, 9 male and 6 female, received test scores within the lowest 20 percent (LoDeaf).

A control group of ten hearing subjects were selected at random on a volunteer basis from the same post-secondary school, five male and five female. They were required to be undergraduate students working toward their bachelor degree, and have English as their first language. All subjects, both deaf and hearing, were between the ages of 18-26.

Procedure

The first test in the battery was the letter cancellation task. Subjects were presented with a copy of the introduction to James Watson's (1968) book, *The Double Helix*, replicating Gibbs (1989), and a pencil. The passage was presented in Times New Roman font at 12 point. The directions were on a separate page covering the passage until the time was started. They were read by the subject and then explained by the investigator using simultaneous communication (SimCom). The instructions were to cross out all the letter e's in the passage as quickly as possible, not to go back to a previous section. They were informed that the test was timed, and when they were done they were to put down their pencil and look up. The investigator used a stopwatch to time each subject.

Next was the series of word-recall tasks. The task consisted of the four lists shown in Table 1. The words in the control list did not rhyme, were not similar according to the parameters of sign, and were not orthographically similar. The length of

the words is from two to five letters. The phonologically similar list rhymed, used words that were two to four letters in length, had various spelling patterns, and did not share sign parameters. The orthographically similar list was confusable on the basis of spelling pattern. Each word contains four letters and a medial vowel string of 'ea'. The words were selected so that although they had similar spelling, none rhymed exactly. The cheremically similar words all shared handshape and location. Palm orientation varied somewhat, as did movement. All lists contained only single syllable words. The control and phonetically similar lists were taken from Lichtenstein (1998) with one word modified in the phonetically similar list to control for word length. The orthographically and cheremically similar lists were adapted from Hanson (1990). The orthographically similar list was modified to control for word length as well. The cheremically similar list was altered to make sure all words had similar handshape with as little variation as possible.

Table 1

Word Recall Lists

Control	**Phonologically Similar**	**Orthographically Similar**	**Cheremically Similar**
BOX	TRUE	BEAR	NAME
MOST	WHO	HEAR	EGG
WHY	DO	MEAT	WEIGHT
TO	NEW	BEAD	SALT
CUTE	YOU	TEAM	TRAIN
SEE	ZOO	MEAL	CHAIR
BREAD	SHOE	HEAD	BUILD
SHIRT	TWO	LEAN	SHORT

Subjects were given a response-sheet packet and pencil. The sheets were stapled sequentially so that, while working on one list, subjects were unable to refer to another. They were instructed that they would see a list of words, one at a time on a computer

monitor, as a PowerPoint Presentation. They were to watch the list of words and, when the star appeared, begin writing the words as best as they could remember them in order. There were four practice runs, one from each type of list. All subjects received the same practice lists in the same order. Procedure for this task was modified from Hamilton & Holzman (1989). The current study added an orthographically similar list. Six test lists of five items per list were created from each type of list. The five words in each list were randomly selected without replacement from the pool of eight in that list. To ensure that words did not appear in the same position twice across lists of a given type and that all words appeared three or four times among the six lists, a modified Latin square was used. Five different presentation orders of the 24 test lists were developed such that one type of list occurred no more than two consecutive times. Three subjects from each of the two deaf groups, and two subjects from the hearing group were assigned to each presentation order.

Finally, the subjects were given a written questionnaire. For the subjects who were deaf, some questions and format were borrowed from Toscano, McKee, & Lepoutre, (1999) and the L/CBQ (1998) used at the National Technical Institute for the Deaf. The main focus of the questions was how the subjects judged their own expressive/receptive communication skills of speech and sign, their communication with others including family, their use of assistive listening devices, their educational background, and their reading habits, attitudes, and strategies. The subjects who were hearing received a survey that asked about their GPA, major, second language background, sign and deafness background, and reading.

Scoring

The letter cancellation task was scored based on the number of misses for silent e's and sounded e's. For example, "e" is silent in the word "mine" and sounded in the word "fear"; "college" has one sounded "e" followed by a silent "e". The percentage of silent versus sounded e's that were missed was compared to determine if a phonological recoding strategy could be observed. Although subjects were timed, this element was not factored into our final analysis.

The word-recall task was scored in two ways. Using strict scoring rules, subjects' responses were counted right only if the correct word appeared in the correct position. Words could be phonetically spelled. Lax scoring was also used, which allowed for phonetically spelled words, or derivations of a word, to appear in any order as long as the word was there. Due to a lack of difference in the results from lax versus strict scoring, only strict scoring will be reported here.

The metacognitive task was scored as follows. If the paragraph had no errors, it was counted correct if the subject circled "ok", regardless of other marks made. Paragraphs with nonsense words were also scored correct if the subject underlined the nonsense word, regardless of other marks. The paragraphs with information that contradicted world knowledge were scored as correct if the subject underlined at least the contradicting word, but no more than the sentence in which it was found. The internally inconsistent paragraphs were scored as correct if the subject underlined at least one word or sentence that contradicted other information. Subjects could also underline as much as

two conflicting sentences. If they underlined more than the two conflicting sentences, it was counted wrong.

Results

Background Characteristics

Both groups of deaf subjects experienced a variety of schooling environments. Slightly more than half of all deaf subjects reported being mainstreamed in elementary school. By high school, 70 percent reported being in a mainstream program. Simultaneous communication, or SimCom, and sign were equally preferred. Only six percent of all deaf subjects use primarily spoken communication.

More HiDeaf subjects started signing before age five as compared with LoDeaf subjects, 73% and 47% respectively. Twice as many LoDeaf reported not using a listening device currently and of those using a listening device only half report using it most of the time.

Reading Habits and Strategies

On a scale of 1 to 5, 5 being excellent, HiDeaf subjects self rated their reading ability at an average of 4.2. This was higher than both hearing and LoDeaf subjects, 3.6 and 3.3 respectively. When asked if they liked to read, HiDeaf subjects were also more likely to report that they like to read. However, LoDeaf subjects reportedly read more often than the other two groups of subjects. As expected, most hearing subjects used a sound system to figure out unknown words, 80 percent. Two said they used a dictionary. All deaf subjects used a variety of strategies to figure out unknown words. Use of a dictionary, fingerspelling, and sound were reported by all deaf subjects; one was not

reported more than another. Only LoDeaf subjects reported using a sign strategy, 7 percent. HiDeaf readers reported using context clues, 10 percent.

Cancel e's Test

It was hypothesized that the HiDeaf readers and the hearing readers would miss more silent e's than sounded e's, providing evidence of a phonological recoding system. LoDeaf readers were expected to miss approximately the same percentage of silent e's and sounded e's. This would mean that one letter stands out no more than another, regardless of whether it is silent or sounded.

Table 2

Mean Performance of Subjects on Letter Cancellation Task (Misses)

Mean

	Silent	**Sounded**	**Total**
Hearing			
Mean	15.4%	15.2%	15.3%
S.D.	10.2	7.4	8.7
HiDeaf Readers			
Mean	13.3%	14.8%	14.1%
S.D.	8.8	11.0	9.8
LoDeaf Readers			
Mean	12.4%	19.0%	15.7%
S.D.	10.0	9.4	10.1
Total			
Mean	13.5%	16.4%	15.0%
S.D.	9.5	9.6	9.6

Results were not as expected. LoDeaf readers missed more sounded e's, M=19.0 percent, than silent e's, M=12.4 percent, but this difference was not statistically significant. The HiDeaf readers and hearing subjects missed approximately the same percentage of each (see table 2) and the differences between error types were not significant. These findings contradict those of Gibbs (1989) who found a

significant difference between the two error types. Gibbs (1989) noted, however, that a relationship between phonological recoding and reading ability was not present.

Word recall Task

As shown in Table 3, overall, LoDeaf readers made more errors than the HiDeaf or hearing. Also, the HiDeaf made more errors than the hearing readers. Overall memory for the control lists was best. There was no significant difference between phonologic, orthographic, and cheremic list types for any group of subjects. However, an analysis of variance did show statistical significance across groups consistent with the findings of poorer memory for the LoDeaf readers overall. $F=58.62$, $p<.0001$. Data analysis also revealed no interaction between the groups and list types. This means that the confusability across lists was relatively the same for all three groups of subjects. With no significant difference among list types, it cannot be concluded that one specific recoding strategy was used more by one group than another. These results are in accordance with Hamilton & Holtzman (1989) who administered a similar recall task and also found that there was "no significant main effect for list type". (p.545) Subjects in Hamilton & Holtzman (1989) were not unlike the subjects in this study. Their subjects were at least 18 years of age and specifically selected for linguistic background and parental hearing status. While subjects in both studies may share similar characteristics, the current study did not distinguish between these specific characteristics for the purpose of the ANOVA.

Table 3

Mean Performance of Subjects on Word Recall Task
(Correct Responses)
max correct = 30

	Control	Phonologic	Orthographic	Cheremic	Total
Hearing					
Mean	26.8	21.4	24.2	24.2	24.2
S.D.	3.5	4.4	5.1	5.1	4.8
HiDeaf Readers					
Mean	23.5	17.7	17.6	19.1	19.5
S.D.	5.5	5.7	6.2	6.0	6.2
LoDeaf Readers					
Mean	15.8	12.5	10.6	12.1	12.7
S.D.	5.7	5.4	5.6	3.6	5.4
Total					
Mean	21.5	16.7	16.6	17.8	
S.D.	6.8	6.3	7.8	6.9	

Baker's Metacognitive Measures

This task was used to determine how aware subjects were of what they were reading. Results are shown in Table 4. There was a significant difference between groups and across conditions, $F=41.66$ $p<.0001$ and $F=8.46$ $p<.0001$, respectively. The LoDeaf readers made more errors than either of the other two groups. The HiDeaf readers were statistically similar to the hearing readers. The internally inconsistent paragraphs were hardest for all groups. Again, there was no interaction. The pattern of error across paragraph type was the same for all groups.

Gibbs (1989) used the same task with prelingually, profoundly deaf high school students. Her results revealed similar results. Her subjects, like the subjects in this study, found paragraphs containing internal inconsistencies to be the most difficult and those with no error to be the easiest. One thing worth noting is that the hearing subjects' mean

error rate on the correct paragraphs is a little higher than would be expected. One speculation may be that they were looking too hard for errors.

Table 4

Mean Performance of Subjects on Metacognitive Task
(Incorrect Responses)
max error = 3

	No Error	Nonsense Word	Internally Inconsistent	Contradicts World Knowledge	Total
Hearing					
Mean	0.3	0.2	0.5	0.4	0.4
S.D.	0.5	0.4	1.0	0.5	0.6
HiDeaf Readers					
Mean	0.4	0.5	1.2	0.8	0.7
S.D.	0.6	0.8	0.8	0.9	0.8
LoDeaf Readers					
Mean	1.1	1.6	2.6	1.9	1.8
S.D.	1.0	1.1	0.8	1.1	1.1
Total					
Mean	0.7	0.9	1.6	1.1	
S.D.	0.8	1.0	1.2	1.1	

Discussion

Confusions in word-list recall suggest that many of the subjects used sign-based, phonology-based, and orthography-based recoding strategies. The investigator also observed articulation and fingerspelling being used during testing. Similar to Chincotta & Chincotta (1996), subjects in this study who are deaf were also seen mouthing while reading. On occasion they were seen fingerspelling words during the word recall task or just the first letter of each word to aid recall. Confusions displayed by the hearing subjects, however, call into question whether or not the words in each list adequately met the criteria for list constructions. There were more errors on the orthographic and cheremic lists than expected and too few errors on phonological lists. The orthographic

lists were too close to rhyming and the phonological list had too many "o"s. The words "to", "two", and "do" are too close and should not have been used together. These lists are hard to construct and were improvements from other previous researchers. Confounds exist in other researchers' work, too.

The letter cancellation task proved not to be useful. Future researchers may want to try using rhyme generation or rhyme judgment instead. Hanson & McGarr (1989) and Parasnis (1996) both did rhyme generation tasks with deaf college students. Hanson & McGarr (1989) focused on phonology. Parasnis (1996) focused on whether or not the rhymes generated were orthographically similar. Hanson & Fowler (1987) used was a rhyme judgment task consisting of orthographically similar word pairs that may or may not be phonetically similar.

This study shows no definitive evidence of one recoding strategy over another by either group of deaf subjects or the hearing subjects. Much research shows that a good reader uses a phonology-based system. That may be true. One must also consider the age of the subjects in this research. Often, subjects in this type of research tend to be young. It could be speculated that a phonology-based system is a primary or key strategy at a young age. However, by the time a person has reached a post-secondary school level they may have learned more strategies and become more apt to use them when necessary. Certain strategies may work better in different situations.

One thing this study did show was that whatever the task, the LoDeaf readers had a pattern of performance comparable to the HiDeaf and hearing readers, but made more errors when compared across groups. If the HiDeaf readers and hearing subjects found

one aspect of a task more difficult than another, the LoDeaf readers would agree, and their performance overall was still poorer. LoDeaf readers seem to have the same strategies as the other two groups, but perhaps use them less effectively. A post-hoc examination of individual performance on the word recall task focused on overall patterns. Some subjects made about the same number of errors on each type of list, some doing well on all, some doing poorly on all. Other subjects made more errors on one type of list than another. There was no other apparent commonality among those subjects showing each of these patterns in he areas of reading ability, type of school, communication preference, and use of a listening device.

Most important, the metacognitive task administered in this study emphasizes the multiplicity of skills that contribute to reading success. Not only were the LoDeaf readers poorer in word recall overall, they failed to recognize errors in context. Their vocabulary knowledge, world knowledge, and ability to relate information from one sentence to another may be affecting their reading performance as much as, or more than, their use of a particular type of coding strategy. HiDeaf performed about the same as the hearing subjects. The tasks selected for this study sampled only two skill areas – recoding and metacognition – but much work remains in other areas relevant to the reading process.

It may be useful for future research to focus on which age students begin to use multiple recoding strategies while reading. Educators, especially at the higher levels, should teach students multiple recoding strategies and teach them to use them effectively. Phonology may be key to learning to read, but does not reliably discriminate good or

poor deaf readers and is not the only strategy available by the time students reach post-secondary education.

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