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# The efficacy of dictionary use while reading for learning new words

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Abstract

This paper describes a study investigating the use of three types of dictionaries by deaf (i.e., with severe to profound hearing loss) high school students while reading to determine the effectiveness of each type for acquiring the meanings of unknown vocabulary in text. The dictionary types used include an online bilingual multimedia English-ASL dictionary (OBMEAD), a paper English-ASL dictionary (PBEAD), and an online monolingual English dictionary (OMED). Results indicate that for immediate recall of target words the OBMEAD was superior to both the PBEAD and the OMED. For later recall, no significant difference appeared between the recall for words learned via use of OBMEAD and PBEAD. Recall for each of these was statistically superior to recall for words learned via OMED.

This paper describes a study investigating the efficacy of dictionary use by deaf (i.e., with severe to profound hearing loss) students during reading text passages that contain unknown words. The importance of vocabulary, deaf and hard of hearing readers'(i.e., with slight to profound hearing loss) vocabulary knowledge, methods of acquiring vocabulary, challenges faced, and the use of dictionaries will serve as background for this study.

## The importance of vocabulary

"Vocabulary is essential for communicating, reading,

thinking, and learning." (Luckner & Cooke, 2010)

Learning vocabulary is an incremental process that begins at birth and continues throughout life. It does not start upon school entrance but is begun in the home. Research (e.g., Anglin, 1993; Biemiller, 2005, 2006; Biemiller & Slonim, 2001) suggests that average hearing children acquire the meaning of about 860 English root words per year (e.g., desk, sleep, cousin), or about 2.4 root words per day, for a total of approximately 6,000 root words by the end of 2nd grade. As education continues the need for vocabulary grows exponentially. Nagy and Anderson (1984) estimated that school texts from grades 3 through 9 contain approximately 88,500 distinct word families. In word families the relationship of words are "semantically transparent." That is, the meaning can be determined by using knowledge of the root word and the context of the text. For example the word family *laugh* would contain the root word *laugh* and its derivatives *laughs*, *laughed*, *laughing*, and *laughter* but not *laughingstock*. Coady (1997) states that the threshold for independent English reading is 5,000 word families. Clearly, acquiring meanings for this many words is a formidable task. This ongoing process of learning word families is necessary in the lifelong quest to master the estimated 450,000–750,000 words that make up the

English language (Stahl, 1999; Tompkins, 2005) in order to ensure the development of reading comprehension and academic success.

General knowledge of spoken words is a strong indicator of reading ability for hearing individuals and this is particularly true for children (Cunningham & Stanovich, 1997; Tabors, Snow, & Dickinson, 2001). Research with hearing individuals indicates that a reader must know 90-95% of the words in a passage to fully comprehend it (Carver, 1994; Chall, Jacobs, & Baldwin, 1990; Na & Nation, 1985, Laufer,1989; Hu & Nation, 2000, Nagy & Scott, 2000). Haynes and Baker (1993) have suggested that the most significant handicap for second language (L2) readers of English is not lack of reading strategies but insufficient English vocabulary. Specifically, one of the most enduring findings in reading research is the extent to which students' vocabulary knowledge relates to reading comprehension (Alderson & Freebody, 1981; Baumann, Kame'enui, & Ash, 2003; Becker, 1977; Whipple, 1925; National Reading Panel , 2000). Cobb and Horst (2001) state that vocabulary is more important than other types of linguistic knowledge, including syntax. The National Reading Panel (2000) concluded that comprehension development cannot be understood without a critical examination of the role played by vocabulary knowledge. Vocabulary knowledge is not only related to reading comprehension but also to content area knowledge (Holmes, Holmes, & Watts, 2012; Nagy & Townsend, 2012).

Investigating young hearing children, Hart and Risley (2003) have referred to a lack of vocabulary as "the early catastrophe" and have provided evidence that lack of vocabulary and English language skills adversely affect a child's English reading ability and overall academic success, sometimes irreversibly (Hart & Risley, 1995). Given that students' success in school and beyond depends in great measure upon their ability to read with comprehension, there is an

urgency to providing instruction that equips students with the skills and strategies necessary for lifelong vocabulary development.

## Deaf and hard of hearing readers' vocabulary knowledge

Ninety-five percent of children who are deaf or hard of hearing are born into families with at least one hearing parent (Mitchell & Karchmer, 2004). Most of these families use speech as the primary mode of communicating with their children who have hearing loss. Specifically, 92.5% of these families use spoken English in the home, 21.9% use spoken Spanish in the home, and only 3.8% of families use ASL in the home (Gallaudet Research Institute, 2008). In school, the majority of students who are deaf or hard of hearing (i.e., 52%) use speech only as their primary mode of communication; 34.9% use sign with speech, and 11.4% use sign only (Gallaudet Research Institute, 2008).

The majority of children who are unable to adequately utilize speech as an expressive or receptive communication mode typically grow up in linguistically impoverished surroundings due to the inability of family members to use some form of fluent signing (Goldin-Meadow & Mylander, 1990, Goldin-Meadow, 1999). Their slow development of language, including English vocabulary (Luckner &Cooke, 2010), has been attributed to inadequate linguistic interaction (Spencer & Lederberg, 1997) and incomplete language models (Hamilton & Lillo-Martin, 1986), "the early catastrophe". For deaf and hard of hearing children "the early catastrophe" affects their reading ability and ability to learn academic content (Hamilton, 2011). This is evidenced by the fact that fifty percent of deaf and hard of hearing high school graduates read at the 4$^{th}$ grade level or below (Gallaudet Research Institute, 1996; Traxler, 2000) and 30% leave high school functionally illiterate (Marschark, 1997; Marschark, Lang, & Albertini, 2002). Only 7-10% of deaf and hard of hearing students read beyond 7th to 8$^{th}$ grade reading level (Strong, & Prinz, 1997; Luckner, Sebald, Cooney, Young III, & Muir, 2006) The academic achievement of deaf and hard of hearing students has remained at these levels for approximately thirty years (Qi & Mitchell, 2007) regardless of the educational or language policy of the day.

As discussed earlier, a major factor that affects English reading ability is English vocabulary knowledge. More specifically, for all readers, both the breadth and depth of vocabulary knowledge are critical (Anderson & Freebody, 1981). Vocabulary breadth is the number of words a person knows. Studies have shown that the breadth of deaf and hard of

hearing students' lexicons is smaller than that of hearing students (Luckner & Cooke, 2010). Not surprisingly, vocabulary breadth has also been positively correlated with reading comprehension for deaf and hard of hearing students (Luckner & Cooke, 2010). Albertini and Mayer (2011) have reported that even for college level deaf (moderately severe-to-profound hearing loss) comprehension of basic grade school-level passages depended on the ability to recognize and comprehend key vocabulary in the texts.

The depth or quality of vocabulary knowledge is also of importance in reading (Shen 2008). Depth entails knowing multiple meanings for a word such as the numerous meanings of "run". It also includes the finer semantic distinctions such as the difference between "happy" and "giddy" or "bad", "evil', and "wicked". For deaf and hard of hearing readers, depth of vocabulary knowledge is also lacking but highly important for supporting reading comprehension (Paul, 1996).

## Methods of attaining vocabulary knowledge

According to Paul (1996) it is necessary to teach vocabulary, especially to poor readers, who are not likely to derive many word meanings from the use of context. Paul (1996) has suggested that print vocabulary instruction for deaf and hard of hearing students should evolve from traditional approaches, such as learning definitions for a vocabulary list or definitions-and-context approach (Nagy, 1988; Paul, 1989; Paul & Gustafson, 1991). In traditional definition-and-contextual approaches, the teacher might have a list of words that are important for students to know prior to a lesson. After practice with pronouncing and signing the words, and learning the particular definitions, students might be required to use the words in sentences. For example, the student might write "very sad" as a meaning for the word *tragic* and create a sentence such as

"The Braves loss was tragic". It would not be uncommon with such an approach for a student to write “I was tragic”.

This method is problematic for several reasons:

- The target text may have a great many words that are unknown to students – too many for direct instruction.
- Direct vocabulary instruction can take a lot of class time – time that teachers might better spend having students read (if the passages are within the students independent reading level).
- Students need opportunities to use word-learning strategies to independently learn the meanings of unknown words.

(Armbruster, Lehr, & Osborn, 2001)

Conway(1990) has stated:

> “Traditional programs of learning definitions for lists of words should give way to learning words in semantically rich contexts. The contexts can serve as bridges to old information and as foundations for developing further conceptual interrelationships.” (p. 346)

The National Reading Panel (2000) has also stated that

- Vocabulary learning is effective when it entails active engagement in learning tasks.

- Vocabulary can be acquired through incidental learning. Much of a student's vocabulary will have to be learned in the course of doing things other than explicit vocabulary learning.
- Repetition, richness of context, and motivation may also add to the efficacy of incidental learning of vocabulary.

Acquiring vocabulary is integral in any language learning situation. In recent years, more emphasis has been given to the role of the learner in the language learning process as language learning is primarily a learner oriented activity (Noor, 2011). Individuals learn many new words indirectly from semantically rich contexts once they are able to read independently. Cunningham and Stanovich (1997) estimated that fifth graders who read for 20 minutes each day read almost 2 million more words per year than students who cannot, or do not, read. If 2% of the words are unfamiliar to students, then they will be exposed to 40,000 new words each year (Anderson & Nagy, 1991).

## The challenge of learning words in context

Vocabulary instruction is said to account for only a small portion of words good readers learn from grades 3 through 12. There is evidence that incidental learning of words from context is more effective than any other type of text vocabulary instruction ( Nagy & Anderson, 1984; Nagy, Herman, & Anderson, 1985, Coady, 1997; Krashen, 1994; National Reading Panel, 2000). It should be noted however that for such a strategy to be useful a reader must know at least 95% of the words in a passage (Johns, 2008). It is not easy to learn difficult words from natural reading because much of the context does not provide sufficient information on the meanings of the words (Beck & McKeown, 1991; Graves, 1986; Graves & Slater, 1987; Schatz & Baldwin,

1986). The use of context cues in a reading passage may not be sufficient for some deaf and hard of hearing readers to comprehend the text and acquire new word meanings. MacGinitie (1969) compared the number of correct responses to items with misleading contexts to the number of correct responses to items with supportive contexts. MacGinitie reported that the scores of hearing students were depressed by the misleading contexts but had no effect on the performance of deaf and hard of hearing subjects. The implication is that the deaf and hard of hearing students might not have had the ability to use context cues effectively.

The problem with natural contexts becomes even more apparent for words with multiple meanings. A word might be difficult if a secondary or less common meaning is encountered in reading materials. For example, in a classic study using hearing students in 3rd and 4th grades as subjects, Mason, Kniseley, and Kendall (1979) explored the effects of multiple meaning words on reading comprehension on a sentential level. For each of the 20 words selected, two sentences were created, one supporting the primary meaning and the other, the secondary meaning. Results indicated that the subjects selected the primary meanings more often than the secondary meanings. The subjects did not select the correct secondary meanings of words even in sentences providing adequate contextual information. The findings of Mason Kniseley, and Kendall (1979) have been supported by more recent studies on hearing students (e.g.,Graves, 1980, 1986; Graves & Slater, 1987; Graves, Slater, & Cooke, 1980; Stahl & Fairbanks, 1986; see reviews in Beck & McKeown, 1991). Not surprisingly, the use of context cues has presented pervasive problems for deaf and hard of hearing students, many of whom are poor readers (MacGinitie, 1969, deVilliers and Pomerantz, 1992, Davey & King, 1990). DeVilliers and Pomerantz, (1992) state that many deaf and hard of hearing students are caught in a vicious cycle: their impoverished vocabularies limit their reading comprehension, and poor reading strategies and skills limit their ability to

acquire adequate vocabulary knowledge from context. Banner and Wang (2011) have empirically validated this statement.

For good readers and for some poor readers, it appears that the use of context cues is most effective or facilitative when the target words are redundant with the rest of the passage (i.e., in context-rich or -explicit environments) and when these words contribute little information to the story. Haynes (1984) found that guessing which only required reference to immediate sentence context was more effective than guessing which depended on textual elements farther away from the target word. In other words, guessing using local context is superior to guessing using global context. Because of this, she suggests that guessing should only be encouraged if clues are in the immediate context, but that students should also be taught when not to guess. Accordingly, if guessing requires global context, the guessing strategy should be abandoned and a dictionary or other resource should be used instead (Dycus 1997).

## .Dictionaries and their usage as a comprehension support tool

One of the most effective compensatory strategies for increasing vocabulary and reading comprehension is to read extensively and widely, something poor readers do not attempt either inside or outside the school setting (Paul, 1996). With a lack of vocabulary it is not surprising this would be the case for deaf and hard of hearing readers. However, for deaf and hard of hearing readers the amount of reading for personal reasons was found to be the best predictor of text comprehension (Limbrick, McNaughton, & Clay, 1992; Parault & William, 2010). Thus, it appears, for increasing vocabulary and reading comprehension of deaf and hard of hearing individuals, independent reading accompanied by vocabulary support may be a useful strategy. A

popular tool that provides vocabulary support and facilitates word learning and reading comprehension among L2 readers is a dictionary.

Dictionaries may be monolingual, in which case the target words are defined using the same language as the target words themselves (e.g., an English language dictionary) or bilingual in which the target words are defined using a second language that matches the first language of the user (e.g., an English to Spanish dictionary). Research has reported that the majority of L2 learners use such bilingual dictionaries no matter what their level of proficiency (Kent, 2001; Laufer & Hadar, 1997; Laufer & Kimmel, 1997, Jian et al, 2009).

The popularity and effectiveness of dictionary use by adult hearing readers has been well documented, primarily with L2 learners. Approximately 95% of graduate students learning English as a foreign language use dictionaries for academic purposes (Hagood, 2003; Shen, 2006; Noor, 2011). Atkins and Varantola (1997) reported that adult beginning level L2 learners used the dictionary nearly twice as often as intermediate and advanced learners when reading the same passage. All groups showed a preference for bilingual rather than monolingual dictionaries.

Dictionaries also facilitate English reading comprehension for children (Stanovich & Cunningham, 1992). However, children are less likely to use a dictionary for support with poor readers never choosing such a tool (Paris & Meyers, 1981). Beech (2004) reported that older children were more likely than younger children to use a dictionary to find the meaning of a word in a text. For the younger children difficulty arises due to the inability to understand the word's textual dictionary definition and relating this to the context of the passage. Consequently, using definitions from dictionaries to help reading is likely to develop later when reading comprehension improves.

Chall and colleagues (Chall, 1983; Chall, Jacobs, & Baldwin, 1990) note that at about 4th-grade level there is a change to reading more demanding texts. Students are now "reading to learn" rather than" learning to read". The texts may contain more advanced vocabulary that is not within the students' vocabulary (Perhaps this is key to the 4th grade reading level of half of deaf and hard of hearing high school graduates.). By contrast, the vocabulary of earlier materials generally would have been common known words. Using a conventional monolingual textual dictionary definition to aid understanding is difficult for both children and adults (Nist & Olejnik, 1995; Scott & Nagy, 1997).

The increase in dictionary use to support reading and learning vocabulary may be a matter of children discovering the usefulness of a dictionary over time as their reading improves so that the definitions in a dictionary are actually comprehensible. Although there are numerous studies of children's development of reading and spelling, there has been relatively little research on the existing or the potential role of the dictionary in furthering this development (Beech, 2004).

In summarizing the research on vocabulary and reading of deaf and hard of hearing students who are learning English, Luckner and Cooke (2010) discuss 41 studies. Of these, only 10 investigated a specific teaching intervention for enhancing vocabulary. None of these studies addressed the use of a dictionary. This is surprising as dictionary use has long been recognized a vocabulary learning strategy for hearing students (Gu & Johnson, 1996; Schofield, 1997; Nation, 1990, 2001; Gu, 2003; Nation & Meara, 2010). One study not included in the Luckner and Cooke review has addressed the effectiveness of signing to support the learning of science content and vocabulary (Vesel, 2005). Deaf and hard of hearing students in grades 3-8 were taught two science units in which they used multimedia online materials as the "textbook". One

feature of these materials was an English to ASL dictionary for a small set of content related vocabulary. Students could scroll through a list of English words, click on a word, and see the signing for it. It was found that the use of this online tool enhanced the learning of the target science information. Teachers also reported that using these materials allowed the students to be independent learners and that the class was able to progress through the science content more quickly with sign-enhanced English print materials as opposed to standard English print materials.

## The dictionary medium and its effectiveness

Dictionaries may be paper or electronic (e-dictionaries). E-dictionaries may be either online (e.g., www.dictionary.com), embedded in a portable device, or available as an app on a mobile phone. Paper dictionary use during reading facilitates reading comprehension and vocabulary acquisition for adults reading a second language (Cho & Krashen, 1994; Luppescu & Day, 1993; Tono, 2001; Hayati & Pour-Mohammadi, 2005; Zhang, 2007; Shi, 2008; Ji, 2009; Welker, 2010). E-dictionary use has also been reported to facilitate comprehension and vocabulary acquisition (Knight, 1994; Koga, 1995; Zucchi, 2010), often better than paper dictionaries (Laufer, 2000; Koga, 1995). Chen (2011) reported bilingual dictionary use positively affected learning and retention of unknown words encountered during a reading passage with e-dictionaries providing a slightly stronger learning effect than paper dictionaries. Dziemianko (2010) reported e-dictionary use being superior to paper dictionary use for learning but found no difference between the two mediums in later studies (Dziemianko, 2011, in press). These latter results were attributed to the difference in the appearance of the e-dictionaries used as the website in the later studies was cluttered with banners and widgets compared to the clean uncluttered look of the original study's website. E-dictionary use has also been found to enhance

reading comprehension of intermediate readers to equal that of advanced readers (Wang, 2011). Online reading materials and e-dictionaries are also the preferred medium by today's adult students (Noor, 2011). L2 learners have difficulty in understanding the text without referring to a dictionary because their vocabulary is very limited. An e-dictionary provides them with a quick look-up tool to enhance comprehension (Bakar, et al 2011)

In summary dictionaries have proven to be powerful tools for enhancing vocabulary acquisition while reading (Hulstijn, 1992; Watanabe, 1992; Jacobs, Dufon, & Fong McAlpine & Meyers; 2003; Lenders, 2008) and improving reading comprehension (Davies, 1989; Vesel 2005). They are most effective for L2 readers when the definitions are provided in the reader's first language (i.e., a bilingual dictionary) (Oskarsson, 1975; Krantz, 1991; Scherfer, 1993).

The current study investigates the efficacy of dictionary usage for vocabulary learning by deaf and hard of hearing students. The research questions addressed in the study are:

1. Can deaf students (i.e., with severe to profound hearing loss) acquire new printed English vocabulary knowledge while reading independently if provided dictionary support?
2. What dictionary type is most effective for learning new words?
    - Online bilingual multimedia English-ASL dictionary
    - Paper bilingual English-ASL dictionary
    - Online monolingual English dictionary
3. What is the long term retention of the new vocabulary knowledge acquired?

## Method

### Participants

Twenty severe to profound prelingually deaf high school students attending a large ASL-English bilingual day school program for the deaf (i.e., with severe to profound hearing loss) participated in this study. No data was available on their level of ASL-English bilingual ability. All used some form of signing as their major mode of communication and had been in a signing school environment since at least age six. There were sixteen African-American students, two Caucasian students, and two Latino students. Fourteen were female and six were male. Their age range was 18 to 21. All had hearing parents whose signing skill varied from none to intermediate based on teacher and student reports. Their independent reading level as measured by the Basic Reading Inventory (BRI, Johns, 2009) was between the 4$^{th}$ and 11th grade. The selection of these participants was based on the purpose of conducting a study to answer the research questions stated earlier regarding dictionary use as a facilitator of vocabulary learning for deaf (i.e., with severe to profound hearing loss) individuals. Consent to participate was granted by the participants' parents and obtained via standard university internal review board participant consent procedures. Parents signed consent forms for all participants.

Insert table 1

## Materials

### Reading materials

Three short reading passages were used in this study, each paired with a different dictionary type. The paragraphs were equal in syntactic complexity due to the means by which

they were constructed. A prototype paragraph was assembled and two subsequent paragraphs were devised by simply changing words which did not alter the syntactic structure of the original. For example, the opening sentence in the original paragraph (Story A) was

"A canine was hungry so the canine stole some greenbacks from a pediatrician."

The subsequent opening sentences for stories B and C were

"A fawn was hungry so the fawn stole a billfold from an organist."

"A heifer was hungry so the heifer stole shillings from a felon."

Each contained five unknown target words which were used in the post-test learning evaluations. The unknown words were all nouns which could be clearly represented in a photograph and thus equal in imagability. The particular words used were determined during pretesting described below. Below are the stories and their readability levels as determined by the Flesch Kincaid Grade level and the Flesch Reading Ease.(Flesch, 1948). The target words are in italics. These were not italicized for the students during the study.

Story A-A *canine* was hungry so the *canine* stole some *greenback*s from a *pediatrician*. She put the *greenbacks* in a box near a tall tree that had birds sitting in it. The *canine* went into MacDonald's and met an *ursine*. The *canine* bragged "I stole some *greenback*s from a *pediatrician*. They are in a box near the tall tree where all the birds sit." The *canine* ate a hamburger and French fries, and drank a Dr. Pepper. The *ursine* drank some water and left. He looked for the tall tree with the birds sitting in it and then looked for the box. The *ursine* found the box with the *greenback*s, stole what was there and bought a *Winnebago*.

Flesch Kincaid grade level: 4.29 Flesch Reading Ease: 89.94

Story B- A *fawn* was hungry so the *fawn* stole a *billfold* from an *organist*. She put the *billfold* in a box near a black car that had cats sitting under it. The *fawn* went into Chick-Fil-A and met a *boar*. The *fawn* bragged "I stole a *billfold* from an organist. It is in a box near the black car where all the cats hide." The *fawn* ate a chicken sandwich and salad, and drank a Sprite. The *boar* drank some water and left. He looked for the black car where all the cats hide and then looked for the box. The *boar* found the box with the *billfold*, stole what was inside and bought *drapes*.

Flesch Kincaid grade level: 3.4 Flesch Reading Ease: 93.86

Story C- A *heife*r was hungry so the *heifer* stole *shillings* from a *felon*. She put the *shillings* in a box near an old house that has mice running around it. The *heifer* went into Subway and met a *condor*. The *heifer* bragged "I stole *shillings* from a *felon*. They are in a box near the old house where all the mice run around." The *heifer* ate a sandwich and chips, and drank some iced tea. The *condo*r drank some water and left. He looked for the old house with all the mice running around it and then looked for the box. The *condor* found the box with the *shillings*, stole what was there and got a *manicure*.

Flesch Kincaid grade level: 4.61 Flesch Reading Ease: 85.18

The Flesch Reading Ease scores categorizes Stories A and C as "easy" to read for 5$^{th}$ and 6th graders and Story B as "very easy" to read for 4$^{th}$ and 5$^{th}$ graders.

The unknown words were encountered in each story from one to five times. Figure 1 shows each unknown word and the number of times it was in a story. In each story a word filling a particular role in the story was seen the same number of times and in the same syntactic environment. For example the stolen item in each story appears four times.

Insert figure 1

### Dictionary support

Three types of dictionaries were selected for use as support tools in this study.

- Online bilingual English-ASL multimedia dictionary (OBEAMD) (www.cats.gatech.edu/mysignlink). This is an electronic dictionary in which students can type any word into a text input box and then see a webpage with the multimedia presentation for that word. The presentation included the English word, a video of the ASL sign, and a picture of the object.
- Paper bilingual English-ASL dictionary (PBEAD) (Costello, 1997)- This is a paper dictionary in which English words are alphabetically ordered and matched with a line drawing, written English description of how the ASL sign is made, and the English definition. Students can manually search through the dictionary to find the target words.
- Online monolingual English dictionary (OMED) (www.dictionary.com ) - This is an electronic dictionary in which students can type any word into a text input box and then see an English definition of that word.

## Procedure

In order to address research question 1 of this study a pretest-posttest design was employed to determine if the participants can acquire vocabulary knowledge during independent

reading when provided dictionary support. The pretest was used to determine unknown words which were then utilized in the reading materials of the study and also in the posttest evaluations as the target vocabulary knowledge to have been acquired during the experiment. To address research question 2, three dictionary types were selected based on their availability for everyday use and the review of the literature on dictionary use while reading by hearing individuals of a similar age as the participants in this study. To address research question 3, the participants were evaluated for the retention of vocabulary knowledge two days after the initial posttest.

**Pretest**

To find words that the students did not know a pretest was done. The experimenter projected a possible unknown word on a whiteboard in the students' classroom. The group of students was then asked if anyone knew the word. If someone did know the word, it was eliminated from the list of possible words for use in the study. To obtain the fifteen unknown words in this study a sample of sixty words was necessary.

**Immediate test**

The experiment was conducted one week after the completion of the pretest. History effects inherent in repeated measures designs should be minimal. The students were not informed about the upcoming experiment during the pretest. It is unlikely that during the week interval they would have encountered one of the unknown words during independent reading and discovered its meaning in some manner. Classroom instruction did not address any of the words used in the study during the pretest-immediate test interval.

All participants in the study read each of the three experimental paragraphs on a laptop computer while using one of the three dictionary types matched with one of the experimental

paragraphs. The dictionaries were provided by the experimenter and paired with the paragraphs as follows. The paragraphs were presented in a web browser connected to the internet. For the online dictionaries, the paragraph was in a frame on the right side of the screen and the online dictionary was available for use in a frame on the left hand side of the screen. The students were instructed to read the passage and use the online dictionary to find words they did not know.

Insert figure 2

For the paper dictionary the passage appeared in a tab on the web browser and the students each had a copy of the paper dictionary at their seat. The students were instructed to use the paper dictionary to find words they did not know.

Story A was paired with OBEAMD. Story B was paired with the paper PBEAD. Story C was paired with OMED. The order of story presentation was alphabetical. After reading a story the students immediately answered simple multiple choice questions about the target vocabulary in the paragraph. The pictures used in all elements of this study were color photographs.

Insert figure 3

The students wrote their choice on a test sheet provided by the experimenter. It should be noted that the pictures used for the test were not identical to the ones that are part of OBEAMD. Below is the picture for *canine* from OBEAMD. Compare figure3 and 4.

Insert figure 4

### Later test

After two days the students were presented with pictures representing all the unknown words from the stories. They were asked to match the picture with the word on the test sheet provided by the experimenter. The pictures used in this test were not identical to the ones used in the immediate test. Compare figures 3 and 5 for an example.

Insert figure 5

## Results

### Immediate test

A one way repeated measures analysis of variance (ANOVA) was used to compare the number of correct responses made using each dictionary type. The ANOVA revealed a significant difference existed between the scores for each dictionary type ($F(2, 40) = 2.79$, $p = .048$). Post hoc comparisons using the Tukey HSD test indicated that the mean score for the OBEAMD (M = 4.9, SD = 0.308) was significantly higher than the mean score for the PBEAD (M = 4.25, SD 1.070) and the OMED (M = 3.70, SD = 1.17). There was no significant difference between the mean correct responses to PBEAD and OMED. Figure 6 presents the percentage correct for each dictionary type.

Insert figure 6

**Later test**

A one way repeated measures analysis of variance (ANOVA) was used to compare the number of correct responses made using each dictionary type. The ANOVA revealed a significant difference existed between the scores for each dictionary type ($F(2, 40) = 4.57$, $p = .017$). Post hoc comparisons using the Tukey HSD test indicated that the mean score for the OBEAMD (M = 2.55, SD = 1.23) and the PBEAD (M=2.55, SD=1.50) were significantly higher than the mean score for the OMED (M = 1,80, SD 1.32). There was no significant difference between the mean correct responses to OBEAMD and PBEAD. Figure 7 presents the percentage correct for each dictionary type.

Insert figure 7

## Discussion

This study sought answers to three research questions:

1. Can deaf students (i.e., with severe to profound loss) acquire new printed English vocabulary knowledge while reading independently if provided dictionary support?
2. What dictionary type is most effective for learning new words?
3. What is the long term retention of the new vocabulary knowledge acquired?

The answer to the first question appears to be “yes”. In each condition the students learned new vocabulary using a dictionary as support. For the test immediately after reading the passage the results suggest that the answer to the second question is that an online bilingual multimedia English-ASL dictionary (OBMEAD) is statistically superior to other dictionary types used in this study. Using the OBMEAD the students made correct responses 98% of the time as

compared to 85% for a paper bilingual English-ASL dictionary (PBEAD) and 74% for an online monolingual English dictionary (OMED).

Student comments were noted during the experimental session and observational data was collected by the experimenter regarding their use of each dictionary type. These also suggest that OBMEAD was the most preferred dictionary type . For example:

- When required to use the PBEAD one student opened a second tab in his browser containing the OBMEAD. The experimenter told him to close it and he said he preferred the OBMEAD to the PBEAD.
- Students could not easily use PBEAD
    - They found it difficult to find words alphabetically. Several stated that searching for words in the PBEAD was hard. One girl said she hated searching for words alphabetically. Another said she had no patience with the alphabetical searching. Several expressed frustration while using PBEAD.
    - Some students could not easily decipher the line drawing of the sign in PBEAD. For example, one girl signed PRAISE when looking at the sign for DRAPES. Another had difficulty deciphering the drawing for BILLFOLD, producing several variants along with a puzzled look.
    - Several students could not find the target word in the dictionary and said so. They were assured that the word was there.
    - Search time using the PBEAD was much greater than either of the online dictionaries. It often required 2-3 minutes, sometimes longer, for a student to find a word in PBEAD. When using an online dictionary the student

quickly typed the target word in the text input box and immediately saw the dictionary entry.

- When they realized that OMED contained no signs several students expressed frustration and wanted to open the OBMEAD in a separate tab.
- Some students commented that they wanted pictures for support when using OMED. OBMEAD provided picture support, PBEAD did not.

Teachers' comments and classroom contents also suggest a preference for OBMEAD. Both teachers whose classes participated in this study were hearing English Language Arts teachers. Neither teacher had either a paper bilingual English-ASL dictionary or a paper monolingual English dictionary in the classroom. Both said they and the students preferred the online dictionaries, particularly ones similar to OBMEAD in this study.

For later recall of the vocabulary words the results were somewhat different than for the immediate test. Correct responses to words learned via OBMEAD and PBEAD were significantly better than to words learned via OMED. There was no significant difference between correct responses to words learned via OBMEAD and PBEAD and the number of correct response to each were exactly the same (51%). This provides support for the statistical superiority of an English to ASL dictionary (electronic or paper) as compared to an English-only dictionary which presents definitions in a  form (printed English) which is difficult for the participants to comprehend due to their English reading level. It also suggests that once a participant had coded an English word into sign, regardless of the initial presentation format,  it is remembered equally well in the long term. The long term learning effects can best be summarized by a statement by one of the teachers. The teacher explained that he would allow his

students to use an OBMEAD during reading and ask the students to record words they searched for. He would then ask them a few days later the sign for the word and they usually remembered it. He said "It stuck in their head". It should also be noted, however, that after two days the students recalled only about half of the words they had learned. Research indicates that up to 80 percent of learned vocabualry is forgotten within 24 hours of initial acquisition (Thornbury, 2000). Thus, the long-term recall reported in this study appears to be above average.

In summary, it appears that the use of an OBMEAD can provide some deaf students with an effective tool for learning new vocabulary while reading. This is true for the following reasons.

1 .Participants in this study recalled significantly more in immediate recall testing with OBMEAD than with PBEAD and OMED.

2. Participants found OBMEAD more user-friendly based on their comments and observed behavior.

3. The user interface provides quick access to information as compared to alphabetically searching through a paper sign dictionary which several participants found to be a frustrating task.

4. OBMEAD provides information in ASL rather than English print which often is problematic for deaf participants in this study due to their reading level. For long term retention of learned vocabulary seeing the sign(s) for a word appears statistically superior to seeing the written English definition.

While providing evidence that the use of a bilingual English-ASL dictionary during independent reading allows students to acquire new vocabulary this study is limited in the following areas. The sample size is small and may not be representative of the population of

students with severe to profound hearing loss. The age group sampled is also limited. Future research should address the use of dictionaries and the effects on a wider range of participants.

Future studies may also wish to investigate finer distinctions which support vocabulary learning for deaf and hard of hearing readers such as:

- The optimum composition of the multimedia presentation provided by an e-dictionary.
- Learning of more abstract vocabulary than the concrete nouns used in this study
- What other print interactions with dictionary support may enhance vocabulary learning
    - Interactive game play
    - Online versus offline activities
    - Traditional classroom activities such as matching or word finds

## Conclusion

Vocabulary acquisition should be a top priority in a classroom. Without an adequate vocabulary, reading comprehension and learning concepts in subject areas that are built with that vocabulary seems difficult at best. The literature review has suggested that one of the best ways to increase hearing students' reading comprehension is to assist them in developing a broad and deep vocabulary through independent reading. This study has provided evidence that for deaf and hard of hearing students the use of a dictionary, and in particular an electronic bilingual multimedia English-ASL dictionary, appears to provide the support needed to acquire new vocabulary during independent reading just as it does for hearing students (Bakar, et al 2011; Noor, 2011). This has particular implications for classroom practice and also everyday reading outside of the classroom. Many hearing students learning English as a foreign language often use

a bilingual electronic dictionary to assist them during reading. In a similar manner, some deaf students should have open access to an electronic bilingual multimedia English-ASL dictionary during reading. Such support is invaluable when the use of context clues or other reading strategies fail (Dycus, 1997).

The OBMEAD utilized in this study is available for free on the internet and accessible on computers, tablets, and phones making it a useful tool anytime, anywhere. The support it provides may increase the likelihood of deaf students engaging in independent reading which can assist them in enhancing both vocabulary knowledge and reading comprehension (Limbrick, McNaughton, & Clay, 1992; Parault & William, 2010).

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Table 1- Sample demographics

| Subject | Age | Hearing loss in decibels | Independent reading grade level-BRI |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | 18 | 80 | 5 |
| 2 | 18 | 80 | 4 |
| 3 | 18 | 80 | 5 |
| 4 | 18 | 95 | 5 |
| 5 | 18 | 95 | 6 |
| 6 | 18 | 100 | 4 |
| 7 | 18 | 105 | 5 |
| 8 | 19 | 85 | 4 |
| 9 | 19 | 95 | 4 |
| 10 | 19 | 100 | 5 |
| 11 | 19 | 100 | 4 |
| 12 | 19 | 100 | 5 |
| 13 | 19 | 100 | 4 |
| 14 | 20 | 85 | 4 |
| 15 | 20 | 90 | 4 |
| 16 | 20 | 100 | 6 |
| 17 | 20 | 100 | 10 |
| 18 | 21 | 75 | 7 |
| 19 | 21 | 80 | 11 |
| 20 | 21 | 105 | 4 |

Figure 1- Frequency of word encounters

| Word encounters | Story A | Story B | Story C |
|---|---|---|---|
| 5 | canine | Fawn | heifer |
| 4 | greenbacks | Billfold | shillings |
| 3 | ursine | Boar | condor |
| 2 | pediatrician | organist | felon |
| 1 | Winnebago | Drapes | manicure |

Figure 2- Screen layout

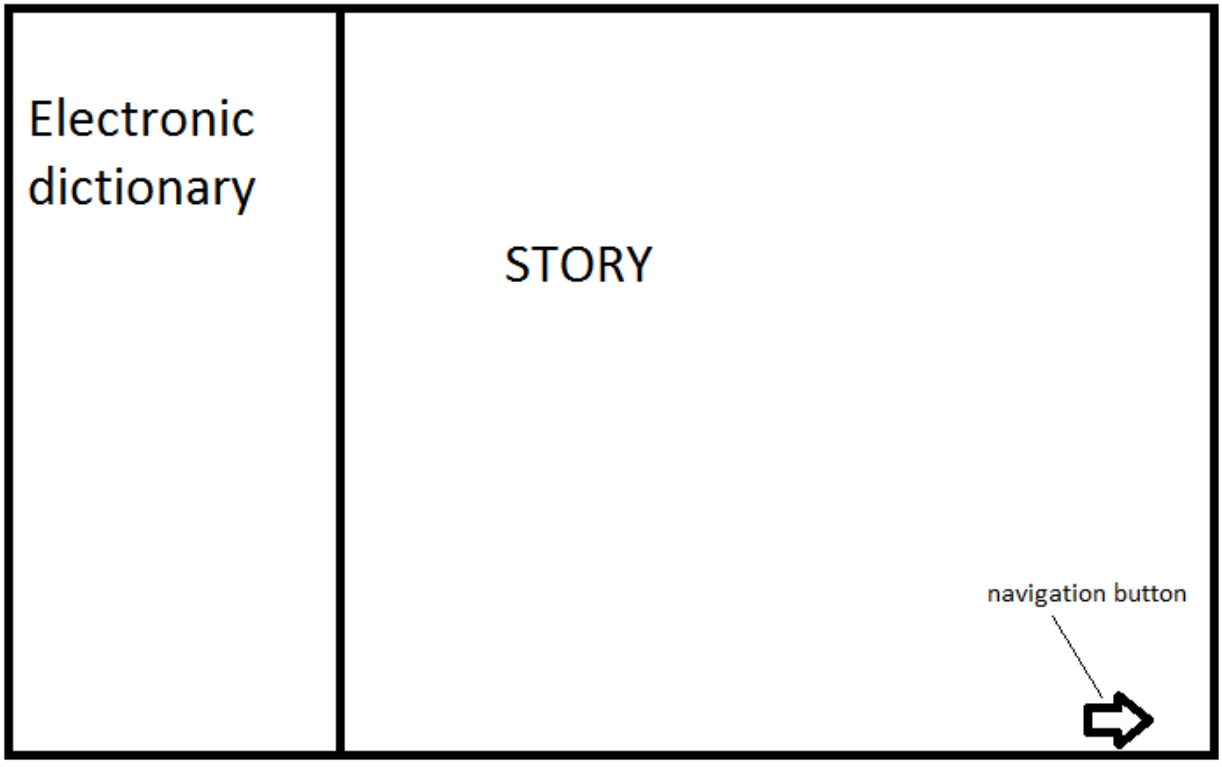



Figure 3- Sample test question

What is a canine?

| | | | |
|---|---|---|---|
|  |  |  |  |
| a | b | c | d |

Figure 4- Original *canine* picture from OBMEAD

Figure 5- Canine- later test

Figure 6- Immediate test: Percentage correct as a function of dictionary type.

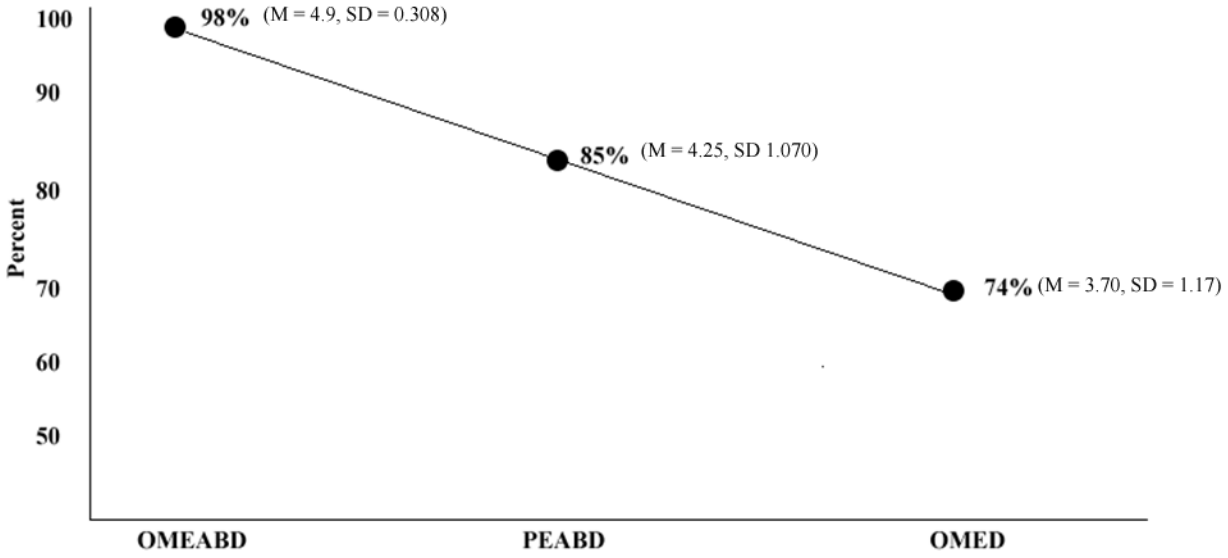
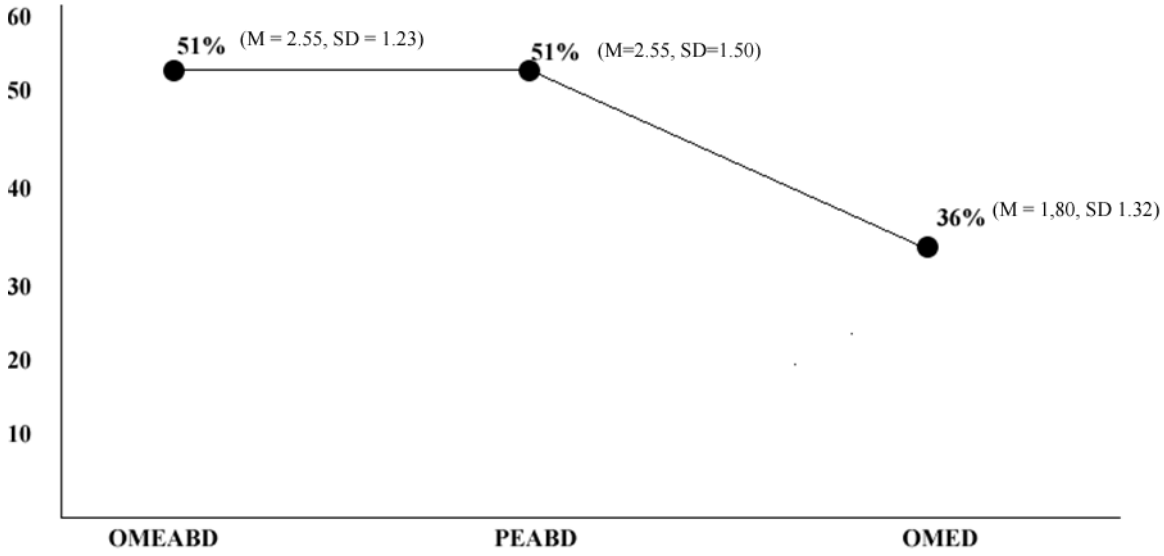



Figure 7- Later test: Percentage correct as a function of dictionary type.


60
50
40
30
20
10
51% (M = 2.55, SD = 1.23)
51% (M=2.55, SD=1.50)
36% (M = 1,80, SD 1.32)
OMEABD
PEABD
OMED