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TELEVISION LITERACY: COMPREHENSION OF PROGRAM CONTENT USING CLOSED-CAPTIONS FOR THE DEAF

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of the Ohio State University

By

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* * * * *

The Ohio State University
1998

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With the intent of making television accessible to people who are deaf and hard of hearing, the Television Decoder Circuitry Act of 1990 states that all U.S.-sold television sets with screens 13 inches or larger are required to have built-in closed caption decoders. Because the auditory component of English is inaccessible to the deaf, their text-based English-literacy rate is quite low. Yet, captions are in written English. The goal of this research is to determine whether the printed script of television is consistent with other forms of text by assessing the comprehension of television programs with and without captions. Specifically, this project examines comprehension and plot-information recall for deaf and hearing participants under three conditions: (1) a video with captions (no audio), (2) a captioned display on a black screen (with no picture), and (3) a transcript of captions without video. Comprehension and information recall are based each student's score on a criterion-referenced test. Results indicate that reading level (measured by SAT score) is highly correlated with comprehension test scores. When SAT is held constant, hearing students outperform deaf students on both comprehension and information-level measures. For both hearing and deaf students, comprehension and recall scores tended to be highest for the captioned video. Other findings regarding the types of questions answered correctly indicate that although both groups are better able to answer text-based questions versus questions which require the application of prior knowledge, deaf students lag behind hearing students in their ability to generalize their reading skills and use prior knowledge to answer questions correctly. These findings suggest a need for improving deaf students' access to prior knowledge and other literacy skills. In addition, these results bring into
question the issue of true accessibility and suggest a change in captioning technology may be necessary.
Dedicated to the students and staff
at the Comprehensive Program for the Deaf,
Columbus, Ohio.
ACKNOWLEDGMENTS

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During a break from a job training class, students were sitting in the kitchen/lounge area where the television was on with closed captioning. Brett saw me watching the television and he turned to see what had caught my attention. It was a popular talk show. Brett watched for a moment and then turned to me and signed.

“What’s going on?” Brett asked; I explained. “Oh. Sometimes I can’t understand television shows, even when there’s closed captioning.”

“Why?” I asked.

“It goes too fast and I don’t understand the words. Sometimes it doesn’t make sense,” he told me.
Television are ubiquitous in our society; education through television starts at home, in nursery and preschool settings, by the availability to very young children of programs such as *Sesame Street*. Television continues to shape our knowledge and understanding of our culture and of the broader world. The audio component of television, however, is inherently inaccessible to people who are deaf or hard-of-hearing. The advent of "captioned television" opened new possibilities for this population to access television media. Captioning is the type-written version of the audio component of television, providing a visual display of the dialogue, narration, music and sound effects for those who cannot hear. Captions are typically displayed at the bottom of the television screen on most television sets; "closed" captions refer to captions that are not immediately visible to the viewer, but can be turned "on" through the television remote control or an external decoder. In contrast, "open" captions, like subtitles, are visible to all viewers and can not be turned "off". With the intent of making television accessible to the deaf and hard-of-hearing, the Television Decoder Circuitry Act of 1990 states that all US-sold television sets with screens 13 inches or larger are required to have built-in closed caption decoders.

As more television programs are captioned, it is still not clear how many people are fully able to utilize this technology. Do captions make TV completely accessible to the deaf? Because making use of captions involves "reading television," reading is an essential
skill for understanding captions and, by extension, comprehending television programs. The process of reading involves the use of prior knowledge and short-term memory; for individuals who are deaf, it may also require skill in a spoken language (i.e., English) which they have not mastered. Thus, issues of literacy, conceptual knowledge and memory constraints come to bear on the comprehension of television captions. Therefore, the goal of this research is to determine how accessible television content is to the deaf and whether the printed script of television is consistent with other forms of text by assessing comprehension of television programs with and without captions.

Literacy Issues

According to the National Assessment of Educational Progress (NAEP) and the National Adult Literacy Survey, literacy is defined as “using printed and written information to function in society, to achieve one’s goals and to develop one’s knowledge and potential.” This definition implies that a literate individual should be able to use and critically assess printed and written information within a variety of modes and contexts (Padden & Ramsey, 1993). Development of a first language, regardless of the mode of communication, is essential for facility with language, vocabulary knowledge and background knowledge, which are necessary skills for literacy (Luetke-Stahlman, Hayes & Neilson, 1996; Paul & Jackson, 1993; Williams, Kantor, & Pinnell, 1992). Williams et al. (1992) further suggest that young children’s language acquisition and early literacy development are simultaneous and interrelated processes. Yet, for many children who are deaf and who use at least some sign-based language, English is not a readily accessible language for them and it has linguistic characteristics that differ from signed languages. Deaf children’s development of English-literacy may be hindered due to difficulties in processing English syntax, accessing phonological representations and utilizing short-term memory efficiently (Luetke-Stahlman et al., 1996). At least 30% of deaf students are
functionally illiterate when they leave school, compared to fewer than 1% of hearing students (Paul & Jackson).

Research has found that literacy development (i.e., the ability to read and write) in English as a second language for deaf students who sign is similar to the development of literacy in English as a first language for the American child who can hear; thus, literacy development for deaf students who sign should follow a similar linguistic process to that of hearing students (Ewoldt, 1990; Strong & Prinz, 1997). Marschark (1993), however, pointed out that in the early years, most children who are deaf have less formal and informal linguistic experiences than their hearing peers. It would appear, however, that literacy development and language development both depend on early exposure to language, which many deaf children raised in oral environments do not have.

Both the signed and spoken expressive vocabularies of children who are deaf are smaller than the vocabularies of same-age hearing peers, indicating that linguistic deficits are not limited to difficulties with English (Marschark, 1993). Because of a possible language barrier and lack of audio input, children who are deaf tend to have restricted social and experiential interactions. Due to these restricted interactions, they may have a limited prior knowledge-base. Griswold & Commings (1974) reported that children who are deaf have fewer opportunities for linguistic experiences than hearing children. They found that young deaf children of hearing parents have fewer labels for objects in their environments than hearing children of hearing parents. In addition, children who are deaf tend to use concrete nouns and concepts rather than abstract concepts or words which define broad categories (King & Quigley, 1985). Furthermore, visual recognition of written words is less automatic for readers who are deaf than for hearing readers (Marschark, 1993); appropriate lexical access is considered an essential skill for reading comprehension because it allows the reader to focus on overall comprehension rather than individual words (Adams, 1990; Yuill, 1997). Moreover, the lack of automatic word recognition skills
places great demands on working memory because the readers must rely more heavily on accessing their existing knowledge to help them understand what they are reading (Garrison, Long, & Dowaliby, 1997; Kelly, 1996), therefore less memory capacity is available to integrate syntactic and semantic information (Jackson, Paul & Smith, 1997; Marschark, 1993).

**Memory Capacity**

Deaf readers tend to use labels for concrete nouns rather than abstract concepts because children who are deaf are often taught specific words rather than broader concepts. Furthermore, although a word may have multiple meanings, deaf children's experiences may be limited to only one specific, concrete meaning for a particular word. Therefore their organization of a hierarchy of conceptual information is narrowly constricted to the initial specific learning. Garrison et al. (1997) examined how working memory affected the language comprehension skills of students who are deaf. They found reading comprehension in readers who are deaf depends heavily on the reader's background knowledge and functional working memory capacity. Lexical knowledge is also a strong predictor of reading comprehension; for deaf readers, retrieval of word meanings requires great attentional resources and long processing times. Deaf readers with poor lexical knowledge may retrieve inaccurate meanings or meanings which are unrelated to the specific context which in which the information is newly embedded (i.e., plant as a growing entity versus plant as factory) (Ewoldt, 1981; Garrison et al, 1997; Quigley & Paul, 1994).

For readers who have an accessible store of word meanings in long term memory, retrieval and application of the meanings to text is rapid, leaving short term memory free to focus on other aspects of the text. However, if retrieval of word meanings is not automatic, readers must use cues such as context to consciously and laboriously discover the meanings; short term memory becomes occupied with this task and is unable to focus
on the larger representation of the text, or overall themes (Kelly, 1990). Moreover, the broader theme, or the gist of the passage, provides a basis for the meaning of the passage in which the information is embedded. That is, an understanding of the broader theme facilitates lower-level processes, such as word recognition and syntactic analysis. Thus, the comprehension process is a continual interplay between the lower-level and upper-level (thematic) processes. For readers who are deaf, memory constraints due to factors such as lexical knowledge and breadth of background knowledge appear to affect reading level and reading comprehension of text and captioned videos.

Developmental Models

In a constructionist model of development, such as Piaget's (and that of many Neo-Piagetians), children's capacities or skills develop as they interact with their environment; that is, development is a function of an organism's interaction with its environment (Fischer, 1980; Gelman, Maccoby & LeVine, 1982). The implications of this model for this research are twofold: Firstly, children must be exposed to print media and they must interact with it in order to develop literacy skills. Gelman et al. (1982) remark, "Whereas preschoolers can apply their ability to only very special tasks, older children can apply the ability more broadly. Development involves, in part, the ability to transfer or generalize a capacity" (p. 151). With cognitive development, children learn to generalize their language skills to different context (i.e., contexts they have not directly experienced) and media. This suggests that children must learn basic reading skills before they can apply those skills more broadly. Young children may not be able to generalize their reading skills to media other than the medium of initial learning. Marschark notes, however, that research on children's reading skills is typically carried out using standardized tests and "simple, well-controlled materials in semantically restricted contexts" (1993, p. 217). In light of this, Marschark proffered that field and naturalistic studies will more accurately reveal children's reading potential and literacy competence. To take this idea one step further, investigations
of literacy should employ realistic contexts in which reading abilities are often assumed, such as television.

Secondly, research has found that linguistic experiences of children who are deaf are limited (Griswold & Commings, 1974; King & Quigley, 1985; Marschark, 1993); yet, within the constructionist model of cognitive development, language development can not progress adequately without a rich linguistic environment. Fischer's (1980) skill theory describes the transaction of the organism and the environment, just as Rosenblatt (1989) discusses the transaction between reader and text in the literary critical framework. Skill theory proposes that the development of skills must be inspired and shaped by the environment; consistent exposure to types of experiences will foster higher levels of skill (Fischer). This proposition is similar to the Vygotskian idea of scaffolding, in which assisted, guided exposure to and experience with tasks related to a skill will help one achieve the next skill level (Paul, 1998). Assumedly, if an individual is not consistently exposed to language in a variety of language related contexts (e.g., interpersonal communication, storytelling, story reading, writing), s/he will not fully develop these language skills. Competence with language increases through use and through interactions with those who have more sophisticated language skills; unfortunately, for children who are deaf, the variety of such interactions is often not accessible.

"Reading" Television

Closed captioning (CC) allows those who are deaf to "see" what has been spoken on the television. It is a moving, written transcription of the television show and requires a knowledge of the written language and its linguistic structure. Compounding the literacy problem for readers who are deaf is the time constraint of captions: they move quickly off the screen, a hindrance for poor readers. Unlike typical print media, which is available to re-read, one cannot go back to review information presented in prior captions (Putz, 1987). Deaf readers also exhibit a lack of fluent word reading, which adversely affects
comprehension; word-reading fluency depends on the ability to recognize letters, spelling patterns, and whole words, effortlessly and automatically (Adams, 1990). Although many individuals who are deaf claim to enjoy watching television, they may not fully comprehend the content of the programs, especially if there is a discrepancy between the action depicted and information conveyed through audio or captions. A person who is deaf watching television may visually perceive the action, but if either the specific information, the subtleties of the conversation or the entire storyline of the program are in some way inaccessible, then the person is only perceiving the program. By watching television in this way, a person can not access all of the information the program has put forth and comprehension is necessarily sacrificed. Fully accessible television may make the difference between perceiving the program and conceptualizing the program.

**Purposes of Study**

Captioned programs such as the evening news, reruns of "The Simpsons" episodes and National Geographic television specials all have one important factor in common for deaf viewers: they require some level of reading ability to understand the reporting, dialogue and narration. Closed captioning has provided a written form which relies on visual presentations for the auditory component of television programs; however, it is not clear how well people who are deaf obtain supplementary information to fully understand the text information conveyed through closed captioned television. This dissertation will compare comprehension of captioned television programs and written transcripts through a criterion-referenced comprehension test designed to examine the viewers' understanding of the story contents. Studies suggest that those with lower vocabulary levels must allocate memory resources toward lexical determinations and away from more global integration of information (Kelly, 1990). Therefore, it will also examine the relationship between reading levels and retention of relevant story information in captioned television programs (c.f. Cavanaugh, 1983).
This study will assess viewers' memory for and comprehension of both explicit and implicit information in the programs using the criteria set forth in Jackson, Paul, and Smith (1997). For the purposes of this study, chronological age is not as relevant a factor for analysis as reading-grade level. Reading level surveys, noted by Jackson et al. and others (e.g., Kelly, 1995; Quigley, 1982) reveal that deaf students are, on average, at the third- or fourth-grade reading level. The researchers further suggest that because the deaf have limited experience with language, their language and literacy development may be delayed chronologically. Research on reading comprehension has shown that comprehension requires the integration of one's existing knowledge with the information in the text (Jackson et al.). Jackson et al. found a predictive relationship between prior knowledge and reading comprehension. Moreover, they found that reading comprehension and reading grade-level were highly related to students' ability to answer script-implicit (SI) questions, those which involved the inferential use of prior knowledge. In contrast, students' abilities to answer text-based questions (text-explicit, TE, and text-implicit, TI), were not related to overall comprehension. TE questions require the least amount of memory processing, as they are based on specific phrases from the text. Working memory strategies related to linking two pieces of information are necessary for answering TI questions. Finally, SI questions demand deeper memory processing in order to access previously acquired knowledge and working memory strategies related to linking prior knowledge to the text.

Research has shown that captions are generally informative to the deaf; that is, comprehension generally improves for programs with captions versus no captions (Nugent, 1983). In addition, Koskinen and colleagues found that when captions are controlled for reading grade level, most learning disabled children can read captions at, or close to, their designated reading grade-level (Koskinen, Wilson, Gambrell & Jensema, 1987). The extent to which this applies for children who are deaf is not clear. Likewise,
Koskinen et al. did not examine the abilities of a non-disabled hearing comparison group. Furthermore, it is not clear whether children who are deaf obtain equivalent information from captions as from other text. This research examines the extent that reading levels of students who are deaf contribute to comprehension of captioned television programs and recall of relevant information in the programs. It will also examine how students' comprehension of captioned television compares to their comprehension of printed text.

**Research Questions**

In order to assess comprehension of the television programs, this study will address the following questions: (a) Given equivalent reading levels, do children who are deaf understand captioned television at the same level as hearing children? (b) To what extent are students' “reading scores" generalizable to other media? That is, to what extent does the reading competence of readers enable them to understand captions versus other printed text? and (c) What type of information are students understanding and recalling better?
CHAPTER 2

REVIEW OF RELATED LITERATURE

In order to investigate deaf students' comprehension of captioned television programs, it is necessary to address several areas of research. This issue encompasses diverse research in television and captioning comprehension, deafness, reading processes, language development, memory capacities, and literacy. To illustrate the interrelatedness of these topics, consider the following: Because captioning involves reading, it is necessary to explore the reading process. Furthermore, learning to read may be qualitatively different for children who are deaf, thus research on deafness must be examined. Each of these areas are vast in their literature, however. The literature reviewed herein will therefore be limited to studies relevant to the issue of whether students who are deaf obtain equivalent information from captions as from other forms of printed text.

This review will begin with a summary of research on television program comprehension. It will then focus on closed captioning comprehension among both deaf and hearing individuals. Next, it will address the reading process and the development of reading skills. A review of other cognitive factors involved in reading will follow. The preceding two sections will lay the groundwork for a survey of the models of literacy and an overview of Deaf culture. Finally, a summary of the review and conclusions drawn from it will be presented.
Television-Program Comprehension

In Western culture, television shapes the way we obtain information (Troseth, 1998); from President Clinton addressing the nation to singing purple dinosaurs, television brings us vivid images of both the real world and fantasy worlds. Although television now provides some “guidance” ratings of programs, it is generally left up to the viewer to distinguish between what is real and what is fictional (Wright, Huston, Reitz & Piemyat, 1994). An issue of concern to researchers (Cavanaugh, 1983; See, Ray & Lovelace, 1995; Troseth, 1998; Wright et al., 1994) is how well people understand the content of the television programs they watch and how well they can distinguish television reality from unreality.

Understanding the world of television Researchers interested in the development of symbolic understanding have examined children’s understanding of video representation. Experimental studies have demonstrated that preschool children have trouble distinguishing the objects and actions depicted on the screen from reality. In one series of experiments (Flavell, Flavell, Green & Korfmacher, 1990), preschool children have asserted that if the television set was turned upside down, the object on the screen (such as a bowl of popcorn) would spill. Other studies suggested that young children believe that television dramas are depictions of real people’s lives (Hawkins, 1977). Yet, by late childhood, children seem to accurately make the distinction between reality and fiction on television (Wright et al., 1994). A study of five- and seven-year old children (Wright et al.) demonstrated that with increasing age, children are better able to correctly identify television programs as fictitious or real. Furthermore, the researchers suggest that “5-year-olds have a bias toward assuming that television is unreal” (Wright et al., p. 236).

Children do, however, seem to observe carefully and learn from what they see on the screen. Very young children (14- and 24-months-old) were able to imitate play with a new toy that they had seen depicted on television (Meltzoff, 1988). In a problem-solving
task, Troseth (1998) demonstrated that 30-month-olds were able to find a hidden toy after seeing the hiding via live video. Troseth was unable to obtain similar results with 24-month-olds and she suggests that the older children have learned to use the video information to form a mental model of the actual current state of affairs, whereas the younger children have not yet developed this skill. This further supports the assertion (Wright et al., 1994) that younger children tend to assume all of television is fictitious.

Recall and comprehension. Once children understand that television is representational, they begin to differentiate genres of television content (Wright et al., 1994). The basic distinction between factual and fictional programs is in place by late childhood (Hawkins, 1977); thus, television and video are regularly used in schools as a teaching tool. With this in mind, it is important to assess to what degree children understand what they have watched. Researchers have evaluated children’s understanding of information that is central or essential to the plot versus peripheral information presented in a television program (Cavanaugh, 1983; Sell et al., 1995). Sell, Ray, and LaNeel (1995) demonstrated that pre-school children’s recall improved after multiple viewings of a television program, but recall was still relatively poor. In general, studies have shown that though early elementary school, children’s comprehension of central information is minimal, however, by junior high school, recall of central information is quite good (see review in Sell et al).

In a similar study, Cavanaugh (1983) examined adults’ recall and comprehension of television programs. Comparing a group of younger adults (18 to 24 years old) and older adults (65 to 70 years old), he probed recall on information that was either central to understanding the program, relevant to the plot (but not essential), or irrelevant to understanding the plot of the television program. Results indicated that for full-length (30 minute) television programs, adults with higher vocabulary levels tended to recall more information than those with low vocabulary levels. The difference was smallest for
information central to the plot and greatest for plot-relevant information. Cavanaugh suggested that one's verbal ability may be positively correlated with the amount of information one encodes and furthermore, comprehension and retention of television programs involves a "substantial verbal component" (p. 195). He concluded that "processing of television programs is likely a highly practiced skill" (Cavanaugh, p. 195).

Captioned Television for the Deaf

Captioned films had made their debut in 1958, 31 years after "talkies" made motion pictures inaccessible to the deaf (Norwood, 1988), however, the technology, market studies, and regulations for television captioning took another 30 years. Captioned television officially began in the United States (on ABC, NBC and PBS) in March, 1980. Captions are similar to subtitles; they are a continuous written transcript of the program, typically appearing on the bottom of the screen in close synchrony with the television audio. They are transmitted in a portion of the video system (Line 21) that is normally unused; the signal for closed-captions is then deciphered by a decoder-mechanism now placed inside the television itself.

Captions in the laboratory. With the advent of television captions still only on the horizon, research studies began to investigate their utility for viewers who are deaf. Boyd and Vader (1972) investigated the extent which captions contribute to deaf students' understanding of a film which was captioned by teachers of the deaf. The results of the experiment indicated that "captions, if appropriately written with due regard to the linguistic level and reading rate of the viewers, when added to a television program", significantly contribute to the information gained (Boyd & Vader, 1972, p. 36). The captions in this study were based on a rate of 120 words per minute (wpm); the average silent reading rate of a student reading at the third grade level is 116 wpm (Koskinen, Wilson, Gambrell, & Jensema, 1987). In a study of caption rate and language level, Braverman and Hertzog (1980) found that although the captioning rate (60, 90, or 120 wpm) did not affect
comprehension, the language level of the captions did have a significant effect on comprehension. Deaf students' performance on a comprehension test was better for captions that used a lower language level. Baker (1985) pointed out, however, that a reduced captioning rate necessitates simplifying the language level of captions; in a series of studies varying reading rate and language level, he found that the combination of reduced rate (60 words per minute) and reduced language level improved program comprehension for British school children.

A further investigation of captioning examined the relative contribution of visuals and captions to overall comprehension (Nugent, 1983). Using specially constructed captions, Nugent compared deaf and hearing students' comprehension for program with (1) visuals only, (2) captions only, or (3) visuals and captions together. The captions were rewritten so that the captions and visual display were redundant; that is, the captions provided a written description of the visual display. (In contrast, in the case of a program that is narrated, the script doesn't necessarily relate directly to the visual scene.) Results indicated that students who are deaf scored significantly lower than hearing students on all conditions; for both groups, however, comprehension was highest on the visuals and captions together condition (Nugent). In this study, however, the researcher notes that "deaf students viewing the visuals plus captions scored as well as hearing students reading the print [captions alone]" (Nugent, p. 232); she suggests that the pictures allow students who are deaf to be on par with hearing students. This finding is particularly interesting when it is taken into account that captions move quickly off the screen, which controls reading rate. Unlike printed text, captioning does not allow a person to go back to correct misunderstandings or retrieve previous information (Putz, 1987).

In the living room. All of the aforementioned captioning research was performed on programs with "artificially produced" captions, that is, the captions did not reflect the rate or language level of an actual television program. In a review of a cross-section of 205
regular television programs, researchers found that the average captioning rate is 141 words per minute, with a range of 74-231 (Jensema, McCann, & Ramsey, 1996). Their data indicated that the overall mean rate for children's television programming was 126 wpm, well above the optimum 60 wpm suggested by Baker (1985). For both pre-recorded and real-time captions, the researchers found varying degrees of editing between the captions and the actual audio; in programs that were closely examined for their degree of editing, the editing typically did not change the meaning of the text, but did provide a more simplified sentence structure (Jensema et al., 1996). Overall, however, the captions matched the audio content about 95% of the time.

In a study of captioning comprehension for a regular television program at 140 wpm, the National Captioning Institute (1983) tested hard-of-hearing children's comprehension for captioned versus non-captioned videos using a 20-item multiple choice test. Again, results found that students who viewed the program with captions had higher comprehension test scores than those who watched the program without captioning. The data also indicated that students who were at the third-grade reading level (Stanford Achievement Test) and above scored significantly higher on the comprehension test than the students who read below the third-grade level (National Captioning Institute [NCI], 1983).

And in the classroom. Researchers have noticed that children who are deaf and hard-of-hearing "eagerly watch closed-captioned television and are highly motivated to read to understand a program's content" (NCI, 1983, p.4). Using this idea, several projects and investigations have examined the utility of captions in reading instruction for the deaf (Koskinen et al., 1987; Loeterman et al., 1995; Putz, 1987). Loeterman et al. describe several projects in which students captioned video tapes themselves, using computer keyboards. Students and teachers who were involved with the projects reported increased motivation in reading and writing activities such as describing scenes and summarizing
stories (Loeterman et al.). In a study designed to test whether captions enhance reading comprehension, Putz incorporated captioned science films and related reading materials into classroom instruction for 15- and 16-year-old deaf students. Although she was unable to find statistically significant differences between those instructed with and without captioned films, anecdotal evidence suggests that the films provided motivation for reading (Putz).

A comparison between reading level (based on the Botel Word Opposites Test) and caption comprehension level (in which television program were assessed for their equivalent reading level) found that hard-of-hearing students were typically able to read captions at their designated grade level (Koskinen et al., 1987). In a second study, the researchers compared reading performance for hard-of-hearing students who viewed captioned television versus those who read a printed text of the captions, both of whom received vocabulary and comprehension instruction related to the programs. Their data suggest that the vocabulary and comprehension lessons which used captioned television enhanced students' sight vocabulary and comprehension.

Captions for the "reading impaired". Although captioning was originally developed for the deaf and hard-of-hearing, captioned television and video programs are used in educational settings for hearing students, as well. In a study of captioned program comprehension, Berkay and colleagues found no difference in comprehension for adolescents watching television programs with or without captions and with or without practice (Berkay, Boyce, & Gardner, 1995). They also noted that "skilled caption readers report that they can quickly glance at captions and then back up at the picture" (p.284). In situations in which captioned television has been used as an educational tool for reading instruction for remedial students and English as a Second Language (ESL) students, teachers reported students’ increased motivation and interest in learning the material (Koskinen, Wilson & Jensema, 1985). Studies have also indicated that captions enhance the vocabulary and reading comprehension for remedial readers (Adler, 1985; Koskinen et
al., 1987). The combination of pictures, auditory information and text provides a meaningful context in which children appear to find motivating (Koskinen, Wilson, Gambrell & Neuman, 1993).

Real-time captions. Real-time captioning first appeared on October 11, 1982 on ABC’s “World News Tonight” (Norwood, 1988). Real-time captioning uses court reporters’ stenographic machines to convert continuous and spontaneous speech into captions on the television screen while it is being spoken. The technology allows “live” programs to be captioned as they are aired, with no delay necessary for captioning; however, because the captioning is also “live”, there is no time to correct spelling, typographic errors, and other misunderstandings. Real-time captioning is now also used in conferences and in classrooms, enabling a participant who is deaf to read a lecture and discussion while it is happening. A survey of deaf students at the Rochester Institute of Technology, where this technology is frequently used, indicated that most students (from mainstream secondary-school programs) preferred real-time captioned lectures to sign-language interpreted lectures and they believed that they understood substantially more from the lectures in the captioned format (Stuckless, 1988). Stuckless noted that this technology does not allow for students to ask questions easily, however, he asserted that “…most deaf students in mainstream classes, even with good reverse interpreters, do not ask a lot of questions” (p. 155).

Children are clearly paying attention to television: approximately 85% of the more than 50 million children in the United States watch television every day: by the time they graduate from high school, most children will have watched at least 22,000 hours of television (NCI, 1983). Thus, television is not to be ignored by researchers and educators; it plays a substantial role in influencing children’s learning and socialization skills (NCI). By middle to late childhood (Piaget’s concrete operations period), children are able to distinguish between factual and fictional television programs, and they begin to recall more
information that is central to the plot of a show (Sell et al., 1995). In terms of recall, however, reading level was found to be a mediating factor for adults, even for non-captioned, regular television programs (Cavanaugh, 1983). If reading ability affects hearing viewers' comprehension of regular (non-captioned) programs, then for deaf viewers watching captioned television, reading ability may have an even more profound effect on their comprehension. Moreover, children who are deaf and hard-of-hearing watch as much or more television than their hearing peers (Liss & Price, 1981). As might be expected, research has demonstrated that although captions improve television comprehension for the deaf, rate and language-level of the captions may affect children’s comprehension of the programs. Researchers and educators also note that captions act as a reading motivator and may enhance reading vocabulary and comprehension for both deaf and hearing students. Furthermore, reading skills are necessary to fill in the gaps from the inevitable errors found in real-time captioning. Clearly, reading skills affect television comprehension; in light of the research on television- and captioning-comprehension research, the so-called “idiot box” may be misnamed.

The Process of Reading

Research indicates that reading skills may be essential for television-program comprehension (Cavanaugh, 1983) and captioned television may inspire students to hone their reading skills (Koskinen et al., 1993). Because of this possible reciprocal relationship between reading and television, it is important to explore in more detail the reading process.

Learning to read. Reading skills are built slowly and begin with general experience with print early in life (Adams, 1990); children are typically first exposed to reading through bedtime stories, seeing others read and learning to recognize the labels on their favorite toys or foods. In addition to early exposure to print, children build on other skills and experiences which contribute to the reading process. Essential to reading is some level of linguistic awareness (knowledge of how language works in general) and, more
specifically, knowledge of the language in which one is reading (Adams; Paul & Quigley, 1994). Thus, in the initial stages, learning to read depends on a certain degree of language fluency. This includes implicit knowledge of phonology (sounds), morphology (individual units of meaning in a language), semantics (word meanings), and syntax (word-order rules) (Just & Carpenter, 1987).

As their knowledge of language develops and children learn the letters of the alphabet, they also begin to understand letter-to-sound correspondence; this is thought to be a critical skill in learning to read (Adams, 1990). A review of studies comparing the effectiveness of phonetic approaches to reading versus whole word methods found that children’s level of phonic knowledge is positively correlated with their level of reading achievement (Adams). Adams also points out, however, that laboratory research indicates that the most critical factor beneath fluent word reading is the ability to recognize letters, spelling patterns, and whole words effortlessly, automatically and visually. The central goal of all reading instruction — comprehension — depends critically on this ability. (p. 54)

Other more global issues which contribute to reading skills include general knowledge of how the world works, social and cultural knowledge, and a sense of logical inference (Adams). The relationship is reciprocal, however, as these skills also improve with increased reading experience and mastery (Lichtenstein, 1985; Marschark, 1993). Based on the idea that reading employs both specific language- and word-related knowledge (bottom-up, perceptual and linguistic skills) as well as the application of prior knowledge about the world (top-down, conceptual skills), it can be described as an interactive process which involves the integration both sets of skills (Just & Carpenter, 1987; Whitehurst & Lonigan, 1998).

Reading as a second language. For deaf children whose primary language is American Sign Language (ASL) or another sign-based language, there is no secondary
form of the language and they must learn to read in the common language of the general society. Quigley (1982) explains the problem:

The average deaf child usually does not have a basic knowledge of the language he or she is learning to read. Both the code (printed symbols) and the language itself (standard English) are unfamiliar. Thus, the task of learning to read often becomes one of language-learning at the same time. (p. 96)

If reading requires language-specific knowledge, children who are deaf are at a disadvantage. Quigley points out that children who are deaf have problems with phonetic analysis, vocabulary, syntax, making inferences, and understanding figurative language. Thus, children who are deaf lag behind hearing children in reading achievement as measured by grade level, and this delayed progress is cumulative (Brooks, 1978).

Statistics on deaf children’s reading achievement test scores indicate that, on average, students who are deaf only achieve a third-grade reading level by the time they graduate high school. Yet even these scores may be erroneously high, based on the studies of more specific reading problems (Kelly, 1995; Quigley). In addition, Kelly notes that only 3% of deaf 18-year-olds read at the same level as an “average” 18-year-old hearing reader.

Reading is often described as a process of recoding orthography into a linguistic form (Kretchmer, 1982); for hearing individuals, the recoding process is done phonetically. Because phonetic-codes are virtually inaccessible to the deaf, they must recode in another form: via articulatory recoding, fingerspelling and/or recoding into signs (Kretchmer). Kretchmer suggests that after the encoding (recoding) process, the reader must analyze the information according to the syntactic, semantic, discourse and pragmatic rules of the language; individuals who are deaf again have problems at this stage because of inadequate vocabulary and syntax development for English. Children who are not raised in an ASL environment often have a “faulty” English-language base; children who consider
ASL their native language “may approach print as a second language” (Kretchmer, p. 112). Kretchmer further notes that,

...hearing and hearing impaired individuals matched on measures of academic achievement do not perform equally when completing cloze passages or making judgments of grammaticality. These studies demonstrate that reading and measures of reading achievement are complex phenomena; with this caution in mind, it is undoubtedly true that the reading difficulties of the hearing impaired are the result of higher order processing (e.g. syntax, etc.). (p. 112-113)

Bottom-up skills are clearly lacking; thus, the integration of bottom-up and top-down skills, as described for hearing individuals, has begun to break down for those who are deaf.

Furthermore, the more effort a person spends on bottom-up processes in reading, the less attention the person can devote to comprehension (top-down), since overall processing capacity is limited. Kelly (1995) found that less skilled deaf readers generally have slower reading rates which places a greater burden on working memory, thus increasing the danger of words decaying before a meaning can be constructed. Further research (Kelly, 1996), which examined the interaction of syntactic competence and vocabulary, suggested that limited knowledge of syntax may indirectly obstruct readers’ ability to apply vocabulary knowledge. Kelly proposed that this effect may be due to a misinterpretation caused by the syntactic limitations, or due to the exhausting of processing resources by the laborious processing of syntax.

Reading and primary language skills. Any discussion about learning a second language implies that a primary language is already in place. In the case of children who are deaf, they have limited or no access to spoken English, which is likely to be the primary language of their parents and caretakers. Equally likely is the probability that the parents have little or no knowledge of sign-based language; 90% of children who are deaf are born
to hearing parents, few of whom know sign language. Often, hearing loss is undetected until a child is three or four years old; after decisions about language-use and schooling are addressed even more time passes, thus further depriving the child of access to any language. By extension, the child is deprived of someone who can explain the how the world works — general world knowledge (Andrews & Mason, 1991). This early language deprivation is thought to be the cause of low reading achievement among the deaf (Kusché, 1985; Meadow, 1980); Kampfe and Turecheck explain that “because language skills provide the foundation on which reading will eventually develop, the early language deficits of deaf children are thought to result in later reading difficulties” (1987, p. 11).

Basic language skills in any language will provide a broader metalinguistic understanding, that is, an understanding of how language works in general, which children who are deaf can then apply to the reading process. Kusché (1985) suggests that reading depends on automatic processing of language and an unconscious linguistic awareness; however, “because deaf children are generally weak in their automatic processing of the patterns, rules, and strategies for linguistic performance, they lack the repertoire necessary for easy transference to a new language-based skill” (p. 115). In addition, with a primary language, such as ASL, children who are deaf can gain basic world knowledge, which they can then apply to the reading process (Hakuta, 1990; Strong & Prinz, 1997). Research has demonstrated that parental use of signs does have a positive relationship to children’s early language skills and later reading achievement; parental skill level in signing may also contribute to this relationship (Kampfe & Turecheck, 1987). American Sign Language or other sign-based languages can be used to develop vocabulary knowledge and comprehension skills, which are critical for high reading achievement (Strong & Prinz, 1997). However, the structure of ASL is different from English, which is often cited as a barrier to reading for students who are deaf (Andrews & Mason, 1991).
Lexical knowledge. Adams (1990) asserts that "...the ability to read words, quickly, accurately, and effortlessly is critical to skillful reading comprehension..." (p. 3). Part of accurate reading involves correctly determining what a word means, which has both bottom-up and top-down components. The bottom-up component includes accessing words in one's internal lexicon. Central to our knowledge associated with words, or lexical knowledge, is the word-concept, which includes the specific meaning of the word as well as more general associations (Just & Carpenter, 1987). Both context and word frequency can facilitate this process of lexical access. In addition to lexical knowledge, readers also must apply their general knowledge about the world to assist their interpretation of a given sentence (Just & Carpenter; Paul, 1998). Moreover, syntactic ability may affect vocabulary processing and thus overall comprehension (Kelly, 1996).

Test scores and empirical research suggest that good readers tend to possess large vocabularies, implying a causal relationship between lexical knowledge and reading ability (LaSasso & Davey, 1987; Paul & Gustafson, 1991). In his review of the literature, Paul (1996) explains that the "knowledge model" may better explain this relationship: words trigger conceptual associations. These associations allow readers to apply related knowledge to their interpretation of any given word in a specific context. The larger "conceptual framework" suggested by an associative model is available to assist a reader with comprehension, thus "lexical knowledge" implies a more in-depth understanding of words than merely their definitions. Thus, direct vocabulary instruction may be necessary but insufficient; elaboration of word meanings and instruction of multimeaning words is warranted (Paul, 1996, 1998).

Lexical ambiguity. In the process of learning to read, children learn to focus on the broader task of comprehension rather than on the smaller components of individual words (Yuill, 1997). It is during this process that children begin to discover that words can have more than one meaning. Lexical decision studies have shown that when an ambiguous
word is read or heard, both (or multiple) meanings of an ambiguous word temporarily come to mind (Just & Carpenter, 1987); however, the appropriate word is typically selected based on context and world knowledge. Adams (1990) suggests that appropriate word selection is due to an understanding of the relations among words above and beyond the understanding of individual words. Based on a reader’s background knowledge, a word can trigger an extensive conceptual framework to assist in word selection and general comprehension.

Readers who are deaf, however, tend to retrieve very specific word meanings where more general meanings apply, select primary meanings over secondary meanings for multimeaning words, and tend to have difficulties in comprehending figurative language (Kelly, 1996; King & Quigley, 1985; Marschark, 1993; Paul & Gustafson, 1991). Knowledge of the meaning of a word is related to the frequency with which that particular word appears in print; yet a reader’s word knowledge may be limited to only one meaning (Paul & Gustafson, 1991). Furthermore, more frequent words are more likely to be polysemous (Lee, 1990). Nevertheless, a reader may lack the broader conceptual framework that is triggered by in-depth knowledge of a word, blocking access to its secondary meanings. Deaf readers may also not be able to use context clue to assist them in deriving word meanings (Paul, 1987).

Research indicates (Yuill, 1997) that children often demonstrate their new-found metalinguistic skill in understanding words with multiple meanings through the telling of jokes. (Many jokes are dependent on the fact that words can have more than one meaning, such as the classic: *Is your refrigerator running? Well then you better go catch it!* ) Although word ambiguity can be amusing to some, a sophisticated knowledge of language is required to understand puns and riddles; thus those with language-impairments and lower-level language skills are left out and often confused (Spector, 1990; Yuill). Paul (1987) suggests that many people who are deaf may be unaware that a word may have
several meanings; he further suggests that activities such as puzzle-type riddles can be used to teach multiple meanings of words to students. This and other types of language-play may give young readers access to the flexibility of language in humor, metaphor and other figurative language (Lee, 1990; Paul).

**Prior world knowledge.** Readers bring experiences and background knowledge about how the world works (prior knowledge) to the task of reading, which they apply to the text to assist in comprehension (Jackson et al., 1997). Jackson et al. (1997) explain that because texts are not explicitly written, readers must use their prior knowledge to make inferences and fill in gaps in information. Thus comprehension is dependent upon a certain amount of existing knowledge already in the reader’s memory. In a study examining the effect of prior knowledge on reading comprehension for deaf and hard-of-hearing students, Jackson et al. found that prior knowledge was a significant predictor of students’ comprehension of a text. They suggest that an in-depth pretest probe of prior knowledge activated relevant background information relevant to the reading passage, which enabled students to relate their knowledge to the story. This effect was context specific, however, and the effect of the prior knowledge probe was not generalizable to students’ standardized reading comprehension (Stanford Achievement Test) scores. In contrast, the data did indicate that reading comprehension scores and SAT scores were both highly related to students’ scores on script-implicit (SI) questions. This may indicate that a reader’s ability to answer SI questions, which make inferences from information stored in memory, is a good index of reading comprehension (Jackson, et al.). This supports the hypothesis that prior knowledge affects reading comprehension among deaf and hard of hearing students, and that it must be both activated and enriched to improve comprehension.
Global Cognitive Factors

In his review of the literature on reading and deafness, Marschark (1993) points out that "nonlinguistic, experiential and cognitive factors affect reading at levels beyond those of phonological coding and vocabulary" (p.219). He suggests that global cognitive factors, such as concept knowledge, cognitive style and memory should be considered in the issue of reading and deafness. Research indicates that deaf and hearing individuals are equal on many aspects of cognitive skill (Paul & Quigley, 1994; see also Rodda & Grove, 1987, for a complete review); however deaf subjects consistently perform below hearing controls in two specific areas, short-term memory storage and English language skill (Rodda & Grove, 1987). The latter encompasses other areas of cognitive organization as well.

The role of memory. Research indicates that both lexical and syntactic knowledge may have an effect on the reading comprehension of readers who are deaf, which in turn affects memory processing. Kelly (1996) explains the broader implications of this relationship.

Because these two processes [lexical and syntactic knowledge] are not applied skillfully by many deaf readers, it is possible that both of them may consume working memory capacity during reading. They also may pass on somewhat flawed information to be acted on by other reading processes.... There is evidence that deaf readers compensate for limitations in syntax and vocabulary by relying more heavily on conceptual reading processes, such as application of world knowledge. However, ...this reliance itself creates a drain on working memory capacity. (p. 78-79)

Research has suggested that the relationship is not causal, however, and regression analyses have indicated that (1) word knowledge and general (world) knowledge and (2) working memory capacity may each uniquely contribute to the prediction of reading
comprehension (Garrison et al., 1997). Furthermore, these two factors may predict deaf readers' ability to integrate information in text (within paragraphs) and draw inferences (Garrison et al.). Memory capacity may have a direct relationship to reading ability above and beyond the burden on working memory due to factors such as poor lexical knowledge (Garrison et al.). Therefore, individuals "may be good or poor readers because they have relatively large or small working memory capacity" (Garrison et al., p. 93).

Garrison et al. (1997) explain that during reading, working memory must maintain two pieces of information simultaneously: information that was just immediately read and information that was previously read. In this manner, working memory directs the processing of information to enable the reader to fully understand the text. Studies examining deaf children's syntactic abilities proffer that the children have the most difficulty with syntactic constructions that involve holding verbal information in short-term memory while awaiting subsequent syntactic or semantic information (King & Quigley, 1985; Marschark, 1993; Paul & Quigley, 1994). Marschark suggests that this is consistent with research findings which indicate that children who are deaf tend to display a lack of concentration and tend to be impulsive in their cognitive styles. It is also possible evidence of memory deficits or smaller memory capacity (Lichtenstein, 1985; Marschark).

Research on memory in general also suggests that individuals who are deaf perform better on spatial or simultaneous memory tasks than on sequential tasks (those for which the order is important) (Kusché, 1985; Paul & Quigley, 1994; Rollman & Harrison, 1996). In a study comparing free recall of texts between deaf and hearing adolescents, Marschark and colleagues found that adolescents who are deaf recalled less than their hearing age-mates, but more than younger hearing children with whom they were matched on reading ability (Marschark, De Beni, Polazzo & Cornoldi, 1993). Moreover, the deaf adolescents remembered less relational information than individual concepts, whereas the reverse was the case for the hearing group (Marschark et al., 1993), which may imply differences in
memory coding and organization. Paul and Quigley (1994) suggest that the sense of audition versus vision may better process input in a temporal-sequential manner; individuals who are deaf cannot rely on this modality difference. Furthermore, researchers propose that encoding strategies differ between deaf and hearing individuals and thus short-term memory may be qualitatively different for each group (Marschark & Mayer, 1998).

Cognitive development and organization. In her review of deaf children’s development, Liben (1978) cites four factors that Piaget set forth as causal agents of development: (1) maturation, (2) experience with objects, (3) social experience and (4) equilibration. Based on these factors, deaf children’s development may be thwarted; most children who are deaf are restricted in both the diversity of their experiences and in linguistic stimulation due to language barriers that exist between hearing parents and their deaf children (Marschark, 1993). As a result, children who are deaf appear to have restricted knowledge about things in the world and fewer labels for things around them (Griswold & Commings, 1974; Marschark, 1993).

Fischer’s skill theory (1980) asserts that cognitive development is domain specific and that skills develop in the context of particular experiences. Thus, if children are not exposed to certain skills, they are unlikely to develop them. This supports the idea that deaf children’s restricted experience adversely affects their skills in areas of general knowledge, language and socialization, and by extension reading and literacy skills. Brooks (1978) suggests that “deaf people have difficulty reading, not because their constructive processes are deficient, but primarily because they integrate information from a different basis, that is, without the data provided from knowledge of particular aspects of linguistic structure” (p. 90). In her review of research in sign language and visuospatial cognition, Emmorey (1998) concludes that use of sign language does not enhance visuospatial cognition in general; however, it does affect visual processes involved in sign language production and comprehension. This suggests that the language a person uses
may enhance certain cognitive processes (Emmorey); this seems to support the idea that cognitive processing may be qualitatively different among those whose language is sign-based.

As previously discussed, readers’ prior knowledge has been shown to assist them with reading comprehension; Schirmer (1994) explains this process through schema theory. Cognitive theories suggest that conceptual knowledge is organized in memory structures called schemata, which are hierarchically organized. Schirmer suggests that in order to understand a concept, the concept must activate a schema that is based on prior knowledge and experiences. Then, through assimilation of the new concept or accommodation of the existing concept to incorporate the new information, readers can use schemata to create meanings from text. Schirmer proposes that readers who are deaf may possess the knowledge to understand text, but may not apply it; she explains that readers who are deaf often “focus on an inappropriate schema because they are misled by nonsalient features of a reading passage or because the text requires combinations of background knowledge” (p. 115). If they are unable to apply the appropriate knowledge to a situation, comprehension may be sacrificed.

**Literacy and Deafness**

Ewoldt (1982) described reading as a process which is “...one and the same time a cognitive, linguistic, cultural, pragmatic, and emotional response to print” (p. 83). If all of these components are taken together, it begs a broader consideration, one which is greater than merely the sum of the parts (Paul, 1998); the concept of literacy encompasses this greater whole. “…Literacy marks a phenomenon that includes reading and writing skills but also includes knowledge of social contexts... beyond individual student achievement and beyond the span of school years.” (Padden & Ramsey, 1993, p. 97). It takes into account not only the reading process, but also the subjective experience of the reader, the politics of text-based literacy, the social milieu of the learning process, and the goal of
critical and reflective thought (Paul). (This is also beyond but inclusive of “functional literacy,” which Paul describes as the essential knowledge of such skills required for effective functioning within a community.) This section will present the aspects of literacy that pertain to captioning comprehension within the framework of this study.

**Literacy Perspectives.** Theories of literacy generally address literacy among hearing children, with whom the majority of such research is carried out; however, researchers have established parallels between the processes of reading for deaf and hearing children (Ewoldt, 1990, Strong & Prinz, 1997). The two broad perspectives of governing literacy theories are the reading-comprehension perspective and the literary critical perspective. This review will broadly outline each perspective and its relevance to captioning comprehension.

Empirical scientific research on reading and literacy is generally based upon reading-comprehension theories. Such theories are generally based in cognitive science or information-processing and focus on developing or improving reading proficiency, as presented in the discussion on the process of reading. The three basic models are (a) bottom-up, (b) top-down, and (c) interactive models. Bottom-up models are inductive in nature and focus on decoding the elements of the text and extracting meaning from them (Adams, 1990). Although each element (e.g., letter and word recognition) is important to the process of reading, the process of decoding lower-level elements of the text is not sufficient to explain reading comprehension. Top-down models emphasize deductive inference, based on the readers’ existing knowledge. Thus, exposure to and experiences with reading are important; knowledge is constructed rather than taught (Paul, 1998). This aligns with Piaget’s theories of cognitive development; as previously mentioned in the discussion on cognitive factors, a reader’s schemata may be transformed during the reading process through assimilation and accommodation of information. Top-down models ignore the influence of the text, such as difficult words or topics (Paul, 1998).
Interactive models have combined the bottom-up and top-down processes into a more comprehensive framework of reading comprehension. They allow for both processes to interact reciprocally in order to contribute to overall comprehension. Therefore, interactive models are less limiting than the previous two models. The interactive models take into account the integration of the information in the text and the information the reader brings to the text. Such models tend to emphasize the importance of schemata, but they are vague about how schemata develop and relate to one another (Paul, 1998). Despite this limitation, the research in the present review generally applied the interactive framework to the discussion of the reading process.

The literary critical perspective addresses issues of empowerment (and oppression), enlightenment and emancipation (Paul, 1998). Concerning literate thought, it poses questions such as whether literate thought (critical and reflective thinking) is possible without text-based literacy (Paul & Quigley, 1994). Critical theorists tend to be concerned with challenging the mainstream assumptions and beliefs; instead of explaining problems (as in the reading-comprehension framework) the focus of critical analysis is on resolving problems (Paul). This approach is more subjective, taking the specific context into consideration. It stresses the transaction between an individual and a particular environment, based on Vygotsky’s views of language as a social process. Relative to this study, Paul avers that the critical perspective examines issues of accessibility and oppression; it examines whose interests are being served in a particular view of literacy.

In his in-depth review of deafness and literacy, Paul (1998) describes the reading-comprehension perspective as based on a clinical paradigm of deafness. It’s aim is to improve and understand the process of literacy and it focuses on identifying skills which are deficient. This view can be quite productive in terms of improving a child’s skills and furthering scientific understanding. In contrast, the literary critical view does not focus on improving literacy, but rather focuses on developing literate thought. From this standpoint,
it approaches literacy from a cultural paradigm (Paul, 1994), addressing the needs and values of a specific culture or subgroup.

**Deaf culture and ASL.** “The term *Deaf culture* is used to identify a set of beliefs and practices shared by a group of deaf people who also share a common signed language” (Padden & Ramsey, 1993, p. 97). This does not suggest that all people who are deaf share the same set of beliefs or that all people within the culture share the same set of beliefs, practices or language variations. Deaf culture does, however, reflect the idea that deafness is not an impairment or disability; that is, it is a non pathological view of deafness (Jackson & Paul, 1993). It recognizes that American Sign Language “is a natural human language, the use of which structures the social and cultural worlds of Deaf people” (Padden & Ramsey, p. 98).

In terms of literacy, the cultural focus is on social practices and strategies rather than on an individual’s mental processes (Padden & Ramsey, 1993). Padden and Ramsey point out that within Deaf culture, some level of reading proficiency is necessary for reading television captions, reading (and writing) TTY messages and email, and possibly for religious study and work or pleasure. They suggest that some Deaf adults may learn to read from other group members, long after formal schooling has ended. An examination of literacy within the Deaf community might look at how people use print and gain literacy skills (Padden & Ramsey).

The challenge of literacy within Deaf culture is compounded by the issue of reading in a second language, as reflected by the bilingual-bicultural model of education. This model asserts that if ASL is established as a primary language, English literacy can be achieved without exposure to spoken English (Mayer & Wells, 1996). Padden and Ramsey describe the relationship between ASL and literacy as follows:

ASL makes the world intelligible to Deaf people, makes it possible for them to have a group life that includes a rich variety of expressive resources, including English in
print. Cultural worlds also provide the foundation for important human capacities such as the ability to learn human language, the ability to use language as objects of reflection, the ability to take conscious control of one's own learning, and in the specific case at hand, one's own literacy. (p. 98)

Case studies of children who are deaf suggest that if children have exposure to literacy activities in their environments, they will develop an understanding of uses for literacy (Williams et al., 1992). Research has supported ASL as a gateway to English literacy; Strong and Prinz (1997) found that children with a higher level of ASL skills outperformed children with lower ASL skills on measures of English literacy, regardless of age and IQ. Mayer and Wells argue, however, that because there is no secondary (written) form of ASL and children who are deaf do not have access to the primary (spoken) form of English, the challenge of literacy is far greater for children who are deaf than for hearing children learning a second language. Furthermore, signs and words convey meaning in different ways, thus, "the relationship between thought, sign, and written word can... be very complex" (Mayer & Wells, p. 98). Both literary critical theory and cultural models of literacy suggest that for Deaf people to achieve literacy, text-based literacy must be perceived within the Deaf community as functional and personally meaningful (Mayer & Wells).

Summary and Conclusions

By mandating that most televisions have built-in caption-decoders, the Television Decoder Circuitry Act took a step forward in making television accessible to people who are deaf. This review has demonstrated, however, that the issue is much more complex and diverse than simple legislation. In recognition of the issues of Deaf culture and the literary critical perspective, it is important to ask members of the Deaf community themselves how they define literacy and what aspects of literacy are important. For example, often when it has been suggested that captions are "watered down" to a more
accessible reading level, members of the Deaf community have cried out, demanding the same information that would be given to a hearing person.

Research to date seems to indicate that most teenagers who are deaf can only read on a third- or fourth-grade level (Kelly, 1995; Quigley, 1982; Jackson et al., 1997), yet captioned television and films (which are presumably at a higher reading level) are quite popular among school-aged children (Liss & Price, 1981). Proponents of the reading-comprehension perspective of literacy suggest that researchers try to determine how the process of reading works and, more importantly, how to improve literacy skills among the deaf (Adams, 1990; Kampfe & Turecheck, 1987; Marschark, 1993; Paul, 1998). Literary critical theorists may instead focus on how television can be used to develop literate thought; they may examine whose interests are being served by learning to read captions (Paul, 1998). From either perspective, for people who are deaf, reading is a necessary skill that is not easily achieved.

Children who are deaf often come in to the reading process at a deficit, as compared to hearing children, who typically have already had exposure to the primary form of the language in which they are learning to read (Kusché, 1985). Written English is not just a foreign language to many people who are deaf, it is a language which is drastically different in terms of production as well as linguistic structure (Quigley, 1982). Research has found that a not only is knowledge of English important for the reading process, but a broader metalinguistic understanding is also essential (Adams, 1990; Paul & Quigley, 1994). For children who are deaf, the demands of word recognition skills, lexical ambiguity, phonetic recoding, prior world knowledge and linguistic knowledge are often a strain on cognitive organization and memory capacities (Marschark, 1993); the process seems like an uphill battle.

Research has also shown, however, that children are motivated to read by watching captioned television (Loeterman et al, 1995; NCI, 1983). Developmentalists who stress the
importance of a child’s learning environment and literacy theorists who focus on the
cultural aspects of literacy would agree that if reading and reading-based activities are
incorporated into daily living, children will come to understand literacy as socially valuable
(Adams, 1990). From that respect, captioning may be welcomed as a path to literacy.
Captioning has made television accessible, to some extent; the question remains, however,
as to whether viewers who are deaf are gleaning the same information from captions as
hearing viewers are able to get through the audio portion of television.
CHAPTER 3

METHODS

Participants

Deaf participants were drawn from elementary school students, ages 8-20, from the Ohio School for the Deaf and the Columbus Hearing Impaired Program (CHIPs). The Ohio School for the Deaf is a residential school program, kindergarten through high school, in which the primary language of instruction is American Sign Language or other sign-based languages, with a “Deaf culture” focus. Students are from throughout the state of Ohio; those from Central Ohio go home every afternoon and the other students return home for weekend visits. The Columbus Hearing Impaired Program is part of Columbus Public Schools and has a mainly oralism/vocalization focus, although students and teachers typically use Total Communication, a combination of sign and speech. The program is somewhat integrated with Columbus Public Schools. Permission slips were sent home to all of the students in both programs who were at least 8 years old.

A comparison group of hearing students from an urban elementary school in Columbus Public Schools and Immaculate Conception School, a private parochial school in Columbus served as a comparison group. For students in the Columbus Public Elementary School, permission slips were sent home to all of the third, fourth and fifth grade students in the school. For Immaculate Conception school, permission slips were sent home to all fourth, fifth and sixth grade students.
Informed consent was obtained from the parents of all potential participants and assent was obtained from the participants themselves prior to any screening and selection procedures: Announcements describing the research project were made in each class, after which a letter was sent to all students along with a cover letter from the building principal in each of the selected schools. The letter informed the parents about the purpose, instruments, and procedures to be used in the study. A permission form was included with the letter that must have been returned before any student was considered as a potential participant. For the students from Ohio School for the Deaf, permission slips were mailed to the parents at home, with a stamped return-envelope. Among the students in the Columbus Hearing Impaired Program, 32 students returned permission slips; 30 students from the Ohio School for the Deaf returned their permission slips. Only 19 of the Columbus Public School students returned permission slips, however 90 of the Immaculate Conception School students returned their permission slips.

From the sample of students whose parents returned permission slips, study samples were drawn. The screening procedures used to select each subject included the following: A file review was conducted to determine dBs of hearing loss. For the sample of students who are deaf, only those students were selected who have a hearing loss greater than 60 dB for the unaided, better ear across the speech frequency range (500, 1000, and 2000 Hertz) and no other disability except for corrected vision. For hearing participants, selected students had no indication of hearing loss or hearing-related problems and they considered English to be their primary language. For both sets of participants, a minimal reading level of 2.0 (based on the SAT) was required.

Based on these criteria, 18 Columbus Public School students were eligible to participate; two students either dropped out during the course of the study or were eliminated for non-attendance. All 90 Immaculate Conception School students were eligible to participate in the study; 20 students dropped out during the study. From the students
who participated in the study, the hearing students who comprised the test sample were those whose reading scores most closely matched the deaf students'. Among the students in the Columbus Hearing Impaired Program, 30 students were eligible to participate in the study; four students either dropped out or were later eliminated. From the Ohio School for the Deaf, 25 students were eligible to participate in the study and one student dropped out. The study used a within groups design with 50 participants per group, for a total of 100 participants. There were 45 males and 55 females, ranging in age from 8-20 and ranging in reading level from 2.0 to 11th grade.

Instrumentation

**Stanford Achievement Test - Hearing Impaired Version (Form S)**. The SAT is scored by grade level equivalents by year and month in the school year. The schools administer the SAT to students biennially; it is a multi-level multiple choice exam, revised for deaf and hard-of-hearing students. Only those scores on the reading battery were recorded. The SAT is included in this study because it is considered a valid measure of literacy for the hearing impaired population. For schools that did not use the SAT (for hearing students), other standardized achievement test scores were converted to the SAT grade-level equivalency.

**Comprehension Test (CT)**. A criterion-referenced test based on the content of the video segments was developed, revised from the reading comprehension test format used in Jackson et al. (1997) for students who are deaf. The test probes information that is explicitly stated in the text (“Text Explicit”), information that can be inferred from combining specific information located in the text (“Text Implicit”) and implicit information which requires inference from prior knowledge (“Script Implicit”). The CT is a measure of caption comprehension in terms of comprehension of specific word concepts in the text and comprehension of the story script.
Information Level Test (IL). Based on Cavanaugh (1983), single-idea statements were generated from the video content. Raters judged each statement as either central to understanding the plot of the video, a detail relevant to the plot, or a detail irrelevant to the plot. Based on interrater agreement of the categorization of the statements, an equal number of central, relevant, and irrelevant statements from which to construct multiple choice questions were chosen. IL scores are expressed as a proportion of correct responses in each category of recall.

Stimulus Construction

This research examines comprehension for deaf and hearing participants under three conditions: (1) a video with captions (no audio), (2) a captioned display with no picture (captions on a black background with no visual scene), and (3) a transcript of captions without video. Table 1 outlines these conditions.

<table>
<thead>
<tr>
<th>hearing status</th>
<th>Condition</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
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<tbody>
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<td>CC without picture</td>
<td>transcript of video</td>
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</tr>
<tr>
<td>(no audio)</td>
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<td></td>
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<td></td>
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<tr>
<td>Hearing</td>
<td>video w/ CC</td>
<td>CC without picture</td>
<td>transcript of video</td>
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<tr>
<td>(no audio)</td>
<td></td>
<td></td>
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Table 1: Captioning Comprehension Model.

Four 10-minute captioned video segments, which are equivalent in comprehension difficulty level, were selected. The segments were selected from four programs in the BBC and NOVA/WGBH-Boston television miniseries, "Secrets of Lost Empires." Based on
Chall and Dale's (1995) readability formula, the transcripts had a readability grade level of 8. Each of the video segments was re-captioned using open-captions, thus the captions appeared on the screen at all times. The four videos were as follows: Stonehenge, Colosseum, Obelisk, and The Incas. The first 10 minutes of each program was chosen, which consisted of mostly introductory narration. Four videos were used so that there are no repeat effects of using the same video under the different conditions within one group (a

<table>
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<td>S1</td>
<td>1A 2B (3)C 4D</td>
</tr>
<tr>
<td>2</td>
<td>S2</td>
<td>(3)C 1A 4D 2B</td>
</tr>
<tr>
<td>3</td>
<td>S3</td>
<td>2B 4D 1A (3)C</td>
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<td>S4</td>
<td>4D (3)C 2B 1A</td>
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<td>S2</td>
<td>(3)A 1C 4B 2D</td>
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<tr>
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<td>S3</td>
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<td>12</td>
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<td>4B (3)A 2D 1C</td>
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<td>S3</td>
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<td>S3</td>
<td>2A 4C 1D (3)B</td>
</tr>
<tr>
<td>16</td>
<td>S4</td>
<td>4C (3)B 2A 1D</td>
</tr>
</tbody>
</table>

16 tapes, with 4 sequences (seq.): VIDEO TAPES: A. Obelisk B. Stonehenge C. Inca D. Coliseum CONDITIONS: 1. Video with CC 2. Black screen 3. transcript and 4. multiple-viewings of video with CC (not used for this study)

Table 2: Tape sequences varied by video content and video condition.

40
fourth condition was tested but not used in this study). Table 2 outlines how the test sequences, video conditions (content) and experimental conditions varied among the subjects. A printed transcript of the captions without video was also provided. A criterion-referenced test of comprehension and caption reading comprehension (CT) was developed based on Jackson et al. (1997).

**Design**

This study was designed to test how students' comprehension of captioned television compares to their comprehension of printed text and whether children who are deaf understand captioned television as the same level as hearing children. Part of the issue of the poor rates of literacy of students who are deaf is their inadequate development of a language. Without a language base (signed or oral), literacy will be deficient. Since television is purported to be an accessible medium using visual presentation of information, closed captioning was introduced to improve the comprehension of the visual information. If students who are deaf have inadequate language skills, then they should be both retarded in reading level compared to their hearing age-counterparts and will have less knowledge of concepts with multiple meanings that are in the transcripts, which would make the comprehension of text a measure of the deaf students' literacy level. The study assesses participants' understanding of concepts in English, which is indicative of language facility in general. It explores the utility of English captions for making the content of television programs accessible and understood within and across age-levels and the implications this may have for the reading development of children who are deaf.

**Procedure**

Each student's score on the Stanford Achievement Test (Hearing Impaired Version, as appropriate) (SAT) was obtained, as an indication of literacy level. For both the deaf participants and the hearing comparison group, comprehension under all three conditions was examined. Presentation order of conditions was counterbalanced across participants.
(see Table 2). Research assistants presented each condition to the participants over the course of one to two weeks during school, as schedules allowed. Each session lasted approximately 45 minutes. Deaf participants were tested in small groups of two or three students, due to interpreting restrictions; hearing participants were be tested in larger class groups. Both sets of students were tested in a quiet classroom in which the testing was the only activity in the room.

At the beginning of each session, a research assistant read the following prepared script:

We want your help to see if captions are really a good way to see what television programs are about. Over the next few days, you will be asked to watch several short video tapes. After each video tape, we will ask you a few questions to see if the captions were able to tell you what the story was about. You will see different types of television programs, all will have captions, or words, at the bottom; some will have no picture, only words; and some you will have to watch twice. We will also give you a story to read, which will also be followed by questions. If you don’t understand some of the words in the story or on the television screen, that is okay. Just try to figure out what is going on and what that word might mean. All we ask is that you try to answer the questions to the best of your ability. There is no grade for this and we will not tell anyone what your answers are.

After each 10-minute video segment, an 18-question multiple-choice test was distributed. Deaf participants were tested in their primary language or their language of greatest competence; in every case, the test was read out loud and sign-interpreted by a certified sign language interpreter. A written version was read out loud for the comparison group. Care was taken that all of the students completed each question before the next question was read. After the tests were collected, students’ questions on the video-content were answered. At the end of the entire testing period, a standard debriefing was read and
students’ questions on the methods of the experiment were answered. Based on the test, the effect of the viewing conditions on comprehension and information level were examined.

Subjects’ tests were scored based on the total number of correct answers. Each item was coded for both the comprehension-test sub-scales and the information-level sub-scales. Based on these codes, the total number correct was tallied in each of the following categories: Text Explicit, Text Implicit and Script Implicit for the Comprehension Test score; Central, Relevant and Irrelevant for the Information Level Test score. Both the overall score (out of 18) and each sub-score (out of 6) were recorded.

Data Analysis Procedures

The data were collected through criterion-based reading tests and reading comprehension assessment (SAT) batteries. Each subject’s school record was used to obtain the SAT scores, which are gathered every two years. A mixed analysis of variance in which SAT score was held constant was conducted in order to assess what effect each viewing condition has on deaf and hearing participants’ comprehension of the video content. This analysis addressed issues raised in the original research questions: (a) Given equivalent reading levels, do children who are deaf understand captioned television at the same level as hearing children? (b) To what extent are students’ “reading scores” generalizable to other media? and (c) What type of information are students understanding and recalling better? The independent variables are the viewing conditions (3) and hearing status, as between subjects variables, and video-content as a within subjects variable; the dependent variables are the comprehension test (CT) and information-level test (IL) scores. Table 3 outlines the hypothesis and analysis procedures for each. All data were compiled and analyzed using the SAS statistical analysis software package.
Table 3: Hypotheses and corresponding analyses.

It was predicted that \((H_1)\) findings would reveal a positive relationship between SAT score and CT score for both deaf and hearing students and \((H_2)\) students' scores for the transcript version will be significantly better than their scores for either video version. Given equivalent reading levels, \((H_3)\) hearing students would score better than students who are deaf across all conditions. \((H_4)\) On the comprehension test, students would tend to recall more Text Explicit information and \((H_5)\) on the information level test, students would recall more Central details. In addition, on the information level test, \((H_6)\) there would be a strong positive correlation between SAT score and IL-score.
CHAPTER 4

RESULTS

The data were analyzed using correlational analyses and ANOVA procedures. This chapter will present the findings as they are related to each of the hypotheses. It will begin with an overview of the results within which each hypothesis will be addressed. It will then focus more specifically on several main issues of the study: the effect of reading score on the Comprehension Test (CT), the effect of each of the experimental conditions, the difference in responses for each of the question-types in the CT, and the Information Level test. A summary of the major findings will follow.

The analyses have demonstrated that students who are deaf tend to score lower on the Comprehension Test than hearing students, given equivalent reading levels. Moreover, SAT reading scores are correlated with Comprehension Test and Information-Level test scores for both hearing students and students who are deaf. Recall of Text Explicit and Central information did not emerge as significantly different than recall of Text Implicit and Relevant information, respectively. The first analysis focused on comparing the comprehension test results of deaf versus hearing students and comparing CT and IL scores to SAT scores. The second analysis examined the effects of the three viewing conditions. Finally, the third analysis focused on the sub-scales of each of Comprehension and Information-Level tests.
It was predicted, in Hypothesis 3, that hearing students' test scores would be higher than the scores of students who are deaf, across all conditions. This prediction is based on the previous findings that reading comprehension among the students who are deaf is much lower than among the hearing students (Paul, 1998; Paul & Quigley, 1994). These results were obtained using a Least Squared Means procedure in a mixed analysis of variance. Research suggests that both comprehension and the type of information recalled is related to reading level (Cavanaugh, 1983; Jackson, et al., 1994), thus hypotheses 1 and 6 predicted that there would be a positive relationship between SAT score and both CT and IL scores for all students. A regression analysis was used to test these hypotheses.

The video-captioning in this study was verbatim captioning, that is, the captions were not altered or adjusted for reading level or captioning rate. From Hypothesis 2, it was anticipated that students' scores for the transcript version would be significantly better than their scores for either video version. This prediction was based on captioning research that suggests that students who are deaf are able to read captions at their grade level, but not necessarily above that level (Koskinen et al., 1987). Cognitive-developmental research also suggests that memory plays a significant role in reading ability (Garrison, et al., 1997), which is essential for captions which can not be "reviewed" in the same way as written text because it is impossible to look back at previous text. A Least Squared Means procedure in a mixed analysis of variance was used to compare the scores of each video condition.

Finally, research on deaf and hearing individuals suggests that readers who are deaf tend to recall more text-based information (Text Explicit and Text Implicit) (Jackson et al., 1997). Cavanaugh (1983) found that adult television viewers recalled more central details than relevant or irrelevant details of a program; however, this research has not been replicated with children or individuals who are deaf. Based on Cavanaugh's research, it was expected that students would tend to recall both more Text Explicit information
(Hypothesis 4) and more Central details (Hypothesis 5). Again, a mixed analysis of variance was used to test these hypotheses.

In order to compare the test scores of hearing students and students who are deaf, this study used a mixed analysis of variance model. Within the MANOVA, both between- and within-subjects factors were used and SAT score was held constant as a covariate. The effect of each experimental condition on CT-and IL-scores was compared through a 2 x 3 (Hearing Status x Video Condition) analysis of variance. An alpha level of .05 was used for all statistical tests. A power analysis indicated that 100 total subjects (50 in each group) are needed for a power of .80 at the alpha level of .05 with an effect size ($R^2$) of .30.

Overall, the mean age for students who are deaf (180.2 months) was higher than for hearing students (129 months) but was not significant, $F_{(1,83)} = 3.27$, $p = .07$, yet the mean SAT-score (reading grade-level) for students who are deaf was significantly lower (deaf SAT = 3.71 $SD=1.64$; hearing SAT = 5.6 $SD=1.99$). $F_{(1,83)} = 75.83$, $p = .0001$). (The overall age-range was 103 months to 248 months; with a range of 103 months - 156 months, $SD=11.18$, for hearing students and an age range of 122 months - 248 months, $SD=34.24$, for students who are deaf.) As a whole, hearing students scored

<table>
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<tr>
<th>Group</th>
<th>age</th>
<th>SAT</th>
<th>CT score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing</td>
<td>129</td>
<td>5.6 (a)</td>
<td>9.79 (b)</td>
</tr>
<tr>
<td>Deaf</td>
<td>180.2</td>
<td>3.71 (a)</td>
<td>7.36 (b)</td>
</tr>
</tbody>
</table>

Note. scores with same letters are significantly different from one another

Table 4: Mean Age, SAT Score and Comprehension Test (CT) Score for Deaf and Hearing Students.
significantly higher than students who are deaf on the video-based comprehension test (hearing mean = 9.79, deaf mean = 7.36), $F_{(1, 83)} = 5.97, p = .0166$, as predicted by $(H_3)$. Table 4 illustrates these findings.

**Effect of SAT on Comprehension Test (CT) Score**

The mixed analysis of variance model indicated significant effects for hearing status, $F_{(1, 83)} = 5.97, p = .0166$ and video-content, $F_{(3, 255)} = 8.48, p = .0001$; the effects for experimental condition did not reach significance, $F_{(3, 255)} = 2.51, p = .0596$. Neither age nor sex contributed independently to test scores. SAT score (reading grade-level) had a strong significant effect on test scores, $F_{(1, 83)} = 75.83, p = .0001$. There is a strong positive correlation between SAT-scores and both comprehension-test and information-level test scores $r = .78, p = .0001$ (Person Correlation Coefficient) for both deaf and hearing students. This finding allowed the null hypotheses to be rejected for $(H_1)$ and $(H_6)$, which predicted that findings would reveal a positive relationship between SAT score and both CT and IL scores for both deaf and hearing students. SAT scores were also strongly correlated with CT- and IL-scores for the transcript condition alone ($r = .73, p = .0001$). Because of the large difference in mean SAT scores for deaf versus hearing students, SAT was held constant as a covariate throughout the remaining analyses.

**Effect of Experimental Conditions**

Using a mixed analysis of variance, the effect of each experimental condition on the comprehension test scores for each video was examined. There were significant main effects of hearing status $F_{(1, 83)} = 5.97, p = .0166$ and video (content) $F_{(3, 255)} = 8.48, p = .0001$. There was not a significant interaction of video and hearing status, however; thus the effect of video content is not of concern for this analysis. A main effect for video condition did not reach significance, $F_{(3, 255)} = 2.51, p = .0596$. It demonstrated that students who are deaf tended to perform better on tests based on the captioned video (condition one) than other conditions, although there was no significant difference among
Figure 1: Comprehension Test Scores by Video Condition for Deaf and Hearing Students
the scores for hearing students. Figure 1 illustrates these comparisons. Because the differences among the conditions were not always as predicted, the null hypothesis could not be rejected for (H2), which predicted that students’ scores for the transcript version would be significantly better than their scores for either video version. Scores for the captioned video condition were consistently higher.

**Comprehension Test (CT) Sub-scales**

The comprehension test (CT) probed comprehension of different types of information: Text Explicit (TE), that which is clearly stated in the text (because the transcript and captioned texts were identical, “text” will hereafter be used to refer to the presented material in either format); Text Implicit (TI), information that can be inferred from information given in the text; and Script Implicit (SI), information that is related to the text but also requires inference from prior knowledge. An analysis of variance on the comprehension test sub-scales indicated significant main effects for video condition (p = .0001), hearing status (p = .0001) and type of question (p = .002) and a significant interaction of hearing status and video condition (p = .0001). A Least Squares Means procedure indicated that in general, both deaf and hearing students tended to answer significantly more TE questions correctly than SI questions (p > .02) and only slightly

<table>
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<tr>
<th>Type of Question</th>
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<th>TE</th>
<th>TI</th>
<th>SI</th>
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<td></td>
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<td>2.65 (a, c)</td>
<td>2.45 (d)</td>
<td>2.27 (a, e)</td>
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</table>

*Note.* Means with the same letters indicate significant differences, p < .01.

Table 5: Mean TE, TI and SI scores for deaf versus hearing students
more TE questions than TI questions. In comparing the deaf and hearing students, hearing students tended to answered more questions correctly overall. Table 5 illustrates the mean TE, TI, and SI scores for deaf versus hearing students. Based on this finding, the null hypothesis (H₄) cannot be rejected; the data do not indicate that students tend to recall more Text Explicit information than all other types of information.

Information Level (IL) Test

The information level test probed recall of information which was central, relevant and irrelevant to the plot. This analysis was based on Cavanaugh's (1983) study of retention of relevant story information in television programs, and thus is only applicable to the captioned video version (Condition 1). An analysis of variance across videos (content) showed a significant main effect for hearing status $F(1,7) = 19.66 \ p = .0001$; a Least Square Means procedure indicated that hearing students outperformed students who are deaf on all videos. There was not a significant main effect for video content, however; thus the “story” (Obelisk, Inca, etc.) did not affect recall. Further analysis using a mixed analysis of variance indicated a significant main effect for the type of information, $F(2,1150) = 9.94 \ p = .0001$. Recall for Central details was significantly better than for Irrelevant information (H₅), but no different than recall for Relevant information, $p < .05$. Figure 2 illustrates these results. Taken with the significant correlation between IL-test scores and SAT-scores, this finding suggests that better readers versus poor readers recalled both more information in general and more information that is either central or relevant to the story.

Summary

This chapter examined effects of (1) SAT scores on both the Comprehension Test (CT) score and Information Level (IL) test, (2) experimental conditions on CT and IL scores, (3) hearing status on question-type, and (4) video content, SAT, and hearing status on information recall. SAT is strongly correlated with CT and IL scores, yet when SAT is
Figure 2: Recall of Central, Relevant, and Irrelevant Information for Captioned Videos
held constant, hearing students' CT and IL scores are still significantly higher than deaf students' scores. In other words, given equivalent levels of reading skill, students who are deaf lag behind hearing students in their ability to generalize this skill or use prior knowledge to answer the questions correctly. For both hearing students and students who are deaf, however, scores tended to be highest for the captioned video (Condition 1). It was predicted that students' scores for the transcript version would be significantly better than their scores for either video version (H2), therefore the null hypothesis cannot be rejected. This finding may suggest that the pictures in the video assisted comprehension in general.

The findings supported three of the original hypotheses: (H1) Findings reveal a positive relationship between SAT score and CT score for both deaf and hearing students. (H3) Hearing students scored better than students who are deaf across all conditions and (H6), there is a strong positive correlation between SAT score and IL-score. The hypothesis (H4) that students would tend to recall more Text Explicit information on the comprehension test was not supported, however. On the information level test, students recalled more Central details than Relevant or Irrelevant details, thus the null hypothesis (H5) can be rejected. In summary, although SAT scores significantly predicted students' test scores, the high scores on the captioned video (Condition 1) were unexpected (H2).
CHAPTER 5

DISCUSSION

The focus of this research is to determine the extent to which reading levels of students who are deaf contribute to comprehension of captioned television and recall of relevant information in television programs. To address the issue, this project examined how students’ comprehension of captioned television compared to the their comprehension of printed text. Findings lend support to the hypotheses that higher reading levels are associated with better captioning comprehension and recall of television program details for both hearing students and students who are deaf. Specifically, results indicated that SAT was highly correlated with comprehension scores for both deaf and hearing students; however, the hearing students consistently outperformed the students who are deaf on all comprehension and recall measures.

Both hearing students and student who are deaf tended to recall more details that were central or relevant to the plot versus those that were irrelevant to the plot. Similarly, recall for text explicit information was not significantly better than recall for text-implicit information, but did significantly exceed recall for script implicit information. An unexpected finding was that students' scores for the captioned version (Condition 1) were higher than for the black screen (Condition 2) or transcript version (Condition 3) of the videos. This discussion will address issues of reading level, recall and captioned television. Finally, it will draw conclusions and suggest areas of further inquiry.
Interpretations of Findings

Reading level. The intent of this study was to match deaf and hearing participants by reading level based on Stanford Achievement Test (SAT) scores; however, due to limited deaf samples and the large discrepancy in reading levels between hearing students and students who are deaf, this was impossible. Comparisons between deaf and hearing participants based on reading level may not account for age-related increases in domains of prior knowledge. People who are deaf are often “shut out” of vicarious experiences and opportunities of hearing age-mates (Griswold & Commings, 1994; King & Quigley, 1985; Meadow, 1980), thus, a large age-related discrepancy in comprehension and information-level test scores was not anticipated. As expected, findings indicated that age did not contribute independently to the video-based test scores.

The finding of a strong positive correlation between SAT scores and video-comprehension test measures suggests that in terms of “reading comprehension,” the task demands are similar, regardless of the media. That is, the students’ SAT scores are a likely predictor of their comprehension test scores. Nonetheless, the scores of students who are deaf were significantly lower than the scores of hearing students, even given equivalent reading SAT scores.

Ewoldt (1987) criticizes standardized tests such as the SAT on the basis that correct answers often depend on assumed prior knowledge. Furthermore, standardized tests depend on specific “test-taking” skills, which are not necessarily the same as “reading skills” (Ewoldt). Thus, students who possess the ability to read well may not have the ability to take tests well. Ewoldt argues that the ability to comprehend is necessary for successful test-taking, whereas comprehension is necessary for good reading. Ewoldt describes comprehending as successfully using semantic cues to process text; however, comprehension involves integrating prior knowledge with the information in the text. “Comprehending involves much smaller units of text and may or may not correlate with
comprehension” (p. 23). She further suggests that because of their lack of prior experiences, children who are deaf need more context than the short passages typically provided on standardized tests.

Rodda and Grove (1987) argue, however, that for children who are deaf, reading is the most efficient receptive method of communication, when compared to oral methods, total communication and various forms of manual communication. Furthermore, they suggest that the low reading scores typically found for children who are deaf may be erroneous due to the techniques used to assess reading comprehension.

Deaf children are known to possess recognition vocabularies (assessed by verbal multiple choice) far smaller than those possessed by hearing children.... Almost all prelingually deaf children experience profound difficulty in grasping complex English syntactical structures.... [And] There is evidence that deaf and hearing children employ radically different strategies in answering reading test questions. (pp. 221-222)

This suggests that the findings of lower comprehension scores for children who are deaf may be due to the assessment techniques used in the present study and may not adequately reflect their comprehension. Rodda and Grove further argue that because a hearing impairment does not “incapacitate their central comprehension processes” (p. 223), reading has a great potential and thus should be emphasized as a vehicle of communication for the deaf.

Nonetheless, other studies have also demonstrated differences in reading skills between deaf and hearing students (Kelly, 1996; Kretchmer, 1982; Luetke-Stahlman et al, 1996). Expository texts tend to be especially difficult for students who are deaf because the students typically lack the necessary background knowledge about the topics (Luetke-Stahlman et al., 1996). Test structures and grammatical forms are often new and complex. Kretchmer (1982) notes that
... hearing and hearing-impaired individuals matched on measures of academic achievement do not perform equally when completing cloze passages or making judgments of grammaticality. These studies demonstrate that reading and measures of reading achievement are complex phenomena; with this caution in mind, it is undoubtedly true that the reading difficulties of the hearing impaired are the result of higher order processing (e.g. syntax, etc.).” (pp. 112-113)

The discrepancy between SAT scores and deaf students' versus hearing students' performance of the video comprehension measures in this study may be indicative of the comprehending/comprehension problem, as described by Ewoldt (1987). That is, students who are deaf and hearing students who score equally well on tests such as the SAT may obtain their scores for different reasons. Whereas hearing students may have achieved a level of comprehension, or an ability to integrate information, students who are deaf may have merely managed to comprehend the test in order to answer the questions correctly. The students who are deaf may not have the prior-knowledge base nor the skills to integrate their existing knowledge with the information presented in the test. Thus, students who are deaf are at a disadvantage in two areas: In general, hearing students may possess more background knowledge to apply to the process of answering the test questions (Luetke-Stahlman et al., 1996). In addition, the sentence structures of the questions may contribute to the difficulty of the question for students who are deaf (Kretchmer, 1982; Rodda & Grove, 1987).

Information recall. Similar to the results of Jackson et al. (1997), this study does not support fully a hierarchy among responses based on the types of questions asked. It was expected that students would score better on the TI versus SI questions and better on TE versus TI questions. Both deaf and hearing students were able to correctly answer text-based questions (Text-Explicit and Text-Implicit) equally well. Scores for questions which required inference from knowledge in memory (Script-Implicit) were significantly lower.
than scores for TE and TI questions for both deaf and hearing students. This difference may be due to the relative difficulty of Script-Implicit questions for both groups. Jackson et al. suggested that the difference among text-based and script-based scores may be due to the relative ease of processing text-based questions for students who are deaf because of the lower processing demands of such questions. They further propose that readers may have relied on pattern recognition strategies rather than retrieval strategies which employ prior knowledge. If this is also the case in the present study, the simpler strategies appear to have been used by both deaf and hearing students.

For each type of question, however, hearing students' scores were significantly higher than those of students who are deaf. Taken with the finding of lower SI scores overall, this may support the assumption that students' ability to correctly answer Script-Implicit questions is a good index of reading comprehension (Jackson et al., 1997). Research with hearing students indicates that prior knowledge about a topic increases the amount of information that children tend to recall after reading a text on the topic (Pearson & Fielding, 1991). High prior knowledge in an area allows readers to relate information in the story to information within their own memories, which enables more extensive processing, and may in turn lead to a higher level of comprehension.

The findings of greater recall of central and relevant information among better readers also supports the idea that prior knowledge enables more extensive processing; when readers can relate information to existing schemata, recall may be facilitated. In his research on television recall, Cavanaugh (1983) suggests that comprehension and retention of television programs is related to underlying verbal ability; individuals with lower verbal ability (measured by vocabulary skills) may encode less information than individuals with higher verbal ability. This is consistent with the present findings, which indicate a positive correlation between SAT scores and information recall. While students with lower verbal skills may encode less information (Cavanaugh), all students are selective in the type of
information they retain; thus, all students tend to be least likely to recall irrelevant information. Findings further suggest that prior knowledge is a major component of verbal ability and may assist students with recall of information, whether the story is conveyed via written text or television captions.

Caption comprehension. The finding of higher comprehension- and information-level test scores for the captioned version (Condition 1) versus the written text and "black screen" versions suggests that the combination of captions and video present an advantage to both deaf and hearing students in terms of comprehension. Although captions move quickly off the screen and the reader cannot look back at text (as is the case with a written transcript), the additional visual cues of the video, which are not available in the other conditions, may significantly contribute to overall comprehension. These findings are consistent with similar studies with both deaf and hearing students. In a study of hearing children learning English as a second language, Neuman & Koskinen (1992) argued that videotaped material may provide context for reading the accompanying captions; the action of the video provides a rich context of meaning, which is accessible to all viewers. Meyer and Lee's (1995) research with reading "deficient" hearing students also demonstrated that significantly more learning occurred for students using captioned videos versus traditional print materials. Moreover, students who viewed captions at a slower pace (78 wpm) retained significantly more information than students who viewed captions at an average rate of 116 wpm.

In a study of captioning with both hearing students and students who are deaf, Nugent (1983) found that comprehension test scores of students who saw videos with simplified captioning were significantly higher than the scores of students who saw captions alone ("black screen") or visuals alone. Results of Nugent's study further suggest that students who are deaf saw the captioned video scored as well as hearing students who saw the "black screen" condition. The present study, which used captions based on the
actual narrative ("verbatim captions"), did not find a similar advantage of the videos with captioning for students who are deaf. That is, hearing students' level of comprehension is higher across all conditions. Similar to Nugent's study, Braverman and Hertzog (1980) also used simplified captions and varied captioning rates. They cautioned that their findings can be generalized to other captioned programs only with qualification.

Television programs vary considerably in the amount and the level of abstractness of their verbal information. Some programs present one message in the audio (captions) and another message in the visual: This conflicting or ambiguous information may be confusing. Other programs present redundant information in the visual and audio (caption), and each may contribute to the understanding of the other. In either case, it is a challenge to determine what information is obtained from the caption. (p. 947)

Taking this caution into consideration, the present study found that the video (visual display) contributed to both deaf and hearing students' comprehension of the narratives, beyond what either group was able to understand from the text alone. This is the case even though the comprehension questions were based solely on the text contained in the transcript/captions.

Kelly (1996) suggests that captions be used in educational settings "to promote acquisition of target forms of printed English" (p. 88), such as difficult syntactic structures. Kelly's findings are relevant to the present study because they demonstrate, in part, how the video (visual scene) can assist a viewer's comprehension of the written text. He proposes that difficult English syntactic structures which are supplemented by video action would be contextualized and thus easier to understand. In a study using silent motion pictures and an accompanying workbook of sentences describing the action, Kelly (1998) tested adults' understanding of complex English sentence structures. He found that most
of the participants who used the video-workbook instructional method demonstrated improvements in their comprehension of relative clause and passive voice sentences.

This research study has demonstrated that the visual scene may assist viewers' comprehension of programs; nonetheless, captions still present their own comprehension problems. Findings such as Nugent's (1983) have led researchers and television stations to suggest editing of television captions; however, simplified captions have been strongly rejected as patronizing and insulting by deaf and hard of hearing viewers (Baker, 1995; Jensema et al., 1996). On the other hand, "captions" in sign language are technologically more difficult and expensive to produce and, as Baker notes, many deaf viewers are not conversant in sign language or may use a variant form of manual communication which is incompatible with the signed presentation. Therefore, Baker suggests offering more than one language level of captions for each program (using captioning channels 1 and 2, for example), one of which is simplified and one of which is verbatim captioning. Baker concludes that "the real long-term solution to the problem of deaf literacy levels is, of course, education" (p. 3).

Cognition and language development

Language is one of the foundations of education for both hearing students and students who are deaf; it is through language that the content of school curricula is conveyed. Yet, for students who are deaf, language is a complex issue: Because approximately 90% of deaf children are born to hearing parents, the language which is most accessible to deaf children is not the native language of their parents. Moreover, even educational systems which employ a sign-based system for communication must used English-based textbooks and materials, as there is no secondary form of American Sign Language. Within the present educational system, it seems essential for deaf children to learn to read English. Because of the original language barrier (due to non-deaf parents), however, deaf children quickly fall behind in their acquisition of general world knowledge
and metalinguistic knowledge. This only puts them at a further disadvantage for learning to read English.

Various systems of communication are used in school systems with deaf children. They typically fall into one of three categories: oral communication, total communication (a combination of oral communication and manually coded English systems), and American Sign Language. Research has indicated that both oral and total communication methods do not produce high levels of educational success (Paul & Quigley, 1994). Proficiency in oral English is quite rare for students who are deaf. Total communication systems which use a form of manually coded English (MCE) combine the signs of ASL with the grammatical structure of English. The result is an awkward and impoverished language model, which produces processing constraints for students. Furthermore, these artificially constructed communication systems defeat the purpose of establishing a sound first-language base from which English literacy can be taught. Thus, Paul and Quigley (1994) suggest,

If English is a very difficult, or perhaps, impossible, language for most deaf students to acquire, perhaps the focus should be on the acquisition of a bona fide language such as ASL. The development of any language is critical, albeit not sufficient, for the development of literate thought. (p. 295)

Acquisition of ASL is easier than English for students who are deaf and may allow for the establishment of a primary language as early as possible (ideally before age 6), from which concept knowledge can develop. In this way, ASL can then be used as a medium of instruction for students who are deaf, perhaps as part of an ASL/English bilingual program.

Prior knowledge consistently emerges as a factor in reading comprehension, recall, and test taking strategies (Ewoldt, 1987; Garrison et al., 1997; Marschark, 1993; Rodda & Grove, 1987). Inadequate prior knowledge also adversely affects working memory capacity and cognitive organization, which further hinders the reading process. With the
establishment of a primary form of a language, a child can concentrate on learning concepts, thus expanding his or her world knowledge. It is only through exposure to diverse and complex information that students can develop critical thinking skills, which they can then apply to learning to read.

Limitations and suggestions for further inquiry

The present study demonstrated that reading levels greatly affect students' comprehension of captioned television programs and furthermore revealed a discrepancy between comprehension levels of deaf versus hearing students. These findings have important educational and developmental implications for students who are deaf; however, the study has some limitations. Because of the limited availability of students who are deaf who met the minimum reading level, overall reading scores for deaf participants were lower than scores for hearing students. Although SAT scores were held constant in the analysis to create a statistical equivalency, the difference in reading levels may have contributed to video comprehension in more subtle ways. Because the better readers tend to be more widely read, they tend to have a broader knowledge base from which to draw in the process of attempting to understand new material. In addition, research suggests that it is likely that the hearing students had more exposure to varied experiences with other media and forms of information. The statistical equivalence of SAT scores may not fully account for these differences. Moreover, hearing students may have developed better test-taking skills and a better understanding of Question-Answer relationships. These are relevant and important skills that can be incorporated into curricula for students who are deaf. Further research is necessary to more adequately assess prior knowledge levels and their effects on television program comprehension.

The video tapes used for the study were chosen because of their educational and informational content, the high level of narration in the video, and the likelihood that students would not be familiar with the general topics or the specific story-lines. Most
importantly, the videos represented real television programs and the captions were not altered. Because the videos were taken from the BBC and NOVA-WGBH Boston miniseries, they were not assessed for grade level; the content may have been too complex for some of the younger and less-skilled readers. It is also highly probable that topics such as “Secrets of Lost Empires” are not part of students’ typical television-viewing schedule. Perhaps comprehension levels for students who are deaf would be higher for television programs that they regularly watch; their prior knowledge and levels of concentration and interest would be higher. Further research is necessary to investigate comprehension for different types of programs.

Moreover, the students who are deaf who participated in the research were taken out of their regular classes on four separate occasions during the late spring. Many of the students were noticeably distracted by the other “end-of-the-year” activities taking place in the school during the testing period. They were often bored by the video content and they found the “black screen” version of the video quite difficult to attend to. In contrast, the hearing students were typically tested in larger class groups in which the regular classroom teacher was present and strict rules of discipline and attention were enforced. Furthermore, they were not missing any other class activities, which may have increased their ability to concentrate on the video. Many of the hearing children had also learned the steps of the “scientific method” and were therefore interested in the research process, which contributed to their attentiveness. In general, the hearing participants appeared more motivated than the deaf participants, the effects of which are unknown.

Among the students who are deaf, there was a great variability in students’ language levels and language use, which could not be controlled. Although the sign-language interpreters adapted their signing for the students’ preferred language or mode of communication, the difference in language use may have had an effect on comprehension of both the videos and the questions. Many students read the questions to themselves
during the testing period. Due to the nature of oral language, this did not present a problem for the hearing students who could also hear the questions read out loud. For the students who are deaf, reading the questions themselves necessarily precludes paying full attention to the signing. Hearing students who read the questions while listening to them read out loud can have the benefit of interpreting the question via two modalities, whereas students who are deaf do not have this advantage.

Conclusions: The role of captioning in literacy and television accessibility

Research has shown that captioning allows television to be more accessible to people who might otherwise be “shut out” from the audio component of programs. Access to the information contained in the audio component is essential to comprehension of a program, especially if there is a discrepancy between the action depicted and information conveyed through audio or captions. From captioning research with handicapped children, Koskinen et al. (1987) concluded that “the technological development of closed-captioned TV has enriched the lives of handicapped individuals by allowing them to interact more successfully with their environment” (p. 5). Similar to the individuals Koskinen et al. described, the deaf students in this study all enjoyed watching television and watched it regularly, despite their apparent inability to comprehend programs at levels on par with their hearing peers.

Just as television is being used in classrooms as an educational tool for students learning English as a second language and students with reading difficulties, it is possible that by watching captioned television, students who are deaf could be advancing their literacy skills through exposure to English vocabulary and syntax. The concept of emergent literacy suggests that children's exposure to literacy activities in their social environment fosters literacy development (Whitehurst & Lonigan, 1998). Fisher (1980) proffers that an “organism’s control of a skill depends on a particular environmental context” (p. 479). Based on these views, consistent exposure to captioning may promote
Thus, captioned television and videos can be used for students who are deaf in educational settings, but in order to use it successfully, it must be used as a vehicle to English literacy. Given the low reading comprehension levels of students who are deaf and the language barriers they typically encounter, captioned videos can not be a substitute for a lesson in a particular content area. Rather, the video may be part of a lesson given in the students' primary language. Taking this approach, students' comprehension of the video content should be monitored. Pre-viewing discussions can help prepare students for the video content and help them access their existing world knowledge. Through classroom lessons using television captions, students who are deaf may gain the skills to develop "television literacy." Ideally, they may develop reading comprehension skills which they can then apply to television media. Captions, after all, are not "interpreters" for television: captioning is merely a form of assistive technology designed to improve functional capabilities of the deaf and others who are unable to access the audio portion of television.

This study has brought to light that although the combination of captions and video may assist in students' comprehension of a topic, captioned videos do not compensate for poor reading comprehension skills. For both hearing students and students who are deaf, captions may be useful for gaining content information, despite the fact that there was not audio component for the hearing students. Importantly, prior knowledge may have accounted for the differences in CT scores; lack of prior knowledge affects script knowledge, cognitive organization and short-term memory, thus putting students who are deaf at a disadvantage understanding the contents of the programs and possibly other media, as well. The results of this study may therefore reflect the issue of accessing world knowledge, as opposed to explicit reading deficits.
In terms of gaining information through television and video, accessibility is the key issue in the literary critical perspective (Paul, 1998). Based on this perspective, Paul cautions that it is important to ask whose interests are being served in promoting text-based literacy (versus sign-based literacy, for example). In the case of captioning, comprehension of program content demands a certain level of English literacy, thus acquiring text-based literacy does serve the needs of many people who are deaf. As previously discussed, text-based captions are technologically easier to produce. Nonetheless, sign-based captions would not serve the needs of all viewers who are deaf, either. Thus, through captions, the media are attempting to serve the needs of people who are deaf by making television program content more accessible. The ideal of accessibility may require accommodations in captioning technology, such as variable levels of captions or a split screen with more slowly-paced captions, as well as the acquisition of text-based literacy by individuals who are deaf and who wish to use the captions.
APPENDIX A

SAMPLE VIDEO COMPREHENSION QUESTIONS

(Text Explicit) 1. Obelisks were formed from
   A. A single piece of granite.
   B. A lot of stones.
   C. Big bricks.
   D. Wood.

(Text Implicit) 2. The Pharaoh who tried to build the largest obelisk was
   A. Tutankhamen.
   B. Thutmose.
   C. Amenhotep.
   D. Unknown.

(Script Implicit) 3. Today we think that
   A. The work on the obelisk was broken up into small segments.
   B. Many slaves worked on the same sections of an obelisk.
   C. The obelisks were made smooth when they were completed.
   D. Only the very large obelisks survived.
APPENDIX B

DEMOGRAPHICS OF DEAF PARTICIPANTS

<table>
<thead>
<tr>
<th>Subject #</th>
<th>age (mo.)</th>
<th>dB loss (in better ear)</th>
<th>Mean CT score</th>
<th>SAT score (level)</th>
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</thead>
<tbody>
<tr>
<td>325</td>
<td>219</td>
<td>90</td>
<td>6.25</td>
<td>2.5 (P2)</td>
</tr>
<tr>
<td>326</td>
<td>207</td>
<td>95</td>
<td>6.25</td>
<td>2.3 (P2)</td>
</tr>
<tr>
<td>328</td>
<td>225</td>
<td>profound</td>
<td>5.25</td>
<td>2.3 (P2)</td>
</tr>
<tr>
<td>329</td>
<td>187</td>
<td>95</td>
<td>4.75</td>
<td>3.8 (P2)</td>
</tr>
<tr>
<td>331</td>
<td>195</td>
<td>profound</td>
<td>9.0</td>
<td>3.2 (INT 1)</td>
</tr>
<tr>
<td>332</td>
<td>192</td>
<td>profound</td>
<td>9.5</td>
<td>5.7 (INT 1)</td>
</tr>
<tr>
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<td>200</td>
<td>profound</td>
<td>7.0</td>
<td>3.8 (P3)</td>
</tr>
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<td>191</td>
<td>100</td>
<td>11.0</td>
<td>6.8 (INT 3)</td>
</tr>
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<td>115</td>
<td>7.75</td>
<td>4.0 (P3)</td>
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<td>profound</td>
<td>8.25</td>
<td>3.3 (P3)</td>
</tr>
<tr>
<td>338</td>
<td>227</td>
<td>75</td>
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<td>3.3 (P3)</td>
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<tr>
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<td>172</td>
<td>100</td>
<td>9.5</td>
<td>3.4 (P3)</td>
</tr>
<tr>
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</tr>
<tr>
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<td>159</td>
<td>profound</td>
<td>4.0</td>
<td>3.0 (n/a)</td>
</tr>
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<td>n/a</td>
<td>6.0</td>
<td>2.2 (n/a)</td>
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</tr>
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<td>156</td>
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n/a = not available. for dB loss, all students were >60
"severe" indicates a loss of 60-89 dB
"profound" indicate a loss of >90 dB
LIST OF REFERENCES


Paul, P. V. (1987, October). Deaf children's comprehension of multimeaning words: Research and implications. Paper based on a paper presented at the 13th Annual Indiana Association for Children and Adults with Learning Disabilities (IACLD), Indianapolis, IN.


Paul, P. V. (1994a, June). Toward an understanding of deafness and second-language literacy. Paper based on a presentation at the TELA Convention, Youngstown, Ohio.


