Television Literacy: Comprehension of Program Content Using Closed-Captions for the Deaf

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Abstract

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 English is auditorally inaccessible to the deaf, their English-literacy rate is quite low. Yet, in the United States, television captions are generally in written English. The goal of this research is to determine how accessible television is to the deaf population by assessing the comprehension of television programs with and without captions. Specifically, this project examines comprehension for deaf and hearing participants under four conditions: (1) a video with captions (no audio), (2) a captioned display on a black screen (with no picture), (3) a transcript of captions without video, and (4) a video with captions, viewed twice. Comprehension is 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 comprehension measures. For both hearing and deaf students, comprehension scores tended to be highest for the captioned video. Deaf students, however, lag behind hearing students in their ability to generalize their reading skills and use prior knowledge to answer questions correctly. An intensive literacy intervention was conducted to address these issues, but the results were not significant. 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.

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Equal access to educational opportunities for children and youth with disabilities has become an important focus of special education related services. Televisions 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 viewer 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 deaf children who use at least some sign-based language, English is not a readily accessible language for them and functions as a second language that has linguistic characteristics that differ from their native signing language. 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 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 deaf children 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 deaf children 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, deaf children 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 deaf children 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, deaf children 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 deaf readers 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 deaf children 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 deaf students. They found reading comprehension in deaf readers 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 deaf readers, 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 deaf children 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 deaf children, 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 deaf readers 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 deaf individuals 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 deaf person watching television may visually perceive the action, but if either the specific information, the subtleties of the conversation or the entire story line 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.

Literacy Intervention

Early intervention in the development of language skills among deaf and hard-of-hearing children and youths is crucial for literacy development. Parents and teachers should be encouraged to use the first language understood by the child (whether oral, cued or signed) when discussing and retelling stories, in order to provide literacy experiences (Leutke-Stahlman, Hayes & Neilson, 1996). In classrooms where captioning has been used to enhance reading instruction, student motivation is high and comprehension improved after several viewings of the same video (Koskinen, Wilson, Gambrell & Jensema, 1987; Putz, 1987). Furthermore, those students who received lessons which used captioned television showed greater improvement on vocabulary and comprehension measures than those who received instruction based solely on the text (Koskinen, et al.). Although this does not remedy the closed captioned television accessibility

issue, it does suggest that captioned videos can be used for literacy intervention in classroom settings. Therefore, this research examined the effectiveness of an intensive literacy intervention program. The program uses captioned videos to teach students how to critically view television by applying their existing (prior) knowledge.

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. 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, et al., 1987). The extent to which this applies for deaf children 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 deaf children obtain equivalent information from captions as from other text. This research examines the extent that reading levels of deaf students contribute to comprehension of captioned television programs and recall of relevant information in the programs. It will compare comprehension of captioned television programs and written transcripts through a criterion-referenced comprehension test designed to measure different reading comprehension skills to examine the viewers' understanding of the story.

Methods

Participants

Deaf participants were drawn from elementary school students, ages 8-20, for a midwestern school for the deaf and a public school program for deaf and hard of hearing students. A comparison group of hearing students from an urban midwestern elementary and a private parochial school in Columbus served as a comparison group. For students in the public school, permission slips were sent home to all of the third, fourth and fifth grade students. For the private 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 the school for the deaf, permission slips were mailed to the parents at home, with a stamped return-envelope.

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 deaf sample, 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. 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'. 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 deaf students. 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.

Literacy Instruction. "Vocabulary Enrichment and Reading Skills for Viewing Closed-Captioned Media" is a video-based instructional unit designed specifically for this project. As originally designed, it is a 10-week program which uses video media to help deaf children build

English reading skills. The program objectives are outlined in Appendix B. The instructional program was designed for students who were targeted for additional assistance because their CT-scores did not reach criterion.

Stimulus Construction

This research examines comprehension for deaf and hearing participants under four conditions: (1) a video with captions (no audio), (2) a captioned display with no picture (captions on a black background with no visual scene), (3) a transcript of captions without video, and (4) a video with captions, viewed twice. Table 1 outlines these conditions.

	Condition			
hearing status	1	2	3	4
Deaf	video w/ CC (no audio)	CC without picture	transcript of video	video w/ CC seen twice
Hearing	video w/ CC (no audio)	CC without picture	transcript of video	video w/ CC seen twice

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." 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. A printed transcript of the captions without video was also provided. A criterion-referenced test of 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 deaf children understand captioned television as the same level as hearing children. Part of the issue of the poor rates of literacy of deaf students 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 Deaf students 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 deaf children.

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 four conditions was examined. Presentation order of conditions was counterbalanced across participants: 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.

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 was examined. Subjects' tests were scored based on the total number of correct answers (out of 18). It was predicted that (1) findings would reveal a positive relationship between SAT score and CT score for both Deaf and Hearing students and (2) students' scores for the transcript version will be significantly better than their scores for the video versions. Given equivalent reading levels, (3) hearing students would score better than Deaf students across all conditions.

Results

The analyses have demonstrated that deaf students tend to score lower on the

Comprehension Test than hearing students, given equivalent reading levels. Moreover, SAT reading scores are correlated with Comprehension Test scores for both hearing and deaf students. The first analysis focused on comparing the comprehension test results of deaf versus hearing students and comparing CT scores to SAT scores. The second analysis examined the effects of the four viewing conditions. The last analysis assessed the effect of the literacy instruction on students' comprehension-test scores.

It was predicted that hearing students' test scores would be higher than the scores of deaf students, across all conditions. This prediction is based on the previous findings that reading comprehension among the deaf is much lower than among the hearing (Paul, 1998; Paul & Quigley, 1994). These results were obtained using a Least Squared Means procedure in a mixed analysis of variance. Research suggests that comprehension is related to reading level (Jackson, et al., 1997), thus it was predicted that there would be a positive relationship between SAT scores and CT scores for all students. A regression analysis was used to test this hypothesis.

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 the second hypothesis, it was anticipated that students' scores for the transcript version would be significantly better than their scores for the video versions. This prediction was based on captioning research that suggests that deaf students 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.

In order to compare the test scores of hearing and deaf students, 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 scores was compared through a 2 x 4 (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 deaf students (180.2 months) was higher than for hearing students (129 months) and approached significance, $F_{(1,83)} = 3.27$, $p = .07$, yet the mean SAT-score (reading grade-level) for deaf students 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 deaf students.) As a whole, hearing students scored significantly higher than deaf students on the video-based comprehension test (hearing mean = 9.79, deaf mean = 7.36), $F_{(1,83)} = 5.97$, $p = .0166$, as predicted by the third hypothesis. Table 2 illustrates these findings.

	Means		
Group	age	SAT	CT score
Hearing	129	5.6 (a)	9.79 (b)
Deaf	180.2	3.71 (a)	7.36 (b)

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

Table 2: Mean Age, SAT Score and Comprehension Test (CT) Score for Deaf and Hearing Students.

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 approached 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 the first hypothesis, which predicted that findings would reveal a positive relationship between SAT score and CT scores for both Deaf and Hearing students. SAT scores were also strongly correlated with CT 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 approached significance, $F_{(3,255)} = 2.51$, $p = .0596$, demonstrating that deaf students tended to perform better on tests based on the captioned video (condition one) than other conditions, although there was no significant difference among the scores for hearing students. Because the differences among the conditions were not always as predicted, the null hypothesis could not be rejected for the second hypothesis,

which predicted that students' scores for the transcript version would be significantly better than their scores for the video versions. Scores for the captioned video condition were consistently higher for both groups.

The first two analyses examined effects of (1) SAT scores on the Comprehension Test (CT) score, (2) experimental conditions on CT scores. SAT is strongly correlated with CT scores, yet when SAT is held constant, hearing students' CT scores are still significantly higher than deaf students' scores. In other words, given equivalent levels of reading skill, deaf students lag behind hearing students in their ability to generalize this skill or use prior knowledge to answer the questions correctly. For both hearing and deaf students, 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 the video versions, therefore the null hypothesis cannot be rejected. This finding may suggest that the pictures in the video assisted comprehension in general.

For the second step of this project, students who are deaf were selected to participate in the Literacy Instruction program. The original timeline proposed a 10-week intervention period, but because of procedures instituted by the school which delayed the initial data collection and the move from the city by the reading intervention specialist, this objective was revised. Because of students' scheduling constraints and restrictions imposed by school schedules toward the end of the academic year, the intervention program changed in two significant aspects: (1) Only eight students from the residential school for the deaf participated in the program. Although other students were identified as eligible to take part in the instructional program, participation was voluntary and many students had other commitments. The instruction took place after school hours. (2) The program was revised satisfy an intensive two-week (10-day) model. The

instructor who taught the time-revised modules was an experienced teacher at the residential school for the deaf. Findings demonstrated no improvement of CT-scores after the literacy instruction.

Discussion

The focus of this research is to determine the extent to which reading levels of deaf students contribute to comprehension of captioned television. 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 for both hearing and deaf students. Specifically, results indicated that SAT was highly correlated with comprehension scores for both deaf and hearing students; however, the hearing students consistently outperformed the deaf students on all comprehension measures. An unexpected finding was that all students' scores for the captioned version (Condition 1) were higher than for the black screen (Condition 2), transcript version (Condition 3), or multiple viewing (Condition 4) of the videos. This discussion will address issues of reading level 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 deaf and hearing students, 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. Due to findings that deaf people are often "shut out" of vicarious experiences and opportunities of hearing age-mates

(Griswold & Commings, 1994; King & Quigley, 1985; Meadow, 1980), a large age-related discrepancy in comprehension and information-level test scores was not anticipated. An analysis of the data in this study 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, deaf students' scores were lower across video conditions 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, deaf children need more context than the short passages typically provided on standardized tests.

Rodda and Grove (1987) argue, however, that for deaf children, 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 deaf children may be erroneous due to the techniques used to assess their comprehension.

> Deaf children are known to posses 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 by deaf children 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 deaf students 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' compared to hearing students' performance of the video comprehension measures in this study may be indicative of the comprehending/comprehension problem, as described by Ewoldt (1987). 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 deaf students (Kretchmer, 1982; Rodda & Grove, 1987).

Caption comprehension. The finding of higher comprehension-test scores for the captioned version (Condition 1) versus the written text, "black screen", and multiple-viewing 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 videos used in this project may significantly contribute to overall comprehension. The finding of lower scores on the multiple-viewing condition may suggest students' inattention due to possible boredom from the repetition. 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 and deaf students, Nugent (1983) found that comprehension test scores of students who saw videos with modified, 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 deaf students who 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 deaf students. 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 [by repetition] 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 and deaf students; it is through language that the content of school curricula is

conveyed. Yet, for deaf students, language is a complex issue: Because approximately 90% of deaf children are born to hearing parents, the language which is auditorally inaccessible to deaf children is 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 acceptable secondary form of American Sign Language. Within the present educational system and broader culture, it seems essential for deaf children to learn to read English. Because of the original language barrier, 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 children who are deaf and hard-of-hearing. 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 consistently high levels of educational success (Paul & Quigley, 1994). Proficiency in oral English is quite rare for deaf students. 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 deaf students 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 deaf students, perhaps as part of an ASL/English bilingual program.

Prior knowledge consistently emerges as a factor in developing reading comprehension skills, 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 deaf students; however, the study has some limitations. Because of the limited availability of deaf students 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 the standardized SAT scores may not fully account for these experiential differences. 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 deaf students 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, such as the more scientific and narrative compared to ones that are social, actor-agent conversational in format.

The deaf students 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 deaf students, 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 deaf students, 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 deaf students do not have this advantage.

The students' CT-scores were compared pre- and post-intervention. Because of the condensed nature of the Literacy Instruction program, the findings of no change were not surprising. Anecdotal evidence from the participants suggests that they began to learn to more critically read captions, however, the length of the instructional program did not allow enough time for the students to process the information. Thus, these results can be interpreted to imply that the technologies of the intervention were ineffective or that the students needed a longer

period of literacy instruction. Clearly, this intervention needs to be reassessed.

Furthermore, students were aware of their difficulties with reading captions. At the beginning of the instruction period, the students were asked several questions with regard to their understanding of captions (see Appendix F). Several students said that they don't always understand captions and that real-time captions are hard to read because of errors. Their preferences for books versus captions varied, however. For example, one student commented that books are easy to read whereas captions are too fast. Another student pointed out, however, that, "captions have lots of active pictures to show. Reading a book is just words and no picture." Reading television captions is clearly an extension of reading skills. If those skills are not strong, perhaps reading of captions needs to be explicitly taught. The literacy instruction piloted in this project may be one such way to incorporate captions into a general literacy curriculum.

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 in ability 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, deaf students 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). Fischer (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 literacy skills within the context of television, thus making captioned television a viable option for deaf viewers.

Thus, captioned television and videos can be used for deaf students 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 deaf student 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 or useful 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, deaf students 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.

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 deaf people. As previously discussed, text based captions are technologically easier to produce. Nonetheless, sign-based captions would not serve the needs of all deaf viewers, either. Thus, through captions, the media are attempting to serve the needs of deaf people by making television more accessible. The ideal of accessibility may require accommodations in captioning technology, as well as the acquisition of text-based literacy by deaf individuals who wish to use the captions.

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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. Thutmoses.

   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

Literacy Intervention Objectives

Behavioral Objectives:

- To understand the meaning of the words structure, building, and monument
- To understand the meaning of the words ancient and modern
- To use critical thinking and organizational skills
- To use written English and ASL to clearly express concepts
- To understand ancient cultures and building methods
- To build English vocabulary related to the "Secrets of Lost Empires" Nova video series
- To distinguish between multi-meaning words by understanding them in context
- To build English reading skills: finding main ideas and important details; reading a story and answering comprehension questions; reading closed-captioned videos
- To understand some differences and similarities between written English and ASL

Affective Objectives:

- To enjoy reading stores and learning about history
- To feel more comfortable and proficient as a reader
- To gain confidence in using ASL to read stories with conceptual accuracy
- To understand the importance of knowing how to read closed captions
- To value both written English and ASL as equal and separate languages
- To gain fluency with the test format and feel batter prepared for the questions

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