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

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Recent legislation has made captioned television programs common technology; consequently, televised programs have become more accessible to a broader public. In the United States, television captions are generally in written English, yet the English-literacy rates among people who are deaf are low compared to hearing peers. This research tests the accessibility of television by assessing deaf and hearing students' comprehension of captions with and without visuals/video based on their ability to respond correctly to questions about the script and central details. Results indicate that reading grade level is highly correlated with caption comprehension test scores. Across caption conditions, comprehension test scores of students who are deaf were consistently below the scores of hearing students. The captioned video provided significantly better comprehension of the script for students who are deaf, suggesting that visual stimuli provide essential information for viewers who are deaf, which improves comprehension of televised script.

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* and *Teletubbies.* 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 information through television media. Captioning is the typewritten version of the audio component of television that provides a visual display of the dialogue, narration, and audio effects for those who cannot hear. Closed captions (CC) are typically displayed at the bottom of the television and are not immediately visible 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 cannot be turned off while viewing a video.

As more television programs are closed captioned, it is still not clear whether viewers are fully able to utilize this technology. The use of captions involves reading as an essential skill for understanding captions and, by extension, comprehending the script of the programs. The process of reading involves the use of an applicable knowledge base, memory processes, and linguistic adequacy with a word-based language. For individuals who are deaf, it may also require skill in a spoken language (i.e., English) that they have not mastered. Issues of literacy, conceptual knowledge, and memory constraints come to bear on the comprehension of television captions. This research assesses deaf and hard-of-hearing students' script comprehension of captioned public television programs.

Captioned films made their debut in 1958, 31 years after "talkies" made motion pictures inaccessible to the deaf (Norwood, 1988). However, application of this technology, market studies, and regulations governing

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television captioning took another 30 years. Early studies of the educational utility of television (Boyd & Vader, 1972) investigated deaf students' understanding of a film that was captioned by teachers of the deaf. The study found that captions adjusted to the linguistic level and reading rate of the viewers significantly improved information gain (Boyd & Vader). 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). Braverman and Hertzog (1980) reported that captioning rates (60, 90, or 120 wpm) did not affect comprehension, but the language level of the captions did have a significant effect on comprehension. Baker (1985) pointed out, however, that a reduced captioning rate necessitates simplifying the language level of captions. In a series of studies, Baker found that the combination of reduced rate (60 wpm) and reduced language level improved program comprehension for British school children.

Other investigations of captioning examined the relative contribution of visuals and captions to overall comprehension. Using specially constructed captions, Nugent (1983) compared deaf and hearing students' comprehension for programs with visuals only, captions only, and visuals and captions together. The captions were rewritten to ensure the captions and visual displays were redundant in that the captions provided a written description of the visual display. Results indicated that deaf students scored significantly lower than hearing students on all conditions. For both groups, however, comprehension was highest on the condition with visuals and redundant captions. Nugent noted that deaf students' scores on captioned videos were equivalent to hearing students reading the captions without visuals. This finding is particularly interesting because of the reading rate differences in captions and text. Captions can move quickly off the screen, and, unlike printed text, they do not allow the reader or viewer to look back to previous information (Putz, 1987).

Much of the captioning research performed on programs has been based on reading grade level with artificially produced captions; that is, the captions did not reflect the rate or language level used in the actual televised program. From a review 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). The overall mean rate for children's television programming was 126 wpm, well above the optimum 60 wpm suggested by Baker (1985). The National Captioning Institute (NCI, 1983) studied hard-of-hearing children's understanding of a regular television program at 140 wpm, by testing comprehension of captioned versus noncaptioned videos, with a 20-item multiple choice test. Results indicated that students who viewed the program with captions had higher comprehension test scores than those who watched the program without captioning.

Children are watching 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). Moreover, children who are deaf or hard of hearing watch as much, or more, television than their hearing peers. (Liss & Price, 1981). Television plays a substantial role in influencing children's learning and socialization skills (NCI, 1983) across the life span. By middle to late childhood, research indicates that children begin to recall more information central to the plot (Sell, Ray, & La Neel, 1995); by older adulthood, the recall of central theme and relevant details from regular television programs is related to reading comprehension level and linguistic abilities (Cavanaugh, 1983). If reading ability affects hearing viewers' comprehension of televised programs, then the reading ability of viewers who are deaf may have a profound effect on comprehension of captioned videos because of language-mediated abilities.

The above studies suggest a reciprocal relationship between reading ability and television comprehension that requires language skills, regardless of the modality of communication, for developing lexical understanding of word-based language and for acquiring background knowledge. These language-based skills are necessary for literacy development (Luetke-Stahlman, Hayes, & Neilson, 1996; Musselman, 2000; Paul & Jackson, 1993; Wilbur, 2000; Williams, Kantor, & Pinnell, 1992). Reading and English-literacy for children who are deaf may be hindered due to processing

difficulties in English syntax, vocabulary, accessing phonological representations, making inferences, understanding figurative language, and utilizing short-term memory efficiently (Luetke-Stahlman et al., 1996; Quigley, 1982). Children who are deaf lag behind hearing children in reading achievement as measured by grade level, and the lag broadens with age (Brooks, 1978; Jackson, Paul, & Smith, 1997). Approximately 30% of deaf students are functionally illiterate when they leave school, compared to fewer than 1% of hearing students (Paul & Jackson, 1993).

Readers bring experiences and background knowledge about how the world works to the task of reading, which they apply to the text to assist in comprehension (Jackson et al., 1997). Jackson et al. explain that because all of the relevant information is not explicitly given in a passage, readers must use their knowledge to make inferences to fill in gaps. Reading comprehension depends on memory processes for recall of knowledge that provides meaning for the text. Jackson et al. found that prior knowledge about the passage concepts was a significant predictor of reading comprehension of deaf students. They suggest that in-depth probes before reading accessed prior knowledge that enabled students to relate their knowledge to the story. This also allowed them to determine beforehand which students would be able to comprehend the text. Their results show test comprehension scores and SAT scores were both highly related to deaf students' scores on script-implicit (SI) questions, indicating that a reader's application of knowledge and cognitive ability to make inferences about the concepts in the passage were indices of reading comprehension level. The ability to use prior knowledge in the process of reading is language-mediated; an inadequate access to oral language and poor competency with the word-based English language often result in restricted social and experiential interactions, and a limited conventional knowledge base for many deaf children.

Marschark (1993) notes that "nonlinguistic, experiential and cognitive factors [also] 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 similar in many aspects of cognitive skill (Paul & Quigley, 1994; Rodda & Grove, 1987); however, deaf students consistently perform below hearing controls in two specific areas: short-term memory storage and English language skill (Rodda & Grove, 1987). Garrison, Long, and Dowaliby (1997) examined how working memory affected the language comprehension skills of deaf students. They found reading comprehension depends heavily on readers' background knowledge, lexical knowledge, and functional working memory capacity. For readers who are deaf, retrieval of word meanings requires great attentional resources and long processing times. Deaf readers with poor lexical knowledge often retrieve singular and inaccurate meanings unrelated to the context in which the information is newly embedded, for example, plant as a growing entity or as an industrial factory (Ewoldt, 1981; Garrison et al., 1997; Griswold & Commings, 1974; King & Quigley, 1985; Marschark, 1993; Paul & Quigley, 1994).

Language development cannot progress adequately without a rich linguistic environment. It is assumed that if an individual is not consistently exposed to language in a variety of related contexts (e.g., interpersonal communication, storytelling, story reading, writing), he or she will not fully develop the skills with language that result in competence. Language abilities increase with use, and through interactions with those who have more sophisticated language skills; unfortunately, for many deaf children, the variety of such learning interactions is often not readily available.

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. Television viewers who are deaf perceive the activity in the scenes, but when the specific visual information and subtleties of the conversation or narrative of the program are not evident, they are likely to misinterpret the intentions of the actions and meaning of the program. When access to relevant information is limited, comprehension is sacrificed. Fully accessible television provides the difference between perceiving what is happening and conceptualizing what the program is about.

Captioned programs, whether the evening news,

quiz contests, animated episodes, dramas, or television specials, all have a common factor: they require some level of reading ability to understand the dialogue. It is not clear, however, how accurately students who are deaf obtain supplementary information to understand the text information conveyed through captioned television that is denied by their inaccessibility to the audio component. This research will compare comprehension of captioned television programs and the program scripts through a criterion-referenced comprehension test designed to examine the viewers' understanding of the story. Studies suggest that people with lower vocabulary levels must allocate memory resources toward lexical determinations and away from more global integration of information (Kelly, 1990). Therefore, we will also examine the relationship between reading grade level and recall of central, relevant story information in captioned television programs. Specifically, this study examines whether captioned video (without audio) provides more information to deaf children that improves comprehension of the explicit and implicit information pertaining to the plot by comparing comprehension scores from captions, with and without the picture-video component, and a transcript. The comprehension scores will be based on the correct responses of deaf students and a comparison group of hearing students to questions that require text explicit and implicit information and recall of central themes and relevant details.

Method

Participants

Deaf participants were drawn from a Midwestern state's residential school for the deaf and program for hearing-impaired students in an urban public school. Hearing students were obtained from an urban elementary school and a private parochial school in the same city to serve as a comparison group. Announcements describing the project were made in each class, after which a letter was sent home with students, along with a cover letter from the building principal in the selected schools. To obtain students in the public school, permission slips were sent home to all of the third, fourth, and fifth grade students; permission slips were sent home to all fourth, fifth, and sixth grade students in the parochial school. For the students from the residential school for the deaf, in keeping with the confidentiality policies of the school, permission slips, with return response forms, which detailed the research procedures for participation, were mailed by the school to the parents' homes.

From the students who agreed to participate, a potential sample was drawn. The final sample selection criteria included for the deaf sample, 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 the hearing students, no indication of hearing loss or hearing-related problems and English was their primary language. For both groups, a minimal reading grade level of 2.0 (Stanford Achievement Test–Reading, or its equivalent) was required. The final comparison sample consisted of hearing students whose reading scores most closely matched the selected group of deaf students. The study used a within-groups design with 50 participants per group, for a total of 100 participants. There were 45 boys and 55 girls, ranging in age from 8–20 and ranging in reading level from 2.0 to 11th grade. (See Table 1 for a description of the sample.)

Table 1 Demographics and test scores of participants

Demographic	Deaf	Hearing	*df*	*F*
Gender				
Male	19	26		
Female	31	24		
Age (months)				
M	15;0	10;9	(1, 83)	3.27
SD	2;10	0;11		
Reading grade level				
M	3.71	5.6	(1, 83)	75.83**
SD	1.64	1.99		
Overall CT score (*M*)	7.36	9.79	(1, 83)	5.97*
CT for captioned video	8.05_a	9.6_c		
CT for captions alone	6.68_b	8.9_c		
CT for transcript	7.01_b	9.45_c		
IL score (*M*)	7.76	10.46	(1, 243)	19.66**

Means with different subscripts differ significantly at $p < .05$.

*$p < .01$.

**$p < .0001$.

Instrumentation

Stanford Achievement Test–hearing impaired version (form S). The SAT was used to obtain the reading grade level for students who were deaf. 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 multilevel multiple choice exam, revised for deaf and hard-of-hearing students. Only those scores on the reading battery were recorded. The SAT-HI is considered a valid measure of literacy for the hearing-impaired population. For hearing students whose records did not contain SAT scores, their standardized achievement test scores were converted to the SAT grade-level equivalency.

Comprehension test (CT). Criterion-referenced tests of the video segments were developed, adapted from the reading comprehension test format used in Jackson et al. (1997) for deaf and hearing-impaired students. (For reliability and validity of the CT format, see Jackson et al., 1997.) Four judges developed the 18-item CT, matched across 3 question types. The test provides an overall comprehension score and probes for the ability to recall information explicitly stated in the text (text explicit, TE), associating related pieces of information in the text (text implicit, TI) and inferring a meaningful script for new information by prior knowledge (script implicit, SI) (for details see Jackson et al., 1997). The CT measures caption comprehension by specific word-phrase concepts found in the text, the comprehension of information in the caption by the number of correct responses to each question type, and it provides an overall assessment of the reading comprehension of captions by correct response total for each student.

Information level test (IL). Based on the procedure used in Cavanaugh's (1983) television recall study, single-idea statements generated from the videos formed the IL test. Four raters judged each statement as to whether it was a central idea for understanding the video, a relevant or irrelevant detail for comprehending the plot. After full interrater agreement of the categorization of the statements was obtained, an equal number of central, relevant, and irrelevant statements from which to construct multiple choice questions was chosen. IL scores are expressed as a proportion of correct responses in each category of information recall for each student.

Stimulus Construction

This research examines video comprehension for deaf and hearing participants under three conditions: (1) a video with captions, no audio; (2) a video with captions, shown twice in a row; (3) a captioned display—no picture and no audio (that is, captions on a black screen); and (4) a printed transcript of the captions. Four 10-minute captioned video segments equivalent in "readability" level were obtained from a televised series. The segments were selected from four programs in a BBC and NOVA/WGBH-Boston television miniseries. Based on Chall and Dale's (1995) readability formula, the transcripts had a readability grade level of eight. Each segment was recaptioned with open captions, enabling the captions to remain visible while the video/picture component was deleted. The first 10 minutes of each program were selected, as they consisted primarily of narration. Four miniseries videos were used to avoid repeated exposure to the same video manipulated by three of the conditions of the study. The fourth condition was a printed transcript of the captions. Criterion-referenced tests for the caption segments (CT) were developed based on Jackson et al. (1997).

Procedure

Each student's score on the SAT (hearing impaired version, or its equivalent) was used as the standardized reading grade level. For both deaf and hearing groups, comprehension under all three caption conditions was examined. Presentation order of conditions was counterbalanced, as were video segments. After each 10-minute video segment, an 18-question multiple-choice CT, consisting of six items in each of three question types, was distributed, and following the captioned video condition an 18-question IL test (consisting of six items in each of three detail categories) was distributed. Instructions were read aloud and signed by a certified sign language interpreter for deaf participants and were read aloud for the comparison group.

Analysis

A mixed analysis of variance (ANOVA) was conducted in order to assess the effect of caption condition on CT scores, that is, comprehension of the plot (video content), for the deaf group, and to assess a between-group comparison by hearing status. CT total scores were based on the number of correct answers (out of 18), and by the number of correct responses to each of three different types of questions. Analyses included bivariate correlations of the relationship between SAT score and CT score, and the SAT and IL scores. In addition, the type of information recalled was analyzed to determine whether students who are deaf recall more text-based information than script implied information, and central themes than irrelevant details.

Results

One set of results analyzed the CT scores of deaf students and hearing students and the relationship of CT and IL scores to SAT scores. A second analysis examined the effects of the three question types on CT scores. Another analysis examined the level of information recall by the IL tests. Analyses of covariance involving the between-group and within-subjects factors included SAT as a covariate. The effect of each experimental condition on CT and IL scores was compared through a 2×4 (Hearing Status $\times$ Video Condition) ANOVA to determine whether there was an effect by the video segments. Condition (2), two viewings of the same captioned video, will not be discussed in this article. An alpha level of .05 was used for all statistical tests. A power analysis indicated that 100 total participants (50 in each group) were needed for a power of .80 at the alpha level of .05 with an effect size (R^2) of .30.

Analyses revealed a main effect for SAT, $F(1, 83) = 75.83$, $p < .05$, but age did not reach significance, $F(1, 83) = 3.27$, $p > .05$. Table 1 indicates the average age difference between groups, with deaf students older than hearing students by 51.2 months. The SAT reading level for deaf students was on average 2 years behind their hearing peers, indicating that while deaf students were 4 years older than the hearing group, they lag 2 years behind on reading grade level. There was a significant effect for group/hearing status, $F(1, 83) = 5.97$, $p < .05$, and video content, $F(3, 255) = 8.48$, $p < .05$; however, the effect for condition did not meet the critical alpha level, $F(3, 255) = 2.51$, $p > .05$. A within-group analysis indicates the captioned video comprehension scores were significantly higher (captioned video $M = 8.05$) for deaf students than comprehension scores for other conditions (captions alone $M = 6.68$, transcript $M = 7.01$), (see Table 1) whereas there was no significant difference in comprehension test scores by condition for the hearing group (captioned video $M = 9.6$, captions alone $M = 8.9$, transcript $M = 9.45$).

There was a strong positive correlation (Pearson correlation coefficient) for SAT and CT scores ($r = .78$, $p < .05$) and SAT scores and the IL scores ($r = .73$, $p < .05$). Because there was a large difference in SAT means between the groups, SAT was a covariate for the remaining analyses. The mixed ANOVA also indicated a main effect for video segment, $F(3, 255) = 8.48$, $p < .05$; there was no significant interaction by video segment and hearing status; thus, the effect by a specific video was not considered further. There was also no independent contribution by age or gender to comprehension test scores, and they were not considered further.

The CT probed comprehension involving three different types of information processing, by correct responses to the TE, TI, and SI questions. Because the transcript and captions were identical, "text" as used here refers to the story presented in either format. An ANOVA of CT question subscales indicates significant main effects for video condition ($p < .05$), hearing status ($p < .05$) and question type ($p < .05$); and a significant interaction of hearing status by video condition ($p < .05$). (See Tables 2 and 3.)

The least square means procedures indicate that, in general, both deaf and hearing students answered significantly more TE questions correctly than SI questions and had slightly more correct answers to TE questions than TI questions. Comparing deaf to hearing students, hearing students answered more of each question type correctly overall, but the pattern of question type responses was similar for both groups.

To test the recall of information (IL), an analysis was performed by the captioned-video condition only. An ANOVA across the captioned-video segments

Table 2 Analysis of variance for CT subscales

Source	*df*	*F*
Video condition	3	48.9**
Hearing status	1	31.59**
Question type (TE, TI, SI)	2	6.25*
Within-group error	184	(0.85)

*$p = .002$.

**$p = .0001$.

Table 3 Mean scores for CT subscales

	Type of question		
Hearing status	TE	TI	SI
Hearing	$3.27_{b,c}$	3.12_{d}	$2.76_{b,e}$
Deaf	$2.65_{a,c}$	2.45_{d}	$2.27_{a,e}$

Means with the *same* subscripts differ significantly at $p < .01$.

shows a significant main effect for hearing status, $F(1, 243) = 19.66$ $p < .05$. The least square means procedure indicates that hearing students score higher in average recall of IL information than deaf students (deaf $M = 7.76$; hearing $M = 10.46$). The multiple ANOVA indicates a significant main effect for information level, $F(2, 1150) = 9.94$ $p < .05$. Recall of central details was significantly better than recall of irrelevant details (M central $= 3.14$, irrelevant $= 2.71$, $p < .05$); there was no significant difference in recall of central and relevant details.

To summarize, the SAT was strongly correlated with both CT and IL scores. With SAT as a covariate, hearing students' CT and IL scores are significantly higher than deaf students' scores. Recall of central details was greater than irrelevant details regardless of hearing status. For students who are deaf, across conditions, their comprehension scores tended to be highest for the captioned video; that is, the picture with captions increased comprehension compared to reading captions alone on a blank television, or as a text transcript.

Discussion

The purpose of this study was to determine the extent to which reading levels of students who are deaf influence their comprehension of captioned television and how their comprehension compares to that of a group of hearing students. We investigated the comprehension of captioned videos compared to comprehension of the captions on a black screen or in transcript format. There was a significant difference in the standardized reading grade level between the groups. Findings indicate the standardized reading grade level is strongly and positively related to caption comprehension tests and to the tests of recall of central details in television programs for both groups. When the SAT was held constant, hearing students' CT and IL scores were still significantly higher than scores of students who are deaf. In other words, given equivalent levels of reading, still, deaf students lag behind hearing students in their ability to generalize information or to use prior knowledge to answer questions correctly.

Although the initial intention was to match the two groups by reading grade level based on standardized test (SAT) scores, due to limitation in obtaining a voluntary sample of deaf students who met the selection criteria, there was a discrepancy in reading abilities between the groups, requiring a statistical control for reading grade level in the analyses. Although the results found that age did not directly contribute to caption comprehension, the lag of approximately 2 years in reading grade level and the large age difference of approximately 4 years suggests that the comprehension differences may be indicative of language issues related to deafness. The students who are deaf may have fewer years of experiences with oral language, which affects acquiring a base of relevant knowledge available at younger ages to hearing students. This difference would manifest in lower SAT and script implicit scores and, over time, would result in a lag in reading comprehension relative to hearing peers. This conclusion is supported by the findings of Jackson et al. (1997) that the base of prior knowledge was a significant predictor of passage comprehension level for students who are deaf. A limited range of language-related experiences results in restricted social and experiential knowledge (Griswold & Commings, 1994; King & Quigley, 1985; Meadow, 1980), and these experiential limitations tend to be cumulative.

The strong positive correlations between SAT-Reading scores and the CT scores and IL tests suggests that the processing demands of these reading tasks may be similar, regardless of the format in which the information is presented. The correlations also indicate that

caption comprehension scores were lower for deaf and hearing students with poorer reading abilities, yet, with SAT as a covariate, the deaf students' caption comprehension test scores were significantly lower than hearing students' given equivalent reading abilities.

Researchers have examined standardized tests given to students who are hard of hearing or who are deaf. Ewoldt (1987) criticizes standardized tests, such as the SAT, on the basis that correct answers often depend on *assumed* prior knowledge. She also proposes that standardized tests depend on specific "test-taking" skills, which are not necessarily the same as "reading skills," arguing that students who possess the ability to read well may not have the ability to test well. Ewoldt suggests that the ability to *comprehend* is necessary for successful test-taking, whereas *comprehension* is necessary for good reading and indicates literacy level. She describes comprehending as successfully using semantic cues to process text; however, comprehension involves integrating prior knowledge with the information in the text and suggests that deaf children need more context to enable them to generalize prior knowledge to the short passages typically provided on standardized tests. Her comments would indicate that, perhaps, the 10-minute segments used here may not have been long enough to provide deaf students adequate information about the gist of the program.

Other studies demonstrate consistent 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 they typically lack the necessary background knowledge about many topics (Luetke-Stahlman et al., 1996); they may also lack the specific skills necessary for comprehending text (Oakhill & Cain, 2000). Test structures and grammatical forms are often new and complex. Deaf students and hearing students may use different comprehension abilities to answer tests, resulting in lower scores, but it is more likely that they lack a relevant base of prior knowledge to integrate their existing knowledge with the information presented in the test and would be unable to answer many SI questions. Thus, students who are deaf may be at a disadvantage in two areas: Hearing students may possess more background knowledge to apply to the test questions (Luetke-Stahlman et al., 1996), and the sentence structures (a linguistic issue) may contribute to the difficulty in correctly answering questions for students who are deaf (Kretchmer, 1982; Rodda & Grove, 1987), as they may be familiar with a linguistically different syntax.

Similar to the results of Jackson et al. (1997), the SI scores for questions that required memory and inferencing abilities were significantly lower than the scores for TE and TI questions. SI questions are the most difficult questions, as the answer is not directly obtained from the text but requires inferencing and deductive reasoning. Both groups scored lower on SI questions than those questions with answers directly obtained within the text, and the SI question type, as shown by Jackson et al. (1997), is a good predictor of the standardized reading comprehension abilities.

There was significantly better recall of central and relevant information than for irrelevant details, which were in the video but not necessarily important for understanding the story's plot. Cavanaugh (1983) suggested that for adult hearing television viewers, comprehension and retention of television programs were related to reading level and underlying verbal ability. He indicated that individuals with lower verbal ability (measured by vocabulary skills) may encode less information than individuals with higher verbal ability. In this study, the recall of central themes by both groups of students was strongly related to their reading comprehension scores on the SAT reading comprehension component.

There were higher scores for tests of comprehension (CT) and information recall (IL) with the captioned video condition compared to the printed text or black screen captions, suggesting combining captions with video provides an information advantage to students who are deaf, which did not particularly benefit hearing students. Even though the process of reading captions, which move quickly off the screen, prevents the caption reader from looking back at the text, the visual cues in the video apparently contribute important perceptual data that supplements the information obtained from the captions, benefiting the deaf television viewers with visual information not obtained by merely reading captions.

This study, which used verbatim captions, did not find a significant difference between comprehension of captions on a black video or as a transcript. We found that the captioned video aided comprehension of the narrative, beyond what deaf students were able to understand from reading the captions alone. This research study has demonstrated that for students who are deaf, the visual information in the scenes combined with verbatim captioning increases comprehension of regular, televised programs, but the adequacy of text comprehension is directly related to reading comprehension grade level and indirectly to language processing skills.

Accessibility of captioned television presents unique comprehension problems because of the dependency on reading proficiency. Conclusions, such as those made by Nugent (1983), about modifying the exact script by simplification of the language, have been rejected as patronizing and a watering down of the plot (Baker, 1985; Jensema et al., 1996). Others have suggested that captions be jointly produced with sign language. That modification is technologically more difficult and expensive to produce and, as Baker notes, many deaf viewers are not conversant in American Sign Language (ASL) or use a combination of communication modalities. Baker suggests offering the viewing public a choice from two language difficulty levels for closed captions for each program, one of which is a simplified modification and one of which is verbatim captioning, to counteract the wide reading level disparity that exists in the deaf community. This option is very difficult, especially for "real time" captioning, which is simultaneously produced as a television personality is speaking. Furthermore, researchers have noted that the "simplification" of texts may make them more difficult to understand (Power & Leigh, 2000).

Educational Implications

Despite the attempt to control SAT scores for statistical equivalency, the persistent group difference suggests that language experiences contributed to video comprehension in more subtle ways. Because better readers tend to be more widely read, they have a broader knowledge base from which to interpret new information and relate it to a domain of knowledge. Studies indicate that hearing students have more exposure to varied experiences with other forms of language-transmitted information. Captions allow television to provide more access to information for people who might otherwise be "shut out" from the audio information, which is the nature of many types of information exchanges in an oral world. Access to the full, often subtle, conversational information contained in the audio component has been considered crucial for comprehending the theme and details in a televised program, yet the visual information is important for the students who are unable to auditorially interpret and understand what is "going on" in the program. At the least, captions permit students to obtain the gist and the relevant details of the script.

By effectively utilizing the technology of captioned television in a classroom setting, students who are deaf could advance their literacy levels through exposure to English vocabulary and syntax (Whitehurst & Lonigan, 1998), making captioned television an opportune medium for enhancing reading comprehension ability. If teachers present words and phrases from the captioning both before and after viewing the video, they can ask students to describe what kind of action or information they would expect such specific English words or phrases to represent and how these phrases are conceptualized in ASL, which may, in turn, facilitate comprehensions of written script. Students can preview and discuss the script with a teacher to highlight areas in which students lack knowledge about concepts used in the televised medium. In addition, teachers can work on reading comprehension skills by having students recall the scenes in the videos that may give specific meaning to the words in the script; words that have multiple meanings can be revealed by the actions or scenes. Because television is not a static medium (such as an illustrated book), it may provide additional information to viewers; moreover, students said that they found videos more appealing than static media. Perhaps the hard-of-hearing and deaf readers do process the images in captioned videos simultaneously with the script in some way that differs from the processing of captioned or print script, even when on video, by the hearing reader. This cannot be directly

answered by this study but may be an area of further investigation. Furthermore, if students can learn general story comprehension skills through videos, these skills may then be able to be transferred to static (written) texts.

Captions are a form of assistive technology designed to improve functional capabilities of viewers who are unable to access the audio portion of television. Ideally, for such viewers, reading captions is equivalent to reading a printed script, and how well they comprehend the script in either of these reading formats is related to their reading grade level. Importantly, the combination of video and verbatim captions—those that follow the exact wording of the video and are paced to a natural rate of narration—for a video in which a narrator was often not included in the scene, greatly improved comprehension of the script for deaf and hard-of-hearing viewers. Although deaf students' reading comprehension scores are lower on average than those of their hearing peers, their script comprehension for captioned videos is greater than comprehension of the script in different text formats, indicating they process additional information from the visual stimuli provided in the video component. The finding of improved script comprehension for captioned videos suggests that acquiring "television literacy" through captioned videos may promote reading skills for students who are deaf.

Appendix

Sample Video Comprehension Questions

Text	1. Obelisks were formed from
Explicit	A. A single piece of granite.
(TE)	B. A lot of stones.
	C. Big bricks.
	D. Wood.
Text	2. How the ancient Egyptians created the
Implicit	obelisks is a mystery because
(TI)	A. The ancient Egyptians didn't have advanced technology.
	B. Some scientists believe the obelisks were not really created by the Egyptians.
	C. The Egyptians couldn't build the obelisks and pyramids at the same time.
	D. The Egyptians nowadays can't build obelisks.
Script	3. Today we think that
Implicit	A. The work on the obelisk was broken up
(SI)	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.

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