RESEARCH STUDY

Using Captioned Television To Improve the Reading Proficiency of Language Minority Students

The National Captioning Institute, Inc.

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EXECUTIVE SUMMARY

Purpose of the Study

Over 35 million of our nation's children come from homes where English is not spoken. Many of these children are recent immigrants, finding themselves in new environments without the skills needed to communicate in their new language. Traditional language classes, typically involving students in rigorous grammatical training programs, have met with mixed success.

In contrast to this approach, new studies suggest that children learn a great deal of language through "comprehensible input" (Krashen, 1985; Trueba, 1989). Stimulated by the sheer exposure of print in and out of school, this approach proposes that children acquire language and literacy incidentally without formal instruction, using the language they already know and cues from the environment. These findings have led to recommendations that successful language programs need to be highly motivating, nonevaluative, involving linguistic minority children in ways that they temporarily seem to "forget" that they are hearing or reading another language.

This study proposed that captioned television, as a multi-sensory, largely entertaining medium might be an important source of "comprehensible input" for bilingual students in learning language and literacy. To explore this issue, the study investigated the following questions:

- Can bilingual students acquire vocabulary incidentally through watching closed-captioned television?
- If specific effects are found, are there certain word-related and video-related variables that contribute to these vocabulary gains?
- What is the relationship between students' linguistic proficiency in English and their learning of vocabulary through "comprehensible input"?

Method

One hundred and twenty-nine bilingual seventh and eighth graders from 17 science classrooms in a middle school participated in the 12-week study. Classrooms were randomly assigned in one of four groups: 1) captioned television; 2) television viewing alone; 3) reading along and listening to text; and 4) textbook only.

Subjects in the first three treatment groups either viewed or read three units of science segments from the 3-2-1 Contact (CTW) science series, twice a week for a period of nine weeks. The textbook-only group served as a control. Pretest checklists, vocabulary tests, and prior knowledge pretests were administered prior to each unit; vocabulary measures analyzing a continuum of word knowledge of the 10 most difficult target words in each segment, for a total of 90 words, were administered following the lessons. As an additional measure of incidental learning, students were asked for written retellings on a weekly basis to analyze science recall and uses of the 90 target words.

Results

The results of this study indicated that students incidentally learned more words from captioned television than either of the two treatment conditions as well as the control group. On all measures of word knowledge, students who viewed captioned television consistently outscored those who did not. Similarly, students in the captioning group appeared to remember more science information than others, and used more target words in their written retellings.

An analysis of word-related and picture-related variables indicated that visual and printed contexts that provided explicit, and thus redundant, information supported incidental learning. Thus, captioned television may be most helpful to bilingual students by providing multiple supportive contexts for learning word meanings.

Students' ability to acquire vocabulary through context appeared to be influenced by their level of linguistic competence. Those who were at least fluent in English gained more vocabulary knowledge than those who were of limited English proficiency.

In conclusion, these data provide strong support for the effects of captioned television on bilingual students' acquisition of language, literacy, and conceptual knowledge. Captioning presented a particularly rich language environment which enabled students to incidentally learn words through context as they developed concepts in science. Overall, this study demonstrated the power of captioned television to provide "comprehensible input" to language minority students.

ABSTRACT

A well-known theory of second language acquisition argues that children's communicative competence in L2 is a function of the amount of "comprehensible input" acquirers receive and understand, without formal reading instruction. To examine this hypothesis, this study analyzes whether comprehensible input in the form of captioned television might influence bilingual students' acquisition of vocabulary and conceptual knowledge in science. The 129 bilingual seventh and eighth graders in the study were assigned to one of the following groups: 1) Captioned TV; 2) TV Viewing Alone; 3) Reading Along and Listening to Text, and 4) Textbook only (Control). Students in the three treatment groups either viewed or read three units of science segments from the 3-2-1 Contact (CTW) science series, twice a week for a period of 12 weeks. Pretest checklists vocabulary tests and prior knowledge pretests were administered prior to each unit; vocabulary measures analyzing a continuum of word knowledge of 90 target words were administered following the treatment, along with a written retelling analyzing recall of science concepts and use of target words. Results indicated that subjects in the closed-captioning group consistently outscored others in word knowledge as well as recall of science information. An analysis of word-related and video-related factors suggested that contexts that provided explicit information yielded higher vocabulary gains. Overall, this study documents the power of captioned television in the acquisition of literacy and conceptual knowledge for bilingual students.

INTRODUCTION

In 1980, after seven years of research and development, a technology became available which offered a bridge between isolation and the mainstream of American life for hundreds of thousands of hearing-impaired people in the United States. The system of closed-captioned television, developed through the joint efforts of the U.S. Department of Education (DOED, formerly part of the U.S. Department of Health, Education and Welfare) and the Public Broadcasting Service (PBS), was designed to make the wealth of television programming available to the nation's deaf and hard-of-hearing population.

The National Captioning Institute (NCI), a private, nonprofit company, was established with support from DOED and the networks in order to introduce the closed-captioned television service.

In March 1980, NCI debuted the closed-captioned television service with only 16 hours per week of programming available on ABC, NBC, and PBS, with four hours specifically targeted to young people. That same year the Department of Education mandated that all public television programming funded with federal dollars be closed-captioned. This led to the captioning by NCI of *Sesame Street*, under a split-funding arrangement between DOED and the program's producer, the Children's Television Workshop.

In the ensuing years, there has been a considerable expansion both in the variety of shows and number of hours available to viewers of closed-captioned television. Today, approximately 190 hours a week of closed-captioned programming are available on the commercial networks, PBS, and independent stations. Included in the captioned schedule are prime-time drama and comedy series, children's programs, news and public affairs programs, major sports events, and special events, such as Presidential speeches and candidate debates. Deaf and hard-of-hearing viewers who have access to pay cable can enjoy another 160 hours a week of captioned television. In addition, there are over 2,000 home video titles that have been closed captioned. Commercial advertisements are captioned by the hundreds each year.

Captioning As an Educational Tool

Television viewing has often been described in negative terms as a passive activity. That description becomes of critical importance to educators and parents in light of recent statistics which indicate that approximately 85% of the more than 50 million children in this country watch television for several hours every day. A recent *Weekly Reader* poll conducted among children in grades two through six indicates that television viewing is the favorite activity of American children, while reading is their least favorite activity.

Although the captioning service was created to provide deaf and hard of hearing people with accessibility to the television medium, captioned television offers a multi-sensory technology (video, audio, print) that can assist hearing children in enriching their vocabulary by viewing words in a meaningful and stimulating context. Preliminary research conducted with adult education students found that comprehension skills increased when using television with captions, even after one viewing. However, a dearth of information existed as to the potential uses of captioning with bilingual students at the upper elementary and middle school grades.

Over 23 million of our nation's children come from homes that do not speak English. Closed captioning, involving the dual coding of information through print and sound, combined with the powerful medium of television, holds great promise as an educational tool. A research project commissioned by the National Captioning Institute as part of a grant from the Pew Charitable Trusts investigated the potential uses of closed captioned television as an approach to enhancing the reading and language skills of bilingual children.

Captioned Television as "Comprehensible Input": Effects of Incidental Word Learning from Context for Language Minority Students

Language acquisition has been described as a subconscious process, learned informally in the context of its functional uses (Chomsky, 1975; Halliday, 1975). Language acquirers are not usually aware of the fact that they are learning language; rather, it is acquired as children use language for communicative purposes.

It has been argued that a similar subconscious process occurs when acquiring competence in a second language (Krashen, 1982; 1985). Children develop linguistically by focusing on the meaning, not on the form or grammar of the message. Thus, one theory of second language acquisition holds that individuals acquire language by understanding messages or by receiving "comprehensible input" (Krashen, 1985). Stimulated by the sheer exposure of print in and out of school, children are thought to acquire language and literacy incidentally without formal instruction, using the language they already know and cues from their environment (Krashen, 1989).

Whether the amount of "input" is likely to strongly influence the acquisition of reading skills, however, is partially a function of the type of competence children bring to their second language. For example, Cummins (1979) argues that if a child's L1 vocabulary-concept knowledge is limited, they may have great difficulty assimilating decontextualized language, and may have little insight into the fact that print is meaningful and that written language is different from speech. Thus, many of these children may be "confronted by nonsense" (Smith, 1977) in the task of reading in L2, since there is no way for them to relate the printed symbols to a known phenomena. This would suggest that there is an interaction between children's conceptual-linguistic knowledge and what may be defined as "comprehensible input."

In addition to these cognitive influences, the motivation to learn and to identify with members of the L2 group appears to be an important determinant in successful second language acquisition (Cummins, 1986; Trueba, 1987; 1989). Fearing failure, some children may construct an "affective filter," or defense system which prevents them from utilizing the input they might receive for language acquisition (Krashen, 1985). In order to lower the filter, Krashen suggests that language programs must be highly motivating, nonevaluative, and involve children in ways that they temporarily seem to "forget" that they are hearing or reading another language.

Considering the range of children's conceptual-linguistic knowledge, motivation to learn and its influence on acquisition of input (Cummins, 1979), this study proposed that captioned television, as a multi-sensory, largely entertaining medium, might be an important instructional resource in learning

vocabulary and concepts. Captions are English subtitles which can be seen only on television sets equipped with a special electronic TeleCaption decoder. Originally developed for the hearing impaired, marketing studies suggest that in recent years over half of the TeleCaption decoders are actually sold to the hearing population, many of whom are immigrant families (National Captioning Institute, 1989).

There are several reasons to believe that captioned television might especially benefit bilingual students. First, television's combination of pictures and sounds used to represent content such as verbal language might help children transform words into a representational form. Blosser (1988), for example, reported a positive relationship between television and reading comprehension scores for Hispanic students, albeit for those children with some English proficiency.

Second, the entertaining qualities of television make it a relatively 'easier' medium to access than text; L1 children generally perceive themselves to be highly efficacious in processing its messages (Salomon, 1984). Anecdotal evidence (Larsen-Freedman, 1983) suggests that L2 students seem to hold similar beliefs about television which might help in minimizing fear of failure in learning. Third, when using appropriate content, viewing can be a cognitively active experience (Anderson & Collins, 1988; Neuman, 1989; in press), engaging children in making meaningful predictions of new vocabulary and content as they watch for entertainment. Rice and Woodsmall (1988), for example, using two 6-minute animated shows found that preschoolers tended to engage in rapid on-line processing of new words with instantaneous attribution of meaning.

Finally, preliminary evidence on the impact of captioning indicate that the technology may be particularly effective for special populations of hearing audiences. Koskinen, Wilson, Gambrell, and Jensema (1987), for example, reported differences between viewing with captions and reading the printed text on word recognition and oral reading skills for learning disabled students. Initial studies with ESL adult students found that captions improved vocabulary and comprehension (Price, 1984), and listening comprehension (Markham, 1989). The multisensory characteristics of captioned television seemed to allow bilingual students to view words in meaningful and stimulating contexts.

To explore this issue in greater depth, this study examines whether "comprehensible input" in the form of captioned television might affect bilingual students' acquisition of vocabulary and conceptual knowledge. The purpose of this study was three fold. First, rather than focus on conscious language teaching, the study was designed to investigate the incidental acquisition of word meanings in context for bilingual students who exhibited a range of conceptual-linguistic knowledge. With the combination of visual (pictures and words) and auditory stimuli (speech and sound effects), the guiding hypothesis was that students of varying levels of English proficiency would learn the meanings of many new words as they watched (and read) programs without any formal vocabulary instruction. Our first analysis was designed to examine whether captioned television might provide comprehensible input in comparison with other media. To assess this possibility, we investigated differences among four conditions: 1) captioned television; 2) television viewing alone; 3) reading along and listening to text; and 4) textbook alone. If specific effects among the captioning group were found, a second purpose of the study was to identify the combination of word-related and video-related variables that contributed to these vocabulary gains. Finally, a third purpose of the study was to examine the relationship between

students' linguistic proficiency in English and their learning of vocabulary through "comprehensible input."

Method

Subjects

One hundred and twenty-nine bilingual seventh and eighth graders from 17 classrooms in a middle school participated in the study. The sample, representing the largest concentration of Southeast Asians on the East Coast included 72% Cambodian, 10% Laotian, 2% Vietnamese students, as well as 16% Hispanic students. Identified by a community needs assessment as an "at risk" target population, children were at least 2 to 3 years below grade level as measured by grade performance (no formal reading assessments administered), 79% were on free or reduced lunch status indicating family financial need, and 69% were refugees (39% arriving in the first wave in the early 1980s; 61%, since 1985). Some of these students had received sporadic education in refugee camps according to family accounts; a small number reported to be entirely new to any formal educational system.

Upon entrance in the school system, each student was given the IDEA Oral English Proficiency Test (IPT), measuring their oral English abilities (Ballard & Tighe, 1982). The IPT is an individually administered criterion-referenced test that has been normed in four areas of English proficiency; vocabulary, comprehension, syntax and verbal expression. Criterion validity, established by analyzing student performance with teacher predictions of student oral proficiency using Pearson's R was .78. Reliability, using test-retest procedures, ranged from .86 - .96. Scores indicated that 77 students were at the mastery level (MEP); 23 were fluent (FEP); 26 were limited (LEP), and 3 were non-English speakers (NEP).

All students were enrolled in various configurations (depending on their subject needs) of a transitional bilingual program. This program refers to the use of L1 as an instructional medium when needed in subjects; students are mainstreamed to L2 as soon as sufficient skills allow them to follow instruction in the language. Students in the sample all attended bilingual classes in their L1 language in science. The number of subjects in each classroom varied from a high of 22 to a low of six. Five teachers participated in the study.

Materials

To explore the effects of learning words in context, television segments were selected from "3-2-1 Contact," a Children's Television Workshop science production, designed for a target audience of 8-12 year old. This series was selected for its motivational focus, its special appeal to girls and minorities, and its magazine format, which offered flexibility in selecting scientific content most appropriate to the specific needs of the seventh and eighth curricula.

Forty 5 to 8 minute segments were screened by the authors. These segments were then given to a panel of three subject-area specialists to review on the basis of three criteria: relevance of science concept to curriculum, comprehensibility, and interest. Nine segments were selected by consensus. These were clustered into three separate science units on survival, protection, and breathing.

Three formats for each segment were created. In one format, segments were captioned. Subtitles, with minimally edited language, appeared on the bottom line of the screen at a speed of 120 words per minute[1]. In the second format, the segments were seen without captions. In the third format, texts were written on the basis of the captioned scripts. These texts provided equivalent conceptual information with the same vocabulary occurring at the same frequency as the captioned materials in a manner that would be most clearly discernable to the reader/listener. Due to differences in media, it was sometimes necessary to sequence the written materials differently than the captioned segments. Thus, for example, in a video segment, sometimes an example of a concept might be conveyed first visually, then described in detail verbally seconds later. When constructing the text, at times it was necessary to reverse this order for comprehensibility sake, presenting first the description of the concept followed by a specific example (see Appendix for sample text). None of these texts included any pictorial information.

The most difficult words from each segment were selected independently by five judges. Words in which four out of the five judges agreed became target words. These words were then pilot-tested for familiarity on a bilingual sample of 30 Southeast Asian seventh and eighth graders in a different school. Using a modification of Johnson and Pearson's listen and locate task (1984) the teacher read a word and students identified the target word among four other distracters. Out of a total of 120 words, 90 target words were selected, 10 for each segment. These words included 54 nouns, 23 verbs, 12 adjectives, and 1 adverb. A description of the segments and the target words are shown in Table 1.

Measures

Pretests. For each unit of instruction, two pretests were developed. The checklist vocabulary test, using guidelines suggested by Anderson and Freebody (1983) and Nagy, Herman and Anderson (1985), was used as a measure of vocabulary knowledge prior to each science unit. Students were to indicate after reading each word silently whether they knew the meaning of the word by circling yes or no. Nonwords were used to adjust for guessing. The checklist tests used in this study contained 120 items in the following categories: 1) thirty general vocabulary words representing a range of words chosen from Dupuy's (1974) list of 123 general vocabulary words: 2) fifteen decoding distracters, (i.e., giraves, tornato); 3) fifteen pseudo-derivatives, (i.e. defeatlous, aunthood); fifteen nonwords, (i.e. behard, yaldo); and 4) thirty target words. Three checklist tests were developed, one for each science unit.

A prior knowledge test was constructed to assess students' conceptual knowledge of the science material about to be presented for each unit. This test contained nine multiple choice questions with four options. Directions were to circle all correct options, with more than one answer possible for each item. Students could score a total of 15 on the test.

Posttests. Based on Nagy, Anderson, and Herman's theory of the incremental nature of learning words in context (1987), tests were designed to measure a range of word knowledge.

Two measures were administered at the end of each week to analyze word recognition and recall of information. A weekly 10-item word recognition test was developed to measure students' ability to

[1] Captions were provided by the National Captioning Institute.

Table 1

Summary of Unit Lessons and Target Words

Unit	Target words
Unit 1: Survival	
Keeping warm in winter	survive, energy, conserve, shelter, extremities, torso, organs, produce, conditions, blood vessels
Conserving energy	calories, carbohydrates, digestion, evaporate, fracture insulate, perspiring, breathe welding, chink
Generating heat	visual, vicinity, photographed muscles, excess scarf, comfortable, friction, generated, thermography
Unit 2: Protection	
Instinctual Behavior	guarding, behave, threatening predator, instinct, novel stimulus, social synchrony, flock, protection, passive
Protecting others through team work	trauma, respiration, pulse fluid, victim, peripheral, dispatcher, rescue, squad tragedy
Fire Fighting	encounter, fuel, shields, extinguisher, smother, burned oxygen, atmospheric, pressure, suffocate
Unit 3: Breathing	
Breathing Underwater	snorkeling, carbon dioxide, scuba, apparatus, compressor underwater, mouthpiece, weigh, sensation, marine
Running a Marathon	marathon, automatically, exhaust, passages, microscopic alveoli, combustion, exhale, thermostat, joints
Running a Marathon (Part 2)	torture, stockpile, kilometers, emergency, experience, partner, relationship, physical, competitors, spectators

distinguish target words from nonword distracters. The test required students to circle a word they knew in each line from three other distracters all resembling the target word, as in the following example:

atparphic	atmosteric	atherostic	atmospheric
suffocate	sappulate	stimigrate	stamurate

A concept question was developed for each unit to elicit weekly written retellings. These questions were designed to measure the frequency of target words used in context, as well as to assess students' ability to recall information. For example, the concept question in Lesson 1 was, "Explain what you learned about keeping your body warm when it is very cold." The question was followed by ten blank lines.

At the end of each unit, a sentence anomaly test was constructed for assessing students' ability to understand the target words in context. Three target words, considered most central to the science concept in each segment, were selected through discussion by three judges. In this manner, nine words were selected for each unit. Using a format developed by Stahl and Clark (1987), three sentences were written for each word; one sentence used the word in context correctly, and one used it incorrectly. A third was randomly chosen to be either correct or anomalous, so that half were correct, and the other half incorrect, as in the following example.

True	False	It is a natural instinct for animals to search for food.
True	False	The instinct has been in the house for a week.
True	False	A dog's instinct is to chase and bit.

Target word sentences were intermixed. Students were told to read each sentence and indicate which of the sentences could be true or false. There were 27 items on the test. Cronbach's alpha, measuring internal consistency for the three unit tests, were .74, .78 and .80 respectively.

Finally, at the end of the study, a multiple choice test was constructed to measure knowledge of all target word meanings. Each of the target words was presented in isolation, with the correct response and three distracters. All options were designed to be relatively easy to read; distracters were the same parts of speech as the target word, but semantically quite different, as in the following example:

<u>thermography</u> means:

a. a place where plays or movies are shown.
b. a photographic record of heat.
c. the shape of a land mass.
d. a long hairy spider.

Cronbach's alpha was .91. To reduce student fatigue, this test was divided into two parts and given on two separate days.

In summary then, these posttest measures analyzed a continuum of vocabulary knowledge. At the lowest level, questions could be answered on the basis of word recognition alone, without any knowledge of an individual word's meaning. At a slightly higher level of difficulty, some understanding of the meaning of a word was required to determine if it made sense in a familiar context. At a more difficult level, some minimal knowledge of the definition of isolated words was needed. Four posttests for each unit were constructed to measure the first two levels of word learning. The final posttest, measuring word knowledge at the most difficult level, was administered to analyze overall gains in word meanings. Three written retelling questions for each unit assessed the frequency of target words used in writing and the ability to freely recall science content.

Procedures

Intact classes were randomly placed in one of four groups: 1) closed-captioning (N=32), 2) television viewing alone (N=37); 3) reading along and listening to text (N=32); and 4) textbook only (N=28). An analysis of variance indicated no significant differences between groups for IPT scores, $F(3, 125) = 1.05$, n.s.. Three of the teachers taught in all four conditions; two teachers, in two of the conditions.

Each science unit was taught over a three-week period. Prior to instruction, students in all four conditions were administered the two pretest measures. One science lesson was then given to each class at the beginning of the week. This same lesson was repeated toward the end of the week, as reinforcement.

Students in the closed-captioning (Group 1) and television viewing (Group 2) conditions were given a one sentence general introduction, such as "watch to find out how animals survive in the winter." The television segment was then viewed without interruption. A brief summary statement followed the lesson. No definitions or explanations of target words were given. Total lesson time was approximately 15 minutes.

Following a similar introduction to the lesson, students in the reading along and listening to text condition (Group 3) were encouraged to read the stories first silently. Then with the help of their teachers, these stories were read aloud by a volunteer; others listened and followed along. As with the other groups, no instruction on target words or general discussion occurred. Questions were answered as briefly as possible. Lessons took approximately 20 minutes.

The textbook only condition (Group 4) acted as a control group. Science instruction in these bilingual classes was given in L1 followed by reading and exercises from their textbooks in L2. No laboratory experiences were provided in these classes.

At the end of each week following the second lesson, students in the first three conditions were given a word recognition test and a concept question for written retelling to measure immediate recognition of vocabulary and recall of concepts. The control group received only the pretests, the sentence anomaly unit tests, and the total word meaning posttest.

Two research assistants monitored the instructional conditions by informally visiting different classrooms and meeting with teachers on a weekly basis. The study was conducted over a 12-week period.

Data analysis

Data were analyzed in three steps. The first set of analyses examined differences among groups in recognizing and understanding words in context across three different science units. Scores from the three weekly word recognition tests in each unit were combined. Written retellings were analyzed by counting the total number of idea units contained in each recall protocol. Nine templates were developed for each concept question. These were used to quantify the number of idea units written in each protocol. Inter-rater reliability, determined by two judges rating a sample of 20 protocols per question, ranged from .90 to .98. The number of student's idea units (not counting repetitions), along with the target words used in weekly retellings were totaled for each unit.

Analyses of covariance were performed separately for each unit with three comparison conditions (captioning, television viewing alone, and reading text) using the word recognition, and retelling scores, along with the target words used in these retellings, as dependent variables.[2] The checklist vocabulary test and the prior knowledge test, specific to the unit of instruction, were used as covariates. Since the textbook control group did not receive weekly tests, analyses were conducted for all four conditions for the sentence anomaly unit tests and the total word meaning posttest only. Planned comparison contrasts (Keppel, 1982) were conducted to test whether the closed captioning group differed significantly from other comparison conditions.

A second set of analyses from the closed captioned group was performed to determine if certain word-related and video-related factors reported to be associated with learning words in context (Carnine, Kameenui & Coyle, 1984; Elley, 1989; Jenkins, Stein, & Wysocki, 1984; Nagy, Anderson & Herman, 1987) were also typical of incidental word learning from captioning.

To conduct this set of analyses, four variables were examined for each of the 90 target words. First, on the basis of research by Jenkins, Stein, and Wysocki (1984), and Elley (1989), exposure to words was predicted to strongly related to vocabulary gains. This variable was measured by the number of times the target word was captioned. Second, the conceptual difficulty of the word has been reported by Nagy, Anderson and Herman (1987) to be an important indicator of incidental word learning. Using a modified coding strategy from their study, this variable was estimated by having three ESL specialists rate each of the target words on a 4-point scale, ranging from "concept known and easily describable" to "concept not know and requires the learning of new information." Third, the importance of the word to the development of the science concept was analyzed by having teachers rate each word on a 4-point scale ranging from "not important to very important." Fourth, the strength of the contextual support for each word was analyzed. Visual support was analyzed using a 4-point scale:

[2] The test of homogeneity of the variance-covariance matrices was conducted using Box's M statistic. No significant differences were reported.

1) word actually represented in video form;
2) word described in video form;
3) word mentioned but not shown;
4) word mentioned with contrasting video.

Contextual ratings for words were measured using Beck, McKeown, and McCaslin's (1983) 4-point rating scale:

1) directive: word meaning explicitly stated in captioned text;
2) general: context provided some information about word meaning;
3) nondirective: context provided no assistance; and
4) misdirective: context seemed to lead to incorrect word meaning.

These two scales were combined to form a contextual support measure, analyzing the degree to which these two contexts facilitated incidental word learning.

Three raters were trained in coding procedures. Following discussion of categories, each rater independently coded all words. The mean rating for each word was calculated among the three coders, and these means were used in the analyses.

These four variables were entered into a hierarchical multiple regression analysis, using the proportion of students in the captioned television group correctly identifying the target word meaning on the posttest as the dependent variable. Knowledge of the target word (as measured by the checklist vocabulary tests) was entered first in the equation to remove variance based on students' prior knowledge of words. Next, word properties were entered in the order of occurrence, difficulty, importance, and context to determine the extent to which each of these properties were likely to contribute to learning words from context.

Finally, a third analysis was designed to measure whether vocabulary gains were influenced by students' existing language competence in L2. Combining all conditions, analyses of covariance, with pretest scores as covariates, examined the sentence anomaly unit tests and the overall word meaning posttest by levels of language proficiency as measured by the IPT scores.[3]

[3] Box's M revealed that Group 3 (Mastery level) had the greatest co-variation while Group 2 (Fluent level) had the least. The effect of a significant difference in homogeneity of variance is felt strongest when the group with the smallest N is the one with the greatest co-variation, resulting in an inflated Type 1 error rate. In the present case, Group 3 had the largest N while Group 2 had the smallest N. This results in a Type 1 error rate that is actually less than our original specified alpha (Glass & Hopkins, 1970). As a consequence, the analysis become conservation to the extent that the null hypothesis is rejected fewer times than would be expected. Given this situation, no transformation upon the data was performed.

Results

Learning words in context

Our first analysis was designed to measure differences between groups in degrees of word learning. Tables 2 and 3 gives the adjusted means and standard deviations for the word recognition, sentence anomaly, and word meaning posttests.

Table 2

Means and Standard Deviations for the Word Recognition Test

Group	Unit 1	Unit 2	Unit 3
	M SD	M SD	M SD
Group 1			
Captioned TV	22.15 (4.35)	21.23 (4.51)	20.22 (4.61)
Group 2			
TV Viewing Alone	20.17 (7.41)	17.97 (7.58)	19.55 (7.01)
Group 3			
Reading Along and Listening to Text	18.89 (6.88)	17.42 (7.09)	20.18 (6.90)

Note: Means are adjusted for pretest vocabulary score and prior knowledge. A total score of 30 was possible.

Planned comparisons indicated that the Closed-captioning group scored significantly higher than the Reading Text group for all three units on word recognition ($F(2, 96) = 6.06$, $p<.05$; 8.04, $p< .01$; 13.20, p. 001). Differences favoring those watching Closed-captioning from the Television Viewing Alone group were significant for Unit 2 ($F(2, 96) = 7.33$, $p<.01$), but not Units 1 or 3.

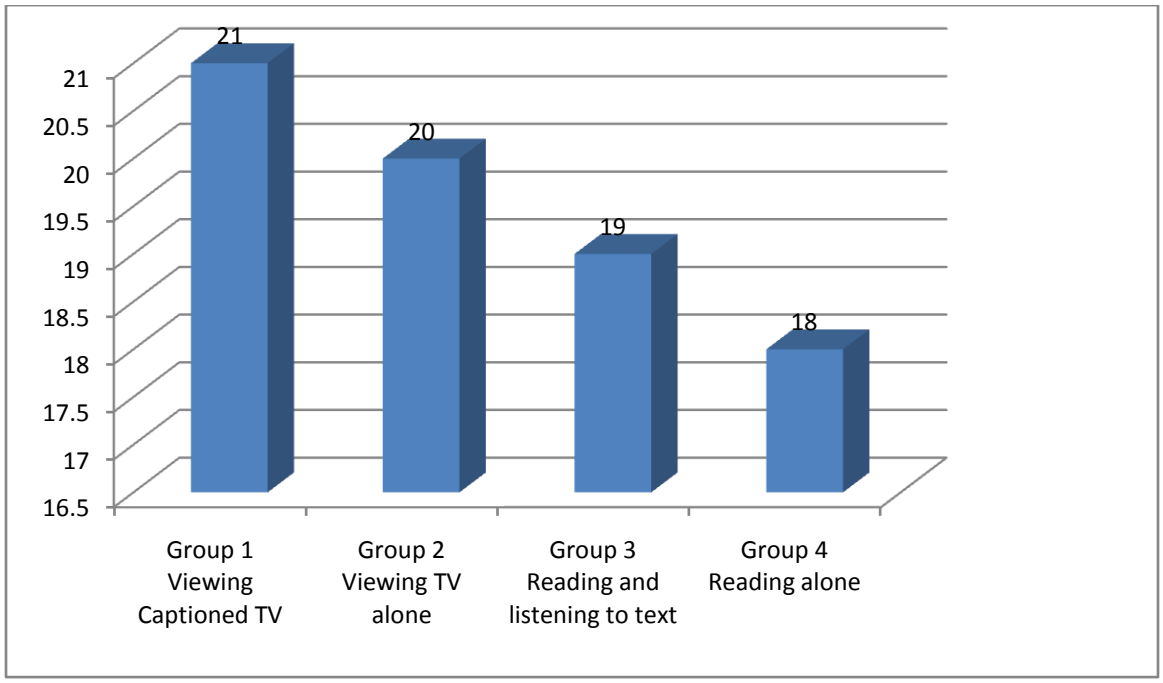
Table 3

Means and Standard Deviations for the Sentence Anomaly Test

Group	Unit 1	Unit 2	Unit 3
	M SD	M SD	M SD
Group 1			
Captioned TV	22.85 (2.45)	19.24 (3.43)	21.23 (2.58)
Group 2			
TV Viewing Alone	20.28 (4.10)	17.50 (4.89)	20.38 (3.38)
Group 3			
Reading Along and Listening to Text	18.00 (3.96)	15.03 (2.86)	17.94 (2.45
Group 4			
Textbook only	17.34 (3.12)	15.03 (2.86)	17.94 (2.45)

Note: Means are adjusted for pretest vocabulary score and prior knowledge. A total score of 27 was possible for each test.

Comparison of Captioning vs. Non-Captioning for ESL Students



Average of mean scores from Sentence Anomaly Test

By watching closed-captioned television, students learning English as a Second Language (ESL) consistently score higher on written tests than students in any other treatment groups.

Note: Tests were given on three separate units. A total of 27 were possible for each test.

Means are adjusted for pretest vocabulary and prior knowledge.

Source: National Captioning Institute, Inc.

Significant differences were recorded for three unit tests between the Closed-captioning group and the Reading Text group (F (3, 123)=11.81, p<.001; 13.41, p<.001; 10.65, p<.001) and the Control group (F (3, 123)=8.56, p<.01; 17.39, p<.001; 16.49, p<.001). Again, differences were significant between Closed-captioning and Television Viewing Alone groups for Unit 2 only (F(3, 123)=4.65, p<.05).

Scores on the word meaning posttest, analyzing students' knowledge of all target words, showed that the Closed-captioning group significantly differed from the three other groups including those viewing Television Viewing Alone (F (3, 123)=23.26, p<.001); and the Control group (F(3, 123)=17.38, p<.001). Through captioned television, bilingual students appeared to make significant gains in vocabulary knowledge without any formal instruction.

Table 4

Means and Standard Deviations for the Word Meaning Posttest

Group	Word Meaning Posttest	
	M	SD
Group 1		
Captioned TV	56.56	(11.68)
Group 2		
TV Viewing Alone	52.34	(15.31)
Group 3		
Reading Along and Listening to Text	40.59	(14.27)
Group 4		
Textbook only	40.51	(9.31)

Note: Means are adjusted for total pretest vocabulary score and total prior knowledge scores. A total score of 90 was possible.

In sum, subjects in the closed-captioning group consistently achieved higher mean scores than all other comparison groups on all word knowledge tests. These differences, however, were not always statistically significant from the other television viewing group. These results suggest that the visual representation of words in video form appeared to be an important contributor to students' increased word knowledge.

Analysis of students' weekly recall of science concepts among the three comparison groups receiving equivalent information indicated a similar trend as shown in Table 5.

Table 5

Means and Standard Deviations for Written Retellings

Group	Unit 1	Unit 2	Unit 3
	M SD	M SD	M SD
Group 1			
Captioned TV	10.92 (2.34)	7.19 (2.46)	6.80 (3.19)
Group 2			
TV Viewing Alone	9.00 (3.78)	7.62 (2.83)	6.37 (2.50)
Group 3			
Reading Along and Listening to Text	6.46 (3.69)	4.82 (2.28)	4.15 (1.96)

Note: Means are adjusted for prior knowledge scores.

Subjects in the closed-captioning group scored significantly higher on the number of idea units recalled from the science selection than those in the Reading Text group ($F(2,97)=21.02$, $p<.001$; 13.81, $p < .001$; 18.18 p .001, respectively). In only Unit 1 were significant differences reported between the two video conditions ($F(2.97)=4.46$, p. 037). Closely associated with the number of idea units, the closed-captioning group used target words more frequently in their writing than those in the Reading Text group for Units 1 and 2, ($F(2, 98= 8.75$, $p < .01$; 13.59, p .001) and differed significantly with the Television Viewing Alone group in Units 2 and 3 ($F(2.98= 5.82$, $p < .018$; 3.91, $p < .05$).

Table 6

Means and Standard Deviations for number of target words used in written retellings

Group	Unit 1	Unit 2	Unit 3
	M SD	M SD	M SD
Group 1			
Captioned TV	6.16 (4.56)	4.34 (2.76)	2.75 (2.42)
Group 2			
TV Viewing Alone	5.19 (3.76)	2.78 (3.15)	1.70 (1.94)
Group 3			
Reading Along and Listening to Text	3.34 (2.93)	1.88 (1.90)	2.00 (2.23)

Note: Means adjusted for pretest vocabulary scores.

Taken together, these data offers rather strong support for the incidental acquisition of word knowledge and conceptual science information through closed-captioning for bilingual students.

Word- and Picture-Related Factors

In the second analysis, data from the closed-captioned group were used to further examine factors that might account for these overall vocabulary gains. A multiple regression analysis was designed to measure whether similar word-related factors found in previous research (Nagy, Anderson & Herman, 1987; Elley, 1989), as well as the contextual support provided by video might account for any of the vocabulary gains reported on the Word Meaning posttest. Table 7 reports the results of the four hypothesized factors, in the order in which they were entered, on the criterion variable—proportion of students correctly identifying each target word.

Table 7

Factors Related to Learning Words from Context

Variable	Regression Coefficient	F	P
Previous Word Knowledge	.67	7.47	.001
Number of Occurrences	.12	1.32	ns
Difficulty of Concept	.01	.14	ns
Importance of Word to Concept	.10	1.10	ns
Context	.21	2.52	.01

The multiple correlation was .67, accounting for 45% of the variance. This analysis indicated that the checklist tests were highly predictive of word knowledge. Once the variance accounted for by students' prior knowledge of target words was removed, only context remained a significant factor. Apparently, the words that were most readily learned in these captioned segments were those for which both the surrounding word—and the surrounding video—context were explicitly stated and visually represented. Table 8 describes this relationship, indicating that as the level of contextual support decreases, so does the percentage of subjects answering correctly on the word meaning posttest.

Table 8

Levels of contextual support and learning from context

Level of Contextual Support	No. of Words at this level	Percentage of students answering correctly on Word Meaning Test
Level 1	16	66%
Level 2	24	64%
Level 3	46	63%
Level 4	4	57%

Linguistic competence and learning words in context

Finally, is the acquisition of word knowledge through comprehensible input influenced by students' linguistic competence? The third analysis examined whether vocabulary gains were related to students' oral language proficiency. Table 9 displays means and standard deviations for those students defined as having limited, fluent, or mastery-level skills in oral English. Three students, defined as non-English speakers, were not included in this analysis.

Table 9

Means and Standard Deviations for Sentence Anomaly

and Word Meaning Posttest by Levels of Linguistic Competence

Level	Unit 1	Unit 2	Unit 3	Word Meaning
	M SD	M SD	M SD	
Limited English	16.51 (3.06)	14.69 (2.95)	18.28 (2.38)	37.85 (12.64)
Fluent English	18.76 (2.98)	14.85 (2.94)	18.93 (2.21)	41.83 (12.39)
Mastery English	19.54 (3.33)	17.21 (4.10)	19.03 (3.77)	46.69 (16.25)

Note: Means adjusted for pretest vocabulary scores and prior knowledge.

Results indicated that after adjusting for prior vocabulary knowledge, students at the mastery level of linguistic competence scored consistently higher than those who were o f limited English proficiency. With the exception of Unit 3, the significant differences reported seemed to lie primary between those who were of limited and mastery proficiency levels ($F2, 121)=33.14$; $p < .001$; 16.36, $p < .001$ respectively) for the sentence anomaly test, and the word meaning posttest ($F (2, 121) = 9.81$, $p < .01$). Once students have become relatively fluent in English, however, scores did not significantly differ with those at the mastery level. The exception was Unit 2, where significant differences between fluent and mastery levels were recorded ($F (2, 121)= 16.44$, $p < .001$).

Higher levels of English proficiency, therefore, were associated with greater vocabulary gains. Though word learning occurred at all levels, these data suggest that without increasing competence in English, word knowledge through incidental learning tended to follow the “rich get richer” maxim of the “Matthew Effect” (Shefelbine, 1990; Stanovich, 1986; Walberg & Tsai, 1983).

Conclusions

Central to Krashen's theory of second language acquisition is that basic communicative competence in L2 is a function of the amount of "comprehensible input" acquirers receive and understand, as well as the degree to which they are provided with the motivation to learn. Children are thought to acquire language and literacy by reading structures that are "a little beyond" where they currently are. Thus, according to Krashen (1989), the acquisition process in language and reading is identical to what has been termed "incidental learning."

It follows, then, that reading materials with informative contextual supports will most likely lead to a greater amount of incidental learning of word knowledge. Herman, Anderson, Pearson and Nagy (1987), for example, found that by elaborating the context to provide more thorough descriptions of concepts, eighth grade students gained more word knowledge than those reading the original texts. Elley (1989), as well, reported that the helpfulness of the context was positively correlated with the incidental learning of words.

In this study, we examined how "comprehensible input" in the form of captioned television, might influence the incidental learning of words for bilingual students. As a medium for incidental learning, it provided a number of clear advantages. Here, there were two contextual supports systems, with words vividly portrayed by video and accompanied by the printed word. In addition, captioned television had the advantage of being rather easy to access, providing a shared learning environment for student participation.

But, there were also a number of potential disadvantages. First, the medium presents its content at an invariant pace; there were no opportunities in each session to review or reread. Second, captions are shown at a rate of approximately 120 words per minute, providing a challenge to even the most accomplished developing readers (Spache, 1981). Third, some have suggested that the "crowdedness" of television, requiring readers to simultaneously process through multiple modalities might be difficult due to hypothesized limits of human attention (LaBerge & Samuels, 1974; Singer & Singer, 1983). With the decoding task so difficult for bilingual students, some question whether they have the attentional capacity to read, view, and listen at the same time (Williams & Snipper, 1990).

Contrary to these concerns, the results of this study clearly indicated that students incidentally learned more words from captioned television than either of the two treatment conditions as well as the control group. On all measures of word knowledge, students who viewed captioned television consistently outscored those who did not. Similarly, students in the captioning group appeared to remember more science information than others. These results suggest that, in contrast to exceeding their attentional capacity, different kinds of information provided by different modalities appeared to enhance incidental learning from context. These findings may extend the results reported in McMahon's "reading while listening" study with developmental readers. Her study reported that the skill of combining modalities occurs early on and that flexibility in applying the skill increases through the grades (1983).

A question of great interest relates to how students actually read the printed captions. Do they fixate on certain words? Are these fixations related to interest? Or, do students read selectively by "going for the meaning," as Krashen (1989) has argued? This experimental study obviously cannot answer these questions. To our knowledge, there are no studies that have measured how bilingual students might make use of a combination of visual, auditory, and written information. This question might be most efficiently addressed through research examining how bilingual children read with differing kinds and degrees of supporting contexts.

In this study, visual and printed contexts that provided explicit, and thus, redundant information supported incidental word learning. With such a carefully designed program as 3-2-1 Contact (CTW), it was not surprising that over 43% of the target words selected were viewed and read in supportive contexts. Using clips from ABC Afterschool Specials, another carefully developed series, Flagg, Carrozza, and Jenkins (1980) found similar results in their pilot study of captioning with partially deaf students, reporting that eye fixations with complementary contexts were not reduced, while comprehension was increased. Whether these findings might also extend to typical television fare with its complex verbal word play, however, is an important area for further research.

The results of this study have important implications for a theory of word learning through context. Nagy, Herman and Anderson (1985) have argued that regular, wide reading must be regarded as the major avenue of large-scale vocabulary growth. Certainly, television as a mass medium, with its vocabulary gauged at about 4th grade level (Cromstock, 1978), cannot compete with the intellectual range of print materials. But it is probably a serious oversight to discount television as a medium for word learning. In this study, for example, subjects who viewed science segments appeared to gain a great deal of vocabulary knowledge, even without the accompanied captioned words. A content analysis by Rice (1984) suggests that at least some of the dialogue presented in children's television is well-suited to their linguistic competencies. Just like storybooks (Elley, 1989), L1 children seem to absorb quick partial meanings of words, referred to as "fast mapping" (Dickinson, 1984) as they view television without intensive conversational interactions. Krashen argues that a similar mechanism occurs with L2 students (1982). These examples would imply that vocabulary growth occurs through many different learning "contexts" in addition to book reading.

The results of this study indicated that student's ability to acquire vocabulary through context appeared to be influenced by their level of linguistic competence. Those who were at least fluent in L2 gained more vocabulary knowledge than those who were of limited English proficiency. In concurrence with Cummins (1979), this analysis suggests that the level of competence or threshold that bilingual children achieve in L2 acts as an intervening variable in mediating the effects of learning through comprehensible input. This finding has important implications, for it suggests that without direct teacher intervention, input alone is not sufficient for those who are below a threshold of linguistic competence in their new language. In this respect, the input hypothesis appears in need of developing specific instructional strategies sensitive to differing levels and types of bilingualism.

In conclusion, these data provide dramatic evidence of the effects of captioned television on bilingual students' acquisition of language, literacy and conceptual knowledge. Captioning presented a particularly rich language environment which enabled students to incidentally learn words through context as they developed concepts in science. Overall, this study demonstrated the power of captioned television to provide "comprehensible input" to language minority students.

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Appendix A

Captioned Script: Fire Fighting: 283 words*

Take the match and light the candle.

Chief Eastside showed me how a fire needs air. This is basically what you have when there's a fire inside a house.

I'll put the glass over here, and watch what happens. The fire went out.

The fire burned up the oxygen inside that glass. Look what else is happening. The water came up! Why?

When the oxygen was used up, it created a space. Atmospheric pressure outside the glass pushes water up inside there. It also left gases inside.

We encounter that when we go into a fire.

So we enter a room low. Any oxygen left will be down low. Inglewood Training Academy, California.

Me.

Firefighter for a day.

Here we got fuel.

We've got heat, what else do we need?

Oxygen. And do we have oxygen?

There's a whole yardful of it.

When I light this, you'll get some heat, so step back, put your face shields down.

Kathy, take that extinguisher and see if you can put it out. All right, hit it one more time.

You notice what's happening?

It's like a grease fire at home. The fuel is lighter than the water, it floats to the top.

Water won't put it out.

How else can we get oxygen from the fire? Smother it. At home, how would you smother it? With baking soda. Here, we'll try dirt. Get those shovels and smother the fire.

We've got to cut off the oxygen. It'll take quite a bit. How does it work? Why doesn't the fire move elsewhere? You're containing it. You're holding the fuel there while you smother the oxygen from it.

You cut off the oxygen and suffocated it.

*Target words underlined.

Written story: Fighting Fires: 304 words

A fire needs air in order to burn. Place a candle and a candle holder in a dish of water. Take a match and light the candle. Then, if you cover the candle with a glass, the candle will go out. This is because the candle burned up all the oxygen. Keep watching and you will also see the water from the dish begin to rise up inside the glass. This is because when the oxygen was used up, it created a space. Atmospheric pressure outside the glass pushes water up inside the glass.

The fire also left gasses inside the glass. Firefighters encounter this when they go into a burning building, so they enter a room low. Any oxygen left will be down low by the floor.

Fuel and oxygen are both necessary for a fire to burn. There is plenty of oxygen in the air. If a pool of oil catches fire, it produces a lot of heat. The firefighters need face shields to get close to the fire. If they try to put it out using an extinguisher they discover it doesn't work on oil. This is because oil is lighter than the water and it floats to the top. This is just like what happens in a grease fire in a house. The firefighter needs to figure out what to use to keep oxygen from the fire to smother it. To smother a grease fire in a kitchen, you could use baking soda. Outside, they can use direct to smother and cut off the oxygen and suffocate the fire. The dirt also holds the fuel, containing it and stopping it from moving while the dirt is cutting off oxygen to smother the fuel. These are some of the ways to protect yourself when there is a fire.

Information about where to purchase a TeleCaption decoder may be obtained from:

The National Captioning Institute

5203 Leesburg Pike

Falls Church, Virginia 22041

(703) 998-2400 (Voice or TDD)

Or

1 (800) 533-WORD (Voice)

1 (800) 321-TDDS (TDD)