Susan B. Neuman
Temple University, Philadelphia

Patricia Koskinen
University of Maryland, College Park

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, taking place informally in the context of functional language use (Chomsky, 1975; Halliday, 1975). Hence, language acquirers are not usually aware of the fact that they are learning language.

It has been argued that a similar subconscious process occurs when a person is acquiring competence in a second language (Krashen, 1982; 1985). Children develop in a second language by focusing on the meaning, not on the form or grammar, of the message. Thus, according to one theory, they acquire the second language by understanding messages or by receiving "comprehensible input" (Krashen, 1985). Stimulated just by exposure to oral and written language 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 (Elley & Mangubhai, 1983; Krashen, 1989).

Whether or not the amount of input strongly influences 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 children's vocabulary-concept knowledge in their first language (L1) 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 a second language (L2), since there is no way for them to relate the printed symbols to a known phenomenon. This suggests 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 designed to involve children in ways that cause them temporarily to "forget" that they are hearing or reading another language.

Considering the range of children's conceptual-linguistic knowledge, differences in motivation to learn, and the influence of such differences on acquisition of input (Cummins, 1979), we proposed in this

Captioned television as "comprehensible input": Effects of incidental word learning from context

A WELL known theory argues that competence in a second language (L2) is a function of the amount of "comprehensible input" received, without formal instruction in reading or grammar. This study analyzes whether comprehensible input via captioned television influenced acquisition of science vocabulary and concepts. The 129 bilingual seventh and eighth graders were assigned to four groups: (a) captioned TV, (b) TV, (c) reading along and listening to text, or (d) textbook only (control). Treatment groups either viewed or read three units of science segments from the *3-2-1 Contact* science series twice a week for 12 weeks. Pretests evaluated vocabulary and prior knowledge; posttests analyzed knowledge of 90 target words and a written retelling. Subjects in the closed-captioning group outscored others in word knowledge and recall of information. An analysis of factors suggested that contexts providing explicit information yielded higher vocabulary gains. Subjects more proficient in English learned more words from context than others. These results suggest that comprehensible input may be a key ingredient in language acquisition and reading development.

Les sous-titres à la télévision en tant que "input compréhensible": les effets d'un apprentissage verter incident en contexte

UNE THEORIE bien connue soutient que la compétence en langue deux (L2) est fonction du montant d' "input compréhensible," sans enseignement formal en lecture ou en grammaire. Cette recherche examine si l'input compréhensible, sous forme de sous-titres à la télévision, peut avoir un effet sur l'acquisition du vocabulaire et la connaissance des concepts scientifiques. Les 129 élèves bilingues de septième et huitième année ont été répartis dans quatre groupes: (a) télévision avec sous-titres, (b) télévision, (c) lecture continue et écoute du texte, (d) manuel uniquemente (situation contrôle). Les élèves des groupes a-c ont vu ou ont lu trois unités des programmes de la série scientifique *3-2-1 Contact*, deux fois par semaine pendant 12 semaines. Avant chaque unité on a administré des tests de vocabulaire et de connaissances antérieures. Après le traitement on a administré des mesures de connaissance de 90 mots-cibles, ainsi que un rapport écrit. Les sujets du groupe avec sous-titres dépassent les autres pour la connaissance des mots et pour l'information scientifique. Les contextes qui procurent une information explicite ont produise des gains supérieurs de vocabulaire. Ceux qui sont le plus compétents en anglais apprennent plus de mots à partir du contexte. Un input compréhensible, peut être un élément central dans l'acquisition du langage et le développement de la lecture.

La televisión subtitulada como "input comprensible": Los efectos de aprendizaje incidental del contexto

UNA TEORIA muy conocida sostiene que la competencia en una segunda lengua (L2) es una función de la cantidad de "input comprehensible," sin instrucción formal en lectura o gramática. Este estudio analiza la influencia de un input comprehensible en forma de televisión subtitulada, sobre la adquisición de vocabulario y conocimiento conceptual sobre ciencia. Los 129 estudiantes bilingües de s éptimo y octavo grado fueron asignados a quatro grupos: (a) televisión subtitulada, (b) televisión, (c) leer mientras se escucha el texto o (d) libro de texto únicamente (grupo control). Los estudiantes de los grupos a-c miraron o leyeron tres unidades de fragmentos de las series de ciencia *3-2-1 Contact*, dos veces por semana durante 12 semanas. Se administraron pretests de vocabulario y de conocimientos previos. A continuación se administraron medidas de vocabulario (90 palabras) y un relato escrito. Los sujetos del grupo de televisión subtitulada superaron, tanto en conocimiento de palabras como en la recuperación de información sobre ciencia. Un análisis sugirió que los contextos que proveen información explícita permiten mayores logros en vocabulario. Los estudiantes más competentes en inglés aprendieron más palabras a partir del contexto. El input comprehensible puede constituir un ingrediente clave en la adquisición del lenguaje y el desarrollo de la lectura.

Fernsehen mit Untertiteln als "verständlicher Input": Effekte von kontextvermitteltem beiläufigen Wortlernen

EINE BEKANNTE Theorie besagt, daß die Beherrschung der Zweitsprache eine Funktion der Menge "verständlichen Inputs" ist, der ohne formalen Lese- oder Grammatikunterricht aufgenommen wird. Die vorliegende Studie untersucht, ob verständlicher Input in Form von Film mit Untertiteln den Erwerb von naturwissenschaftlichem Vokabular und konzeptuellem Wissen beeinflußt. 129 bilinguale Siebt- und Achtklässler arbeiteten mit: (a) Film mit Untertiteln, (b) Film ohne Untertitel, (c) Hören und Mitlesen von Texten oder (d) nur Lesebuch (Kontrollbedingung). Versuchsgruppen (a-c) sahen oder lasen zweimal wöchentlich 12 Wochen lang drei Einheiten naturwissenschaftlicher Ausschnitte der Serie *3-2-1 Contact*. Vor jeder Einheit wurden ein Vokabeltest und ein Vorwissen-Test durchgeführt; nachher wurden Vokabelteste (90 Zielwörter), sowie eine schriftliche Nacherzählung durchgeführt. Versuchsteilnehmer in der Untertitel-Gruppe übertrafen die anderen in Wortwissen sowie der Erinnerung naturwissenschaftlicher Informationen. Kontexte, die explizite Informationen lieferten, führten zu besserem Vokabelerwerb. Weiterhin lernten diejenigen Schüler mehr Wörter vom jeweiligen Kontext, die über bessere Englischkenntnisse verfügten. Die Befunde legen nahe, daß der verständliche Input eine Schlüsselfunktion im Spracherwerb und der Leseentwicklung hat.

study that captioned television, as a multisensory, largely entertaining medium, might be an important instructional resource in learning vocabulary and concepts. Captions are subtitles that can be seen only on television sets equipped with a special electronic telecaption decoder. Although telecaption decoders were originally developed for the hearing impaired, marketing studies suggest that over half of the decoders are sold to the hearing population and that many purchasers 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 might help children establish relationships between words and meanings. Blosser (1988), for example, reported a positive relationship between television viewing and reading comprehension scores for Hispanic students, albeit for those children with some English proficiency.

Second, the entertaining qualities of television make it a somewhat easier medium to access than text; L1 children generally perceive themselves to be highly successful in processing its messages (Salomon, 1984). Anecdotal evidence (Larsen-Freeman, 1983) suggests that L2 students hold similar beliefs about television, which might help in minimizing fear of failure in learning. A third reason to expect benefits from captioned TV is that when appropriate content is used, viewing can be a cognitively active experience (Anderson & Collins, 1988; Neuman, 1989, 1990, 1991), 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 indicates that the technology may be particularly effective for special populations of hearing audiences. Koskinen, Wilson, Gambrell, and Jensema (1987) reported significant differences in word recognition and oral reading skills between learning disabled students who viewed TV with captions and those who read the print text of captions without TV. In initial studies with ESL adult students, Price (1984) reported that captions improved vocabulary and comprehension. Markham (1989) also found improvement in listening comprehension. 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, we examined 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 threefold. The first purpose was to investigate the incidental acquisition of word meanings in context for bilingual students who exhibited a range of conceptual-linguistic knowledge. Given the combination of visual (pictures and words) and auditory (speech and sound effects) stimuli, we predicted 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: (a) captioned television, (b) traditional television viewing without captions, (c) reading along and listening to text, and (d) textbook only. A second purpose of the study was to identify the combination of word-related and video-related variables that contributed to any vocabulary gains found among the captioning group. 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 of the U.S., consisted of 72% Cambodian, 10% Laotian, 2% Vietnamese, and 16% Hispanic students. Identified by a community needs assessment as an "at risk" target population, the children were at least 2 to 3 years below grade level as measured by grade performance (no formal reading assessments were administered by the school district), 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 were 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, 1982). A criterion-referenced test, the IPT assesses four areas of English proficiency: vocabulary, comprehension, syntax, and verbal expression. An analysis of con-

tent validity by the IPT authors indicated that the test covered a representative sample of language items. Using test-retest procedures, the IPT authors found that reliability ranged from .86 to .96. Scores from this test indicated that 77 students in our sample were at the mastery level (MEP), 23 were fluent (FEP), 26 were limited (LEP), and 3 were nonEnglish speakers (NEP).

All students were enrolled in various configurations (depending on their subject needs) of a transitional bilingual program. In this type of program L1 is used as an instructional medium when needed in certain 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 in science. These classes were heterogeneously grouped, containing children of varying ability levels. The number of subjects in each classroom varied from a high of 22 to a low of 6. Five teachers participated in the study.

Materials

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

We screened 40 segments of 5-8 minutes, then gave them 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 3-week 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. 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 in the captioned materials. Due to differences in media, it was sometimes necessary to sequence the written materials differently than the captioned segments. For example, in a video segment an example of a concept might be conveyed first visually, and the concept described in detail verbally seconds later. When constructing the text, at times it was necessary to reverse this order for the sake of comprehensibility, presenting first the description of the concept and then a specific example (see Appendix for sample text). None of the texts included any pictorial information.

The most difficult words from each segment were selected independently by five judges. Words for which four out of the five judges agreed became target words. These words were then pilot-tested for visual word 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 distractors. 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. The target words and a description of the segments are shown in Table 1.

Measures

Pretests. For each unit of instruction, two pretests were developed. Using guidelines suggested by Anderson and Freebody (1983) and Nagy, Herman, and Anderson (1985), we measured vocabulary knowledge with a checklist vocabulary test 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: (a) 30 general vocabulary words representing a range of words chosen from Dupuy's (1974) list of 123 general vocabulary words, (b) 15 decoding distractors (e.g., *giraves, tornato*), (c) 15 pseudoderivatives (e.g., *defeatous, aunthood*), (d) 15 nonwords (e.g. *behart, yaldo*), and (e) 30 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 in 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 (1987) theory of the incremental nature of learning words in context, tests were designed to measure a range of word knowledge.

Two measures were administered at the end of each of the 9 weeks to analyze word recognition and recall of information. The first was a weekly 10-item word recognition test designed to measure students' ability to distinguish target words from nonword distractors. The

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, weight, sensation, marine*
Running a marathon (Part 1)	*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*

test required students to circle a word they knew in each line. Each line contained three distractors, all resembling the target word, as in the following examples:

1. *atparphic atmosteric atherostic atmospheric*
2. *suffocate sappulate stimigrate stamurate*

The second weekly measure was a concept question developed to elicit written retellings of the week's lesson. These questions were designed to measure the frequency of target words in students' writing, 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 10 blank lines.

At the end of each 3-week unit, a sentence anomaly test was administered to assess 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), we wrote three sentences for each word. One sentence used the word in context correctly, one used it incorrectly, and 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.

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

Sentences with the same target word were randomly interspersed among the total number of items. 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 for each unit. Cronbach's alpha, measuring internal consistency, was adequate for each unit test measure (.74, .78, .80, respectively).

Finally, at the end of the study, we constructed a 90-item multiple choice test to measure knowledge of all target word meanings. Each of the target words was presented in isolation, with the correct response and three distractors. All options were designed to be relatively easy to read; distractors were the same parts of speech as the target word, but semantically quite differ-

ent, as in the following example:

thermography 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 2 separate days.

In summary, 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 a 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, greater knowledge of the definition of words was needed to determine their meaning in isolation. The first level of word knowledge was assessed by weekly posttests, and the second level at the end of each unit; a final posttest was given to measure the highest level of word knowledge. Three written retelling questions for each unit assessed the frequency of target words in writing and the ability to freely recall science content.

Procedures

Intact classes were randomly placed in one of four groups: (a) captioned TV (n = 32), (b) traditional TV without captions (n = 37), (c) reading along and listening to text (n = 32), and (d) textbook only (n = 28). An analysis of variance indicated no significant differences between groups for IPT scores, $F(3, 125) = 1.05$, ns. Three of the teachers taught in all four conditions; two teachers, in two of the conditions.

Each science unit was taught over a 3-week period. Prior to instruction, students in all four conditions were administered the vocabulary and prior knowledge 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 captioned TV- (Group 1) and traditional TV-viewing (Group 2) conditions were given a one-sentence general introduction to the video, 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.

After the same introduction as in the video conditions, 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 the teacher, a volunteer read the stories aloud; others listened and followed along. This condition was designed to measure the effects of learning words from context without the video stimulus. 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 textbooks in L2. Lessons in the textbook and target words were different from those in the experimental conditions. Although students would eventually be introduced to many of these target words in their textbooks, the relevant units were introduced in the second semester of the school year after the study had been completed.

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. These measures assessed 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. In the first set of analyses, we 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 in each recall protocol. Nine templates were developed for each concept question; these were used to quantify the idea units in each protocol. Inter-rater reliability, determined by two judges rating a sample of 20 protocols per question, ranged from .90 to .98. Each 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 (captioned TV, traditional TV, and reading text), using the word recognition and retelling scores, along with the target words used in these retellings, as dependent vari-

Table 2 Means and standard deviations for word recognition test

Group	Unit 1		Unit 2		Unit 3	
	M	SD	M	SD	M	SD
Captioned TV	22.15	(4.35)	21.23	(4.51)	22.46	(4.61)
Traditional TV	20.17	(7.41)	17.97	(7.58)	20.17	(7.01)
Reading along and listening to text	18.89	(6.88)	17.42	(7.09)	17.32	(6.90)

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

Table 3 Means and standard deviations for the sentence anomaly test

Group	Unit 1		Unit 2		Unit 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
Captioned TV	20.85	(2.45)	19.24	(3.43)	21.23	(2.58)
Traditional TV	20.28	(4.10)	17.50	(4.89)	20.38	(3.38)
Reading along and listening to text	18.00	(3.96)	15.91	(3.60)	18.84	(3.10)
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.

ables. The checklist vocabulary test and the prior knowledge test, specific to the unit of instruction, were used as covariates. Because the textbook control group did not receive weekly tests, we conducted analyses for all four conditions for only the sentence anomaly unit tests and the total word meaning posttest. Planned comparison contrasts (Keppel, 1982) were conducted to test whether the captioned TV group differed significantly from other comparison conditions.

A second set of analyses from the captioned TV 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; Shefelbine, 1990) were also predictive of incidental word learning from captioning.

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

Table 4 Means and standard deviations for word meaning posttest

Group	*M*	*SD*
Captioned TV	56.56	(11.68)
Traditional TV	52.34	(15.31)
Reading along and listening to text	40.59	(14.27)
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.

Table 5 Means and standard deviations for number of idea units in written retellings

Group	Unit 1		Unit 2		Unit 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
Captioned TV	10.92	(2.34)	7.19	(2.46)	6.80	(3.19)
Traditional TV	9.00	(3.78)	7.62	(2.83)	6.37	(2.50)
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.

Table 6 Means and standard deviations for number of target words in written retellings

Group	Unit 1		Unit 2		Unit 3	
	M	*SD*	*M*	*SD*	*M*	*SD*
Captioned TV	6.16	(4.56)	4.34	(2.76)	2.75	(2.42)
Traditional TV	5.19	(3.76)	2.78	(3.15)	1.70	(1.94)
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.

sented in video form, (b) word described in video form, (c) word mentioned but not shown, (d) word mentioned with contrasting video. Contextual ratings for words were measured using Beck, McKeown, and McCaslin's (1983) 4-point rating scale: (a) directive: word meaning explicitly stated in captioned text, (b) general: context provided some information about word meaning, (c) nondirective: context provided no assistance, and (d) 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 visual and verbal 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.

The four variables were entered into a hierarchial 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, we entered word properties (number of ocurrences, difficulty, importance, and context) to determine the extent to which each of these properties was 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, we used analyses of covariance, with pretest scores as covariates, to examine the sentence anomaly unit tests and the overall word meaning posttest by levels of language proficiency as measured by the IPT scores.

Results

Learning words in context

Our first analysis was designed to measure differences between groups in degrees of word learning. Tables 2, 3, and 4 give the adjusted means and standard deviations for the word recognition, sentence anomaly, and word meaning posttests.

Planned comparisons indicated that the captioned TV 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 captioned TV over the traditional TV group were significant for Unit 2, $F(2, 96) = 7.33, p < .01$, but not for Units 1 or 3.

Results analyzing differences among all four groups from the sentence anomaly unit tests, requiring knowledge of words in context, indicated a similar trend in

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

Table 8 Relationship of learning to level of contextual support

Level of contextual support	No. of words at this level	Percentage of students answering correctly on word meaning test
Highly supportive context	16	66%
Supportive context	24	64%
Nondirective context	46	63%
Misdirective context	4	57%

favor of captioning.

Significant differences were recorded for three unit tests between the captioned TV 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 captioned and traditional TV viewing groups for Unit 2 only, $F(3, 123) = 4.65, p < .05$).

Scores on the word meaning posttest, which tested students' knowledge of all target words, showed that the captioned TV group differed significantly from the three other groups, i.e., those viewing traditional TV $F(3, 123) = 3.85, p < .05$; those reading text, ($F(3, 123) = 23.26, p < .001$, 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.

In sum, subjects in the captioned TV group consistently achieved higher mean scores than any comparison group 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 is an important contributor to students' increased word knowledge.

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

Subjects in the captioned TV 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. Table 6 indicates that significant differences between the two video conditions were found only for Unit 1, $F(2,97) = 4.46, p < .037$. Use of target words was closely associated with the number of idea units. The captioned TV 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 traditional TV viewing group in Units 2 and 3, $F(2,98) = 5.82, p < .018$; $3.91, p < .05$.

Thus, the results favoring captioning reflected not only different degrees of word knowledge, but qualitatively different kinds of word knowledge. Taken together, these data offer 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, we used data from the captioned TV group to further examine factors that might account for the overall vocabulary gains. A multiple regression analysis was designed to measure whether word-related factors shown to be important in previous research (Elley, 1989; Nagy et al., 1987), as well as the contextual support provided by pictures, 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.

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 word- and the video-context were strongly supportive. Table 8

Table 9 Means and standard deviations for sentence anomaly and word meaning posttest by levels of linguistic competence

	Sentence anomaly posttest						Word meaning posttest	
	Unit 1		Unit 2		Unit 3			
Level	*M*	*SD*	*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.

shows this relationship, indicating that as the level of contextual support decreases, so does the percentage of subjects answering correctly on the word meaning posttest.

Linguistic competence and learning words in context

Finally, in the third analysis we examined whether the acquisition of word knowledge through comprehensible input was influenced by students' linguistic competence. Oral English proficiency scores were used to define language competence; posttest scores on the three sentence anomaly tests and the word meaning posttest were used as dependent measures of vocabulary learning. 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 nonEnglish speakers, were not included in this analysis.

Results indicated that, after adjustments for prior vocabulary knowledge had been made, students at the mastery level of linguistic competence scored consistently higher than those who were of limited English proficiency. With the exception of Unit 3, the significant differences were found primarily between those who were of limited and mastery proficiency levels, $F(2, 121) = 33.14, p < .001$; $16.36, p < .001$, respectively, for the sentence anomaly test, and the word meaning posttest, $F(2, 121) = 9.81, p < .01$. For students relatively fluent in English, however, scores did not significantly differ from those at the mastery level. The exception was Unit 2, where significant difference between fluent and mastery levels were recorded, $F(2, 121) = 16.44, p < .001$.

Higher levels of English proficiency, therefore, were associated with more learning of vocabulary. Though word learning occurred at all levels, these data suggest that, without increasing competence in English, word knowledge through incidental learning tends to follow the "rich get richer" maxim of the "Matthew Effect" (Shefelbine, 1990; Stanovich, 1986; Walberg & Tsai, 1983). Students who were most proficient in English at the outset of the study made more gains than others from the same experience.

Discussion

Central to Krashen's theory of second language acquisition is the idea that basic 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 greater incidental learning of word knowledge. Herman, Anderson, Pearson, and Nagy (1987), for example, found that when the context was elaborated to provide more thorough descriptions of concepts, eighth-grade students gained more word knowledge than when the original texts were used. 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 influ-

ence the incidental learning of words for bilingual students. As a medium for incidental learning, it provided several clear advantages. There were two contextual support systems: video portrayal and the printed word. In addition, captioned television had the advantages of being rather easy to access and of providing a shared learning environment that encouraged 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 within a 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 process simultaneously 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, our results clearly indicated that students incidentally learned more words from captioned television than in either of the two other treatment conditions or in 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. Thus, providing different kinds of information through different modalities appeared to enhance incidental learning from context rather than overwhelming students' attentional capacity. These findings may extend the results reported in McMahon's (1983) "reading while listening" study with developmental readers. McMahon reported that the skill of combining modalities occurs early on and that flexibility in applying the skill increases through the grades.

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. Generalizations regarding the benefits of captioned television, therefore, must be limited to take into account the relationship between the particular content and incidental learning.

The results of this study have important implications for a theory of word learning through context. Nagy et al.(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 fourth-grade level (Comstock, 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 accompanying 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. 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 (1982) argues that a similar mechanism occurs with L2 students. Hence, vocabulary growth occurs through many different learning contexts in addition to book reading.

The results of this study indicated that students' ability to acquire vocabulary through context is influenced by their level of linguistic competence. Those who were more fluent in L2 learned more vocabulary 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. Thus, specific instructional strategies sensitive to differing levels and types of bilingualism must be developed.

In conclusion, the results of this study substantiate previous research (Elley & Mangubhai, 1983) indicating that bilingual students develop word meanings and language through comprehensible input. Captioned television appeared to provide a particularly rich language environment which enabled students to learn words incidentally through context as they developed concepts in science. These results suggest that, along with the development of instructional strategies, com-

prehensible input may be an essential environmental ingredient in language acquisition and reading development for bilingual students.

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FOOTNOTES

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1. Captions were produced by the National Captioning Institute.

2. Tests of homogeneity of the variance-covariance matrices were conducted using Box's M statistic. No significant differences were reported.

3. Box's M statistic revealed that Group 3 (Mastery Level) had the greatest covariation while Group 2 (Fluent Level) had the least. The effect of a significant difference in homogeneity of variance is felt most strongly when the group with the smallest *n* is the one with the greatest covariation, 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 analyses become conservative to the extent that the null hypothesis is rejected fewer times than would be expected. Given this situation, no transformations upon the data were performed.

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APPENDIX

Captioned script: Fire fighting (283 words; target words in italic):

Narrator: 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.

Chief: 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.

Kathy: The water came up! Why?

Chief: 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.

Narrator: Ingelwood Training Academy, California. Me. Fire fighter for a day.

Chief: Here we got *fuel.* We've got heat, what else do we need?

Kathy: *Oxygen.*

Chief: And do we have *oxygen?*

Kathy: There's a whole yardful of it.

Chief: 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.

Kathy: How does it work? Why doesn't the fire move elsewhere?

Chief: 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.

Written story: Fighting fires (304 words; target words in italic)

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 gases inside the glass. Fire fighters 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 fire fighters 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 fire fighter 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 dirt 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.