Is Learning from Media Distinctive? Examining Children's Inferencing Strategies

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The purpose of this research was to investigate the influence of different media on children's interpretations of stories. Two studies are reported that examine whether different inferencing strategies are elicited with different media presentations. Study 1 explored the inferencing strategies children use across text and video by asking 2 fifth graders to think aloud as they read and viewed episodes from two mystery stories. A qualitative analysis identified a range of inferencing strategies. Study 2 examined the extent to which 83 fifth-grade high and low achievers used these strategies and whether there were strategy differences across media presentations. High and low achievers were randomly selected to either read or watch brief episodes of stories and to report verbally on their predictions and thinking processes. Results indicated that there were no significant differences for medium or achievement; nor were there interaction effects. Rather, a similar pattern of inferencing strategies appeared to be employed by children in both print and video forms. These results suggest that the interpretive process may be similar across different media presentations and that the medium per se may have little direct influence in cognition and learning.

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S ince Marshall McLuhan's elliptical phrase, "the medium is the message" (1964), there has been a continuing and broadening debate on the influence of media in shaping cognition. Much of the debate focuses on whether or to what extent media should be used in instruction and how learning can be maximized (Clark & Salomon, 1986). The argument centers around the relative role of the characteristic symbol system of such media as television, print, and radio—the combination of pictures, sounds, print— and how these distinctive forms might affect information processing demands. Olson and Bruner (1974), for example, argue that each medium implicitly cultivates new skills for exploration and internal representation. Thus, as children are taught to read, Olson (1977) reports, "They are learning both to read and to treat language as text" (p. 279).

Extending this theory, Salomon (1979) argues that not only can a medium implicitly teach an information processing skill as Olson and Bruner had assumed, but by arousing certain attentional processes it can become internalized as a "scheme of thought." Reporting on a number of intriguing studies, Salomon found that students deficient in cue attending after watching a film were able to internalize the zooming of a camera lens into a stimulus field, thereby increasing their ability to identify details in a visual montage (1974). In another study using computers to stimulate metacognitive skills in reading, students were able to transfer these metacognitive modes of representation when given a new condition (Salomon, 1987). While Salomon acknowledges that these features may merely activate already established skills, he contends that these data show evidence that media codes were internalized, schematized, and then applied to new circumstances.

Both Olson and Bruner (1974) and Salomon (1974, 1987) suggest that the medium itself may serve a particular instructional function and, thus, provide specific learning benefits to individuals. The closer the match between the characteristics of the symbol system, the content of instruction, and the strategies to be learned, the easier the instructional message will be to recode and comprehend. In Salomon's cue-attending study, for example, it was the zooming feature of film that was thought to provide the most effective modeling strategy for students who needed it. Thus, there is the belief that given the proper mix of medium, student needs, and learning task, instruction may be more appropriately tailored to meet the special aptitudes of individual learners.

In contrast to these claims bearing some resemblance to Paivio's dual coding theory (1978), however, others argue that all kinds of incoming information, regardless of the symbol system, become transformed into internal propositions (Pylyshyn, 1981; Rumulhart, 1980). Symbolic codes, or pictorial images for that matter, are not a fundamentally different form of cognition, but merely a species of a single form used in all cognitive processing. Similarly, Clark (1983), in his synthesis of research on learning from

media, finds no evidence to suggest that symbol systems serve any unique function at all in cognition and learning, arguing that "media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries cause changes in our nutrition" (p. 445). It is not the symbolic elements themselves, according to Clark, that influence learning, but how well the symbols are shaped to represent the critical features of a cognitive task. Since a variety of symbol systems might be manipulated to represent a learning goal, the choice of particular media may be less important for learning than the symbol system theories have assumed.

These differing theories have led to a rather substantial body of literature investigating the cognitive consequences of media on learning (Beagles-Roos & Gat, 1983; Greenfield & Beagles-Roos, 1988; Hayes, Kelly, & Mandel, 1986; Hoffner, Cantor, & Thorson, 1988; Holmes, 1987; Meringoff, 1980; Neuman, 1991; Pezdek, Lehrer, & Simon, 1984). Meringoff (1980), for example, analyzed children's apprehension of an African folktale that was either presented in an animated televised film or read aloud from a picture storybook. Verbal retellings indicated that children in the television group used character actions and visual cues to describe the story content, while the read-aloud group used more expressive vocabulary and inferencing skills. Concurring with Salomon's thesis, Meringoff suggested that specific skills, such as drawing on one's prior knowledge, may vary according to the symbol system employed by the medium.

Other media comparison studies, however, have not substantiated the claims that different media, such as storybook reading, television, and radio, actually enhance particular cognitive skills (Beagles-Roos & Gat, 1983; Hoffner, Cantor, & Thorson, 1988; Neuman, 1989). While many studies do report differences in the way children recall stories across conditions, there is no consensus regarding the specific information processing skills a medium might elicit. For example, in contrast to Meringoff's first study (1980), Banker and Meringoff (1982) found that children's inferences from a film story were far more frequent than those from the same story delivered by a storyteller, suggesting that the differences previously reported may have been related more to the specific details in story content rather than the medium itself.

Therefore, while indicating that different media presentations of similar stories might elicit slightly different interpretations of the stories, these studies do not provide convincing evidence that a medium's symbolic attributes activate specific cognitive processing skills or affect learning in specific ways. Of course, there are some important limitations in these studies. Media comparison studies have been naturally constrained in many cases by having to achieve adequate comparability of content across media (Clark, 1983). For example, with the exception of Banker and Meringoff (1982), many of these studies used animated films (usually supplied by

Weston Woods) that employed the same graphic pictures as the book for their televised condition. These types of presentations and the attributes they exploit may differ dramatically from typical television fare, therefore compromising the ecological validity of the study findings.

Further, a study by Gibbons, Anderson, Smith, Field, and Fischer (1986) indicates that media difference studies might be confounding the content conveyed by the medium and the uses of cognitive skills. In their study of different media presentations (audio vs. audiovisual), these researchers experimentally controlled for redundancy of audiovisual information by providing narrated actions in the audio version. Analyzing young children's reconstruction of stories, they found that all children, regardless of the particular medium, recalled more story actions than utterances. Their findings suggest that previous studies reporting media differences may have inadvertently confounded these differences with the type of information actually presented.

In examining the unique strengths and limitations of media, researchers have relied on measures of "literal" comprehension or inference at the point of retrieval or when investigators imposed a task demanding such reasoning. Yet Kintsch (1974) has argued that textual information is not stored in memory in precise textual form; rather, it is integrated with existing knowledge structures during the encoding process. Starting out from the explicitly conveyed information, learners apply their prior knowledge (Warren, Nicholas, & Trabasso, 1979) and develop strategies to construct new semantic representations from incoming information (Collins, Brown, & Larkin, 1980). Consequently, the making of inferences is crucial in deriving meaning, serving to fill in missing slots in the structure and to connect elementary events with other events in order to move to a higher level of organization (Schank, 1975). Inferences, therefore, represent an important part of what is actually conveyed and remembered (Rickhert & Strohner, 1985) and, thus, might serve as a more accurate method than previous approaches to examine the cognitive processes children are using as they interpret stories in different media.

The present research, designed to analyze the influence of different media presentations, differs from those previously cited in several specific features. First, this investigation used video and print materials judged to be equivalent in story content. Second, it concentrated specifically on children's inferencing strategies, providing an opportunity to examine their constructive thinking processes as they proposed and evaluated competing hypotheses on the meaning of stories. Third, it used open-ended verbal reporting procedures to elicit inferences *as* children were actively processing video or print stories. Fourth, the inferencing strategies examined emerged from a preliminary analysis of subjects' reading the stories or listening to the stories rather than from a predetermined set of categories.

Two studies are reported. Study 1 describes a qualitative analysis of

two children's inferencing strategies in reading and viewing two stories. This case study was designed to gain some preliminary impression of what inferencing categories might emerge in a larger scale study and to analyze whether a verbal reporting procedure could be used with fifth-grade students. Based on this analysis, Study 2 set out to determine the extent to which these strategies were used, whether there were commonalities among these strategies, and whether there were significant differences between strategy use in video and print formats.

Study 1

Method

Subjects

To examine the potential range of inferencing strategies used in reading and viewing stories, two students of differing abilities and media habits were selected from a fifth-grade classroom in the Boston area to participate in this study. Metropolitan reading test scores indicated that David was a good reader (75%) and Melissa was a below average reader (38%). David spent a good deal of his free time reading *Motor Trend* and sports magazines and watched about 18 hours of television weekly; Melissa reported that she did not enjoy reading and watched approximately 30 hours of television per week.

Materials

Video segments were selected from the "Bloodhound Gang" series on *3-2-1 Contact*, a science television series developed by the Children's Television Workshop for children ages 8–12. The "Bloodhound Gang," a 5-minute fictional drama segment, features three young detectives who solve mystery cases using general deductive principles. Two episodes were selected: "The One-Ton Jewel," a mystery about a jewel (a white dwarf) supposedly from outer space that was to be auctioned for a great deal of money, and "The Blob," a story about a stolen ice sculpture. These stories were chosen on the basis of several criteria: (a) it was reasoned that the mystery genre might encourage children to infer and predict events; (b) the stories were well structured, included multiethnic female and male characters, and were appropriate to the children's age and interest level; and (c) the stories had not been broadcast in the Boston metropolitan area for at least 2 years.

Narratives were created from these video episodes. Each story was written using the identical dialogue and character names from the episodes. Each video segment was then viewed for indications of visual or audio information not conveyed in the dialogue. Sentences describing the setting, selected objects, and character attributes were inserted to control for audiovisual information not provided for in the narrative version. Each visual action, therefore, had a corresponding narrative statement appearing at the same point in each story version. No pictures were included in either story.

dents (in education) who viewed and read these stories to determine if the equivalent story information was provided in both versions. Each story was revised according to their comments and then given to three other judges with graduate training in education. These judges unanimously concluded that each version included the same story information and that the narratives constituted well structured stories. Thus, while it is impossible to match materials in different modalities entirely, the narrations for the print versions of these stories were designed to include an accurate and concise description of the visual actions (see Appendix A). The final narrative versions of "The Blob" and "The One-Ton Jewel" included 931 words and 1,294 words, respectively. Both stories were written at the fourth-grade reading level according to the Fry readability formula (1968).

Stories in both print and video versions were divided into seven episodes; with the exception of the final episode, each ended with a new clue that related to solving the case. In the narrative versions, colored pieces of paper were inserted in booklets containing each story to indicate the end of an episode. In the video version, a blank screen followed the conclusion of each episode.

Procedure

Each child was individually presented with one story in video form and the other in print form presented in counterbalanced order by medium. Immediately after reading or viewing each episode, the child was asked to report on what he or she was thinking about and to answer any follow-up questions. All sessions were taped and later transcribed. Sessions were approximately one hour long.

To illustrate the children's responses, Appendix B presents the protocols from "The One-Ton Jewel" episode by episode as each child worked through the selection. To simulate the task, each episode is first shown and then followed by David's viewing responses and Melissa's reading responses. Experimenter questions are in parentheses.

Results

Utterances were examined from all four protocols by two judges to analyze the different inferencing strategies David and Melissa used when constructing meaning from stories. The term *strategy* was defined here as a plan or technique used for interpreting materials. Similar to Phillips's research (1988), it was considered independent of the correctness of the actual interpretation.

Judges first reviewed each protocol independently and recorded the strategies used. Then they compared their results and, through discussion, identified all inferential utterances into seven inferencing strategies. The first, *assigning default values*, occurred in the absence of specifically substantiating information in the text. In this strategy, the children appeared to construct hypotheses about the events of the story based on their

Narratives and video segments were then given to two graduate stu-background information. For example, David's prior knowledge clearly leads to a well-defined hypothesis of why a needle and magnet might be used in Episode 1. The second type of strategy, *proposing solutions*, refer-red to attempts to invent new solutions not related to information presented thus far in the text, as in the case of Melissa's inference that the house is really a "rental car agency."

Binding, the third strategy, referred to an attempt to draw conclusions on the basis of a number of stated facts. The logic followed a pattern something like this: if *x* were there and *y* were there, then they must have been involved in a crime together. Though incorrect, this type of strategy is evident in Melissa's attempt to connect events in Episode 5 by suggesting that Mr. Butterfly and Mr. Oliver are about to be arrested. The fourth type, *rebinding*, similar to a strategy defined by Collins, Brown, and Larkin (1980) and Phillips (1988), appeared when new information apparently led to a conflict in the children's understanding of the story. Here, children were forced to either adjust the new information to fit the past interpretation or readjust their previous understanding with the new data. For example, David modifies his understanding of the magnet used by quickly adjusting to this new information, adding "Oh, it's probably an electrical magnet." *Confirming*, the fifth strategy, occurred when a new fact was used to ex-plain a prior interpretation. This type of inferencing appeared to model the process of instantiating slots within a selected schema (Anderson & Pear-son, 1984) as the children attempted to provide a coherent overall represen-tation of the story. For example, David confirmed a previous interpreta-tion by adding "cause . . . they found that there must be a strong magnet."

The children also appeared to use two other strategies in interpreting stories. The first was simply *reiterating* a previously made inference without adding any new explanation or interpretation, as when David adds "I think that's it." The final strategy included *refraining* from responding, like when Melissa says "I'm not sure" or "I don't know." Though reflecting a lack of knowledge, it was defined as a strategy because one could argue that it revealed a child's tolerance for ambiguity or ability to remain open to multiple interpretations.

Protocols revealed that both children used similar inferencing strategies with the exception of rebinding; Melissa did not rebind in either story. Pro-tocols were also analyzed by judges for differences in the children's suc-cessful application of inferencing strategies (Holmes, 1987). The number of errors, defined as implausible responses, were counted across both stories for each child. Differences were recorded between the two children; David made no incorrect inferences in either story while Melissa made nine in-ference errors in total.

Discussion

Though preliminary in nature, this qualitative analysis highlighted several important issues relevant to further research on media differences. First, it was clear from David and Melissa's responses that a variety of inferencing strategies were used in interpreting stories. In contrast to previous media studies (e.g., Meringoff, 1980; Neuman, 1989), these results emphasized the potential range of inferencing strategies that children may use as they go about comprehending narratives.

Second, the results indicated that both children generated many inferences as they read and viewed stories. Therefore, previous media difference studies, analyzing inferencing at the point of retrieval alone (Beagles-Roos & Gat, 1983; Hoffner, Cantor, & Thorson, 1988; Meringoff, 1980), may have seriously underestimated the number of inferences that are made during the comprehension process itself.

Third, analyses of protocols indicated that there might be important differences in strategy use for high and low achievers. For example, as noted in "The One-Ton Jewel," Melissa made six inference errors while David made none. Thus, children's ability level may be an important factor in determining whether there are processing differences in learning from media.

And finally, by developing a set of categories inductively across both video and print formats, these results provided for a more grounded theoretical approach than previous studies to analyze how children might construct meaning from stories in different media.

Study 2

This study was designed to provide a more systematic examination of the influence of different media presentations on children's inferencing strategies. Since inferencing ability appeared to be influenced by overall ability level, high and low achievers were selected to analyze whether different strategies were elicited by stories in print or video form. Specifically, this study addressed the following questions: (a) What inferencing strategies do high and low achieving students use when interpreting stories in either print or video forms? and (b) Are there differences in the strategies employed in constructing meaning from stories in different media?

Method

Subjects

The subjects were 83 fifth-grade students (37 girls; 46 boys) from an urban school district in the Boston metropolitan area. They came from 11 classrooms in 4 schools serving primarily blue-collar families. All students selected in the sample spoke English as their first language. None was identified as learning disabled. High-achieving students, defined as those who

scored above the 85th percentile on the Metropolitan Achievement test ($\overline{X}$ = 90.81, *SD* = 4.37), and low-achieving students, those who scored below the 50th percentile ($\overline{X}$ = 32.67, *SD* = 8.85), were selected from each classroom.

Procedure

Stimulus materials included "The One-Ton Jewel" and "The Blob" mystery stories in print and video form used in the first study. High achievers were randomly assigned to either read (*n* = 20) or view (*n* = 22) the two mystery stories; similarly, low-achieving students were assigned to either read (*n* = 22) or view (*n* = 19) the two stories. This particular within-subject design was used to avoid any potential carry-over effect that might contaminate the interpretation of results for either the read or view condition. *T*-tests revealed no significant differences in achievement between the two groups of high achievers (*t* = 1.25, *df* = 40, n.s.) or low achievers (*t* = .98, *df* = 39, n.s.).

Based on the results from Study 1, verbal reporting procedures were modified to account for those in the sample who might be more reticent or less able to introspect about their cognitive knowledge. Introducing a modification of verbal reporting, Phillips (1988) used a limited-probe-when-necessary technique, where clarification questions were used after students read brief episodes of text. This approach helped to increase the completeness of reporting as well as to minimize the interval between processing and retrospection considered to be essential in obtaining reports of cognitive activity (Ericsson & Simon, 1980). Further, Phillips's approach combined aspects of retelling and verbal reporting. Students were first given opportunities to tell all they wished about a particular episode without probing; then, if or when necessary, clarification questions were asked. Norris (1989), in a validation study, found that these verbal reports did not alter subjects' comprehension processes or performance. Consequently, similar to Phillips's (1988) technique, general probing questions were created for use if or when clarification of children's inferences was required. The questions included the following: (a) What do you think will happen next? Why do you think so? (b) Did this part of the story give you any new ideas? (c) What do you think the (episode, fact, etc.) means? and (d) Did you find any clues in your (reading or viewing)?

Students met individually with the researcher or one of two graduate research assistants in a private room for one session of approximately one hour. Using a sample protocol, the researcher described the verbal reporting procedures, emphasizing the open-endedness of the activity and assuring the student that no corrections or grades would be given for his or her responses.

Following this introduction, each student was asked to either read or view an episode of a story and immediately report on what he or she was

thinking about. Stories in both conditions were counterbalanced. Students given the print versions were told to read at their own pace; students shown the video versions, of course, viewed at the same pace. Those in the print condition were encouraged to request the pronunciation of any unfamiliar words. After each episode, the researcher asked each student what came to mind while reading or viewing the story. Clarification questions, given orally by the researcher, were used when a student's statement was not clear or when he/she appeared to be hesitant to make inferences. In all, students were asked to report verbally on 6 episodes in each story, for a total of 12 times. These sessions were audiotaped and later transcribed verbatim.

Data Analysis

Verbal reports from each story were combined to form a protocol for each student. The protocol was then divided into idea units, defined as a proposition containing at least one relational concept and one argument. Each was then examined by two judges to determine whether it represented a recall idea unit, one that was stated directly from the story, or an inference-level idea unit, one that might be suggested but not stated in the text. Percentage of agreement between judges on a sample of 10 protocols was 98%. The average frequency of recall idea units and inference idea units was 39% and 61%, respectively.

These protocols were then examined by judges for evidence of children's inferencing strategies. Strategies were compared with the initial typology developed in Study 1. From this analysis, one additional strategy was identified: *empathizing*, a strategy involving a personal response from the reader or viewer. Here, the subject seemed to place himself or herself in the story emotionally, attributing feelings to the characters on the basis of his or her own beliefs and responses. For example, one student, after reporting that Vickie thinks the white dwarf is a fake, says, "Everbody's gonna be surprised when she picks it up." In all, eight inferencing strategies were identified, as summarized in Table 1.

Judges then independently coded five protocols from each condition in order to establish reliability. Agreement between coders on the identification of strategies used was 85%. After establishing the reliability of the coding system, each inference idea unit in all protocols was classified by strategy.

Results

Table 2 reports on the average frequency of inference strategies used, the standard deviations for high and low achievers, and the number of prompted versus spontaneous inference responses.

The strategy of assigning default values was clearly employed most often in both conditions, accounting for approximately half of all reported

Table 1
Types of Inferencing Strategies

Inference types	Examples
Assigning default	The student recalls that the Bloodhound Gang is at the auction for the white dwarf. After the gang meets the secretary, the student says, "They're using that lady to get some words out the guy—some evidence."
Proposing solutions	After recalling that the cars were all rented, the student says, "Maybe they'll look in the windows until they find something interesting about it."
Binding	The student recalls that the cars look all the same: "So maybe the same person owns all of them."
Rebinding	Following her decision that Mr. Atlas could lift the white dwarf, the student says, "Well, wait a minute . . . probably there's something under the table connecting it to the rock."
Confirming	The student thinks that the rock or star is fake: "Because Vickie said that she could lift it up with one hand."
Empathizing	The student reports that Vickie is saying that the white dwarf is only worth 10 cents: "Everybody's gonna be surprised when she picks it up."
Reiterating	The student reports that Mr. Butterfield is suspicious: "Yeah, I think he did it."
Refraining from responding	The student recalls that Vickie bids ten cents for the white dwarf; then in response to the question of what might happen next, "Well, probably, well, I don't know."

inferences among subjects. Other strategies used frequently included binding story elements together and confirming prior interpretations with new information. Perhaps due to the nature of the task, the strategies of rebinding or empathizing with characters or character actions were not used frequently among any of the groups. Inventing responses by proposing solutions was also rather uncommon. Reiterating and refraining strategies were used with relative infrequency, indicating either a lack of knowledge or, at least, an unwillingness to draw inferences.

Differences between groups were analyzed using a 2 × 2 factorial multivariate analysis of variance (MANOVA) with medium and achievement as independent variables and the number of spontaneous and prompted inferences as dependent variables. The MANOVA revealed no significant differences for medium ($F(2,78) = .11$; p = n.s.) or achievement ($F(2,78) = 1.87$; p = n.s.). In addition, there was no significant interaction effect for medium × achievement ($F(2,78) = .71$; p = n.s.).

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Table 2
**Means and Standard Deviations for Frequency of Strategy
Use for Readers and Viewers**

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Strategy	Readers		Viewers	
	High	Low	High	Low
Assigning defaults	23.02	24.77	20.25	23.31
	(7.28)	(6.35)	(6.66)	(7.18)
Proposing solutions	1.76	2.34	2.52	1.53
	(1.58)	(2.42)	(1.76)	(1.34)
Binding	8.93	6.39	8.74	6.99
	(5.18)	(3.43)	(3.68)	(3.14)
Rebinding	.46	.76	.57	.19
	(.96)	(1.04)	(.72)	(.44)
Confirming	5.90	6.99	7.70	6.75
	(2.14)	(2.95)	(3.17)	(3.32)
Empathizing	.70	.47	.29	.21
	(1.09)	(.78)	(.55)	(.44)
Reiterating	2.69	3.42	4.85	3.16
	(1.68)	(2.50)	(2.86)	(3.05)
Refraining	4.69	4.00	3.76	3.33
	(4.48)	(4.45)	(3.96)	(4.17)
No. of spontaneous inferences	28.50	24.41	25.87	24.47
	(10.03)	(9.30)	(15.17)	(12.48)
No. of prompted inferences	19.65	24.73	22.81	21.00
	(9.71)	(11.86)	(8.36)	(9.43)
Total no. of inferences	48.15	49.14	48.68	45.47
	(10.19)	(18.18)	(16.79)	(18.77)

To determine differences in strategy use, a 2-factor MANOVA was performed with frequencies of the eight strategies used as dependent variables. No significant multivariate effects were reported for medium ($F (8,72) = 1.21; p$ = n.s.) or for achievement ($F (8,72) = 1.51; p$ = n.s.). Further, there was no significant interaction between medium and achievement levels ($F (8,72) = 1.15; p$ = n.s.). Thus, these results indicated that neither the number nor the types of inferencing strategies used in interpreting stories were influenced by the medium presentation or achievement level.

To determine whether there was an underlying structure common to these strategies and whether this pattern was similar across the two media, a factor analysis was performed on data from each medium. First, the correlation matrix for strategies used in each medium was examined to determine its appropriateness for factor analysis. The Bartlett test of sphericity

(Bartlett, 1950) indicated that neither correlation matrix was an identity matrix. In addition, each of the correlation matrix determinants was greater than zero. Given these results, it was concluded that the correlation matrices contained sufficient covariation for factoring.

Data by medium were then subjected to a principal components analysis with varimax rotation (Kaiser, 1958). Strategies were treated together, and the respective 2-factor solutions were accepted as most interpretable. The reading group solution accounted for 43.9% of the total variance; the video group solution accounted for 48.8% of the total variance. The correlation matrices and the rotated factor loadings are summarized in Tables 3 and 4.

Both tables reveal a pattern of negative correlations between strategy 1 and other strategies, suggesting that assigning default values was often used in lieu of other techniques for interpreting materials.

Of particular note, an inspection of these 2-factor analyses reveals that 26 out of the 32 loadings across the 2 factors were of similar magnitude and direction. The coefficients of congruence for factors 1 and 2 were .86 and .37, respectively. The drop in congruence for factor 2 was due to strategy 4 and strategy 5 loading in opposite directions. This effect is supported by an analysis of the correlation structure for each strategy across

Table 3
Correlation Matrix and Factor Analysis of Strategies: Reading

Inference strategies	Intercorrelations							Factors	
	2	3	4	5	6	7	8	1	2
1. Assigning default values	− .39	− .44	− .29	.04	− .30	− .21	− .52	− **.81**	− .46
2. Proposing solutions		− .19	.09	− .03	.12	.12	.04	**.47**	.14
3. Binding			.02	− .11	− .17	.08	− .17	.01	**.61**
4. Rebinding				.12	.46	− .03	− .12	**.51**	− .11
5. Confirming					− .19	− .34	.08	.03	− **.58**
6. Empathizing						− .18	.09	**.68**	− .18
7. Reiterating							− .18	− .10	**.75**
8. Refraining								**.49**	− .14
Percent of variance								24.5	19.4
Total variance									43.9

Note. Loadings for each factor are shown in bold face.

Table 4
Correlation Matrix and Factor Analysis of Strategies: Video

Inference strategies	Intercorrelations							Factors	
	2	3	4	5	6	7	8	1	2
1. Assigning default values	-.42	-.43	-.34	-.14	-.48	-.36	-.50	**-.83**	-.51
2. Proposing solutions		-.07	.18	.00	-.03	-.15	.10	**.41**	.07
3. Binding			-.04	.23	.25	.11	-.21	.17	**.50**
4. Rebinding				.31	.03	.35	.03	.15	**.63**
5. Confirming					-.17	.19	-.18	-.23	**.67**
6. Empathizing						.002	.27	**.68**	-.02
7. Reiterating							-.17	-.03	**.69**
8. Refraining								**.74**	-.27
Percent of variance								27.7	21.1
Total variance									48.8

Note. Loadings for each factor are shown in bold face.

the pairs of factor loadings: .99, .97, .92, .13, -.98, .98, .98, .98. Since small sample sizes are usually associated with greater error, these results are particularly noteworthy because they indicate a high degree of factorial replication.

Taken together, the results of the MANOVA and factor analyses suggest that similar inferencing strategies were employed by children for constructing meaning from narratives in print and video forms. This pattern differs from that envisioned by those researchers who claim processing differences.

Conclusions

Current research based on symbol system theories argues that the very nature of cognitive processing may be influenced by the symbolic codes employed by the media (Meringoff, Vibbert, Char, Fernie, Banker, & Gardner, 1983). Through these symbol systems, media are thought to deliver distinctive messages that may activate (Olson & Bruner, 1974; Olson, 1976) and may cultivate (Salomon, 1984) certain mental capabilities and methods of reasoning. Others (Clark, 1983; Rumulhart, 1980), however, claim that these symbolic codes are mere conveyors of content and, therefore, do not serve any unique function in cognition and learning.

The findings of this research indicate that, contrary to symbol system theories, both media elicited similar inferencing strategies from fifth-grade students. Differences in the pacing, rules, and conventions of each medium did not appear to generate a distinctive form of interpretation. Further, high and low achievers seemed to use a comparable repertoire of strategies. These results support and extend research by Oakan, Wiener, and Cromer (1971) and Olshavsky (1976–77), who found that strategies employed and frequency of use in comprehending written materials did not significantly differ among high and low proficiency groups. Further, these findings substantiate Clark's claim (1983) that the medium per se may have little direct influence on learning.

Thus, rather than evoking different processes, this research suggests that the interpretive process of "viewing" stories may correspond to that of "reading" stories. Anderson and Pearson's schema-theoretic model of reading comprehension (1984) might very well apply to learning from other media as well. According to this model, reading is conceived of as an interactive, strategic, and constructive process, involving a simultaneous analysis of cues at many different levels—graphophonemic, semantic, syntactic—and for multiple purposes. In this process, attention is allocated selectively as readers use their prior knowledge to construct meaning from text.

These processes appeared to be characteristic of children's viewing of stories as well. For example, David's interpretation in Study 1 was guided by a well constructed "magnet" schema. Following his initial selection, each new bit of information was measured or tested for "goodness of fit" while he remained open to alternative interpretations if new incoming information refuted his major expectation. Only when enough confirmatory information was provided did he definitively settle on a particular schema that he used in seeking a coherent interpretation of the story. Consequently, the "magnet" schema appeared to act as an executive editor by screening, directing, and helping David to assimilate information into an existing knowledge structure.

While research supports various elements of the schema-driven model of viewing (Anderson & Lorch, 1983; Collins, 1983; Meadowcroft & Reeves, 1985), it is clear that further research is required to examine its overall "goodness of fit," particularly in nonschool settings. If this model is empirically validated, however, it suggests that the role of a medium's symbol system may be less consequential than some researchers have assumed. Indeed, as conveyors of content, symbol systems may play a supporting role in processing information. After all, each system of codes, particularly at the initial stage, does require a different set of activities, such as decoding print, sound, and pictures. But at higher levels of thinking as in inference generation, these processes might be independent of the symbol system. Thus, media selection in teaching might be related more to its convenience, its cost, and its efficiency in achieving particular learning goals, rather than

the medium's perceived cognitive benefits.

It may be the case that, for certain types of instruction, video contexts may be preferred over textual contexts to attain learning objectives. Bransford and his colleagues (Cognition and Technology Group at Vanderbilt, 1990; Rowe, Goodman, Moore, & McLarty, 1990), for example, found that the visual content in videodisc format allowed teachers to access children's ideas for discussion more rapidly than through print, particularly for those low-achieving students with little knowledge or interest in the domain. These lessons ultimately led to written stories containing more story elements, character actions, and goal resolution statements than those in the control group. Further, it may be more efficient at times to use a combined multimodality approach. In a recent study of seventh- and eighth-grade language minority students (Neuman & Koskinen, in press), we found that significantly more words were learned incidently through context when using captioned video, combining visual and print forms, than through either the video or print medium alone.

Previous research focusing on media differences has relied to a great extent on a deficit model, which assumed that the cognitive processes children bring to bear in using one medium might constrain their learning from another (Meringoff et al., 1983). However, this research, indicating that children's inferencing strategies are similar for both media, argues for a common, schema-driven theory of comprehension. Instead of limiting learning, different media may act synergistically, affording children opportunities to activate and practice skills necessary for subsequent phases of mental elaboration in higher levels of learning. This potential for synergy should encourage educators to adopt creative uses of video-related and print technologies to support students' engagement in active learning and thinking.

APPENDIX A
Example of Video and Print Versions

Video	Print
"The One-Ton Jewel": Episode 2	
Scene: auction house (close-up on Vickie, Ricardo, and Carl).	Vickie, Ricardo, and Carl meet in front of the auction house.
(Camera pans to cars coming to the house)	Many cars are coming to the house.
(Zooms to one car with VIP 1 license plate)	Carl notices that the license plate on one car says VIP 1.
Carl to others: "Did you ever see so many rented cars?"	"Did you ever see so many rented cars?" Carl asks Ricardo and Vickie.
Vickie: "How do you know they're rented?"	"How do you know they're rented?" says Vickie.

Carl: "The license plates are practically the same: (points) VIP 1, 2, 3. They must have come from the same garage."	Carl explains, "The license plates are practically the same." Pointing to the other cars, "See, VIP 1,2,3. They must have come from the same garage."
Vickie: "I wonder what that means."	"I wonder what that means?" questions Vickie.

"The Blob": Episode 2

Scene: Mrs. Smith's house. Mrs. Smith and T. Roger Hastings are standing together.	The gang goes over to Mrs. Smith's house. Mrs. Smith and T. Roger Hastings begin to tell the gang what happened to the Blob.
Mrs. Smith: "Dreadful, perfectly dreadful. We were about to pop the Blob into the freezer before tonight's auction. But you can see for yourself the ice sculpture is melted." (close-up on box with melted sculpture)	"Dreadful, perfectly dreadful," says Mrs. Smith. "We were about to pop the Blob into the freezer before tonight's auction. But you can see for yourself the ice sculpture is melted," Mrs. Smith exclaims.
Hastings (looking upset): "Oh, I can assure you Mrs. Smith, the ice sculpture was frozen solid when I picked it up at the airport."	Hasting looks at the box with the melted sculpture, and cries, "Oh, I can assure you, Mrs. Smith, the ice sculpture was frozen solid when I picked it up at the airport."
Mrs. Smith (to Vickie): "Are you sure that the man who drove it over here was a notorious art thief?"	Mrs. Smith looks at Vickie, and says, "Are you sure that the man who drove it over here was a notorious art thief?"
Vickie: "Oh, positive."	"Oh, positive," replies Vickie.
Mrs. Smith (to Hastings): "Hastings, I smell a rat!"	Mrs. Smith gasps, "Hastings, I smell a rat!"

APPENDIX B
Think-Aloud Responses to "The One-Ton Jewel"
(+ indicates an inferencing error)

Episode 1
Scene: Detective office; Carl, Vickie, and Ricardo

Vickie: (The phone rings) Bloodhound Detective Agency. White dwarf from outer space? Yes, we'll be discrete.

Vickie to Ricardo: Here, you look up the white dwarf. They're stars. Someone's trying to sell a piece of one and I smell a swindle.

Ricardo: It says here that white dwarfs are dead stars collapsed, shrunk, pressed by their own gravity. The stuff is so heavy you couldn't lift a teaspoon of it. No one knows how much it weighs being nothing that dense could exist on earth. It's got to be a fake.

Vickie: Fake? How?

Ricardo: I don't know, but I've got a hunch. Carl, run home and borrow a needle and if you have a magnet, bring that too.

David's Response
(Any questions?) Nope. (What are you thinking about?) I think they're going to make a compass out of the magnet and the pin and I don't know what they're going to do with it, but. . .maybe they're going to find the direction where the magnetic force is.

Melissa's Response
(What are you thinking about?) I think they're going to use the magnet, to see if the phone call was from outer space. +

Episode 2

Scene: Outside of a large estate where the white dwarf will be auctioned.

Ricardo: Look at all the rental cars.

Vickie: How do you know they're rented?

Carl: The license plates are practically the same: VIP 1-2-3. They must have come from the same garage.

Vickie: I wonder what that could mean.

David's response
(Any questions?) Nope. (Why do you think there were so many rental cars?) I don't know actually. But 1-2-3—I bet that was a clue.

Melissa's response
(Any questions?) Yeah, it's unusual to have two cars with the same license plate, so maybe they suspect that one of them is the guy that called. (Anything else?) Yeah, I think the house is a rental car agency. +

Episode 3

Scene: Outside of auction house. Secretary of client talking to Vickie.

Secretary: I don't like to interfere with Mr. Oliver's hobbies but he's so easily swindled and I'm suspicious.

Vickie: This whole thing's a hoax. But we can't prove it. (They walk in the auction) (To Waiter:) I'll have some water and can I also have the cork?

David's response
(What's happening?) I'll think the girl is going to make a compass.

Melissa's response
(What do you think is happening?) I think they will use the needle and thread and the magnet to find out why he was swindling. + (How?) I'm not sure.

Episode 4

Scene: At the auction. The Bloodhound Gang makes a compass.
Vickie: The compass should point north.
Carl: That's not north. The compass doesn't work.
Ricardo: Sure it does. The compass is directed to a very strong magnetic force. There. . .(The compass points directly to the white dwarf.)

David's response
(What do you think is happening?) Well, I bet that it's probably a very strong magnet in there and there's probably a magnet in the box under it. I think that's

it. Cause when they used that compass, they found that there must be a strong magnet.

Melissa's response
(What's happening?) They're going to find the rock. (How?) I don't know.

Episode 5
Scene: The auction begins with Mr. Butterfield, the auctioneer.

Mr. Butterfield: Millions of dollars are about to change hands today. Feast your eyes on the rarest rock on earth—a fragment of a white dwarf. Do we know the unique character of a white dwarf? Matter is condensed beyond the wildest imagination. Observe. (In walks Mr. Atlas) Mr. Atlas can lift a car with his feet. But can he lift that bauble from outer space? (Mr. Atlas can't move the white dwarf).

Mr. Butterfield: Would anyone else like to try?

Ricardo: You keep everyone busy. I'm going to run downstairs.

Vickie: I'll keep them busy as long as I can.

David's response
(What's happening?) I think there's probably a magnet under the table and they won't be able to move it. Oh . . . wait, it's probably an electrical magnet under there.

Melissa's response
(Any ideas?) I think Mr. Butterfly and Mr. Oliver are gonna get arrested. + (Why did you say that?) Because they really have the jewel. +

Episode 6
Mr. Butterfield: Shall we start the bidding at $500,000?

Vickie: Mr. Butterfield, will you accept bids in silver? My client, who has empowered me to bid, bids ten cents.

Mr. Butterfield: Who is your client?

Vickie: Mr. Oliver and he is of the opinion that this whole auction is a joke. A swindle. That hunk of rock is a fake. I can lift it with one hand.

Mr. Butterfield: Nonsense!

David's response
Oh, I bet the guy's going to pull the plug on the electric magnet under it, so she can pull it up.

Melissa's response
(What's happening?) Vickie's going to jail for giving the guy a fake thing. +

Episode 7
Vickie: So you think this is a white dwarf?

Mr. Butterfield: No question about it.

(All of a sudden the room goes dark. Ricardo has turned off the electricity).

Vickie: (She picks up the white dwarf with ease) See, it was just a hunk of iron held down by an electromagnetic force.

(The police come and arrest Mr. Butterfield.)*

David's response
I was right!

Melissa's response.
Oh, that's how it ended.

*No thinking aloud requested on the final episode.

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