

THE EFFECT OF PICTURE POSITION ON LEARNING FROM AN ACCOMPANYING TEXT

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Abstract:

This study examines whether the spatial configuration of two adjunct pictures influences processing of accompanying text as has been found in the case of other types of graphic displays. Forty-eight undergraduates studied a text along with drawings or verbal descriptors portraying the main characters of a story. These adjuncts were spatially arranged on the page with the senior character situated above the junior, or vice versa. Analysis of variance of performance on constructed-response questions showed no effect for configuration. However, significant differences in achievement were noted for questions derived from paraphrased parts of the story versus ones developed from verbatim rewordings of the text. Analysis of simple effects revealed these differences were only significant in cases where the story was studied in concert with an adjunct picture. Results are discussed in terms of residual processing demands brought about by switching from linguistic to imaginal codes. When adjunct pictures do not contribute to an understanding of the text, a net loss in processing may occur for the memory system.

Article:

An enduring question for educational researchers has been whether pictures enhance verbal recall when used as adjuncts for text materials. A second, less imposing but equally important question is whether pictures can be altered in ways that make them more effective in increasing what is learned from accompanying texts. Addressing this second question, several researchers have adopted the idea that pictures and, in fact, all forms of graphic displays (e.g., diagrams, maps, charts) can and should be studied in terms of their symbol system characteristics (Salomon, 1994). An underlying assumption of a symbol systems approach is that a correspondence exists between the critical features of a communicational symbol system and the operations of the cognitive representational system employed (Salomon & Gardner, 1986). For instance, a feature of both the symbol system peculiar to text and the mental processing mechanism associated with verbal information is the serial nature in which symbolic elements (e.g., letters and words) are organized (Paivio, 1971, 1986).

By adopting a symbol systems perspective in the study of graphic displays, researchers can identify psychologically-based design factors that may serve as independent variables in their research (Kealy & Webb, 1995; Winn, 1991). Potentially, such a strategy could yield discrete, empirically-based prescriptions for designing graphics that are more effective aids to text learning.

The current study adopted this symbol systems perspective in examining the effectiveness of simple line illustrations (hereafter referred to simply as "pictures") as adjuncts for a related text. With this view in mind, the study asks: "How does the relative placement of two pictures influence recall of an accompanying story in which the characters they depict are hierarchically related?"

The role of pictures in texts

The stance on whether or not pictures are generally effective in learning from text has evolved over the years. In a review of research on use of pictures in text, Samuels (1970) concluded that pictures actually interfered with learning when the educational objective was reading performance. However, as subsequent reviews have pointed out, there is an enormous difference between the task of learning to read and that of learning from

reading (Levin, Anglin, & Carney, 1987, Schallert 1980). When the learning criterion involves reading comprehension, Samuels (1970) conceded, the case against the value of adjunct pictures is less clear-cut.

Even when the educational goal is learning from text, more recent investigations on adjunct pictures have been less inclined to make definitive conclusions about their efficacy. Instead, researchers raise questions about the value of a specific kind of graphic image for learning from a certain type of text when particular forms of tasks and groups of learners are involved. Levin and Lesgold (1978), for example, delineated specific conditions such as the types of learners (children) and linguistic materials used (oral narrative fiction), under which increased learning could be expected from including pictures with verbal information.

In terms of the types of graphic images employed in a text, Levin, Anglin and Carney (1987) note much greater effect sizes are realized in studies on facilitation of text learning with adjunct pictures than with figural displays such as diagrams and maps. Further, they propose that pictures may perform any number of distinct functions relative to an accompanying text: decoration, representation, organization, interpretation, and transformation (i.e., a mnemonic role). Their point in making this distinction is that when a picture serves merely decorative purposes it does not enhance learning from an accompanying text because the picture and text do not share semantic content.

It is in this semantic relationship between picture and text that one discovers a capacity for adjunct pictures to facilitate what is learned from text. Further, as Schallert (1980) asserts, such "pictures have their effect more from providing a different access route to the text content than from merely repeating the information" (p. 510). Hence, the semantic "bridge" between a text and an accompanying picture does not necessarily consist of pictorial features that literally match details in the text. To illustrate this point, Schallert (1980) cites the well-known study by Bransford and Johnson in which subjects recalled significantly more of an incomprehensible passage when it was accompanied by a contextually appropriate picture. By contrast, when the same graphic elements were arranged to form a picture that was contextually irrelevant to the text, subjects remembered notably fewer details from the story and rated it far less comprehensible. The possibility that what is learned from a text studied in concert with a picture may be influenced by the latter's spatial organization is an interesting idea that will be next examined within the framework of symbol systems theory.

Pictures as symbol systems

When a symbol systems approach has been taken in the study of graphic displays in texts, such studies have typically involved figural (e.g., maps, diagrams, charts) versus pictorial (i.e., drawings, photographs, cartoons) representations. It has also been typical for research in this area to examine graphic variables that deal with either the discrimination (i.e., appearance) or configuration (i.e., spatial arrangement) of symbolic elements. In the case of the former, a map has been shown to facilitate better recall of related text when its features are presented as mimetic images (i.e., small pictures that literally depict the feature being portrayed) rather than as verbal labels (Kulhavy & Schwartz, 1980). The latter, on the other hand, is demonstrated by research showing that subjects recall significantly more text information when mimetic features on an accompanying map are spatially distributed over the cartographic surface rather than listed along the side of the map (Mastropieri & Peters, 1987).

Of the two aspects of symbol systems, configuration may be a particularly important source of experimental variables for understanding how pictures support learning from text. Rules dealing with the syntax or organization of symbolic elements often functionally correspond to underlying cognitive principles about how people learn. With the earlier discussion of the serial nature of text in mind, words placed earlier in a sentence structure may be perceived to "cause" events or things named later on. This was recently demonstrated in a study by Winn and Solomon (1993) in which subjects considered a word-diagram more representative of the sentence, "junk food causes indigestion" when the cause (i.e., "junk food") was spatially located to the left of the effect (i.e., "indigestion"). Over a decade earlier, Winn & Holliday (1982) reported a similar syntactic phenomenon for pictures of dinosaurs in a diagram of their evolution. In this instance, diagrams were more easily

understood when the older species were located to the left of the newer ones.

Researchers are just beginning to understand the effect that spatial organization can have on how figures facilitate learning from related text. By contrast, much less is known about the role spatial organization plays in the effectiveness of pictures as text adjuncts. Nevertheless, the previous example suggests that when pictures are used as substitutes for elements in another symbol system, they partially adopt the spatial syntax of the system in which they are being used. In this instance, the syntactic rules inherent in the left-to-right signal processing of text (that predominates in Western languages) were, in all likelihood, applied (albeit unconsciously) to the interpretation of the dinosaur diagram. Changing the spatial organization of parts of a larger picture has been similarly shown to effect how both the picture and related verbal information is processed (Reynolds, 1968). Whether the configured elements are small pictures or parts of a larger scene, however, the psychological effect of configuration may likely originate in the logographic (i.e., text-based) symbol system.

The encoding of a pictorial symbol system may also be mediated by syntactic rules that originate from culture and prior knowledge. Mandler and Parker (1976), for example found subjects exhibited superior recall for location of objects in a scene when its pictorial elements were spatially arranged to be congruent with real-world phenomena. In a similar vein, the current study examined the cultural predisposition to signify hierarchical relationships through a vertical spatial arrangement and how, when presented graphically, this may influence learning from text.

It is common practice to situate senior members of an organization above junior ones on an organizational diagram. Offices of company executives are, in fact, often physically higher or "above" those of subordinates. In a similar fashion, diagrams of family lineage are normally configured so that parental figures are located at the top of the display. Numerous instances have been documented in which language, culture, and the conventions of graphic displays share the same spatial metaphor (see Downs, 1981). At issue is the degree to which such spatial metaphors can be extended to the graphic domain to enhance the effectiveness of graphic displays as tools for learning (Winn, 1987). Is it possible that the vertical arrangement of two drawings depicting story characters with a hierarchical relationship (e.g., father and son) might influence recall from an accompanying story? Would an incongruent arrangement of such drawings (i.e., the picture of the father placed below that of the son) result in details recalled about one character being attributed to the other? The purpose of the current study was to address these questions.

Method

Subjects and Design

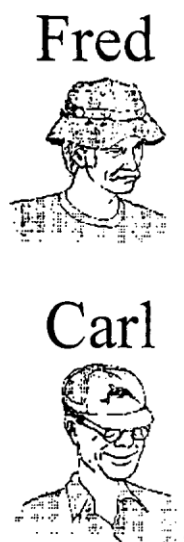
Forty-eight undergraduate education majors read a short narrative passage where a senior junior relationship existed between the two characters in the story. The story contained one of two kinds of adjunct material printed in its margins: either a line drawing of each of the two characters in the story or a list of keywords that verbally described the features depicted by the illustrations. For half the subjects in each of these conditions, the picture or keyword list portraying the senior character was located above the junior one. The remaining cases represented an incongruent configuration depicting the junior character above the senior. After reading the text passage, students answered constructed-response questions about the story that were either verbatim or paraphrased rewordings of the original text. Hence, the base design for the study was a 2 Adjunct (picture vs. list) X 2 Configuration (congruent vs. incongruent) X 2 Question (verbatim vs. paraphrased) factorial where the first two conditions served as between-subject variables and question type was a repeated measure.

Materials

Adjunct pictures. Two line drawings of adult males were created depicting the main characters of a story used as the experimental text. The pictures were line drawings taken from a commercially available clip-art book which were then modified by a professional artist. Both drawings fit the story line and were equivalent in style and clarity of execution. Each measured approximately 4.45 cm x 4.45 cm with both figures looking to the right

in three-quarter profile. Above each picture, printed in sentence- case 48-point palatino bold typeface, appeared the first name of the character it represented.

Figure 1. Congruent experimental condition in which pictures are configured with the senior character (the father) positioned above the junior character (the son).



To maximize the hierarchical effects resulting solely from how the two pictures were configured on the page, it was reasoned that the drawings should be visually ambiguous so that each picture could reasonably represent either of the two story characters. To accomplish this, a small pilot group of 10 subjects examined the two images, each one printed on a separate sheet of 21.59 cm x 27.94 cm white bond. Participants were instructed to indicate which of the two was the father (the senior figure) by placing that sheet on top. Based on the results, several facial and dress features were altered on each drawing. For example, the more youthful-looking baseball cap was placed on the figure perceived to be older while the more traditional fishing hat was placed on the other figure. Additionally, the character initially identified as the younger person was given a somewhat sterner facial expression and his hair color was changed from black to white. While these changes are seemingly superficial, pictures can convey enormously different messages based on subtle changes to lines and tones. It is, in fact, this capacity of repleteness that sets pictures apart from other types of graphic symbol systems Salomon (1994).

Using the modified drawings the judging process was then repeated with a group of 12 subjects of whom half identified one drawing as the father while the remaining subjects chose the other picture as the father.

Experimental text. A fictitious prose passage of approximately 800 words was developed about a fishing trip taken by a father (Carl) and his son (Fred). The familial relationship of the two characters formed the basis of the senior-junior (respectively) relationship exploited in the study. The story was organized into 12 paragraphs of approximately equal length that alternated in discussing one character and then the other. Every two paragraphs covered a particular topic with respect to the two characters: the type of bait each used, the brand of car driven, occupation, and so forth. These pairs of topics represented story concepts (i.e., topical categories), applicable to either character, that served as material from which constructed- response type questions about the text were developed. In terms of readability, the experimental text had a Flesch Grade Level of 7.7, a Flesch-Kincaid Index of 8.1 and a Gunning-Fog Index of 10.6. The first pair of paragraphs used in the study follows:

Even though the sun had not yet risen, Carl could tell it was going to be an unusually warm day for March. It was a perfect excuse to put a "gone fishing" sign on the door of his dental office. So, with fishing gear and lunch he began the 85-mile trip east along Interstate 312 in his Chevy pickup to Bedford Pond. A long time passed since he had spent any time with his son, and he looked forward to this chance to do so.

The sun was just beginning to rise at 6:40 a.m. as Fred hopped into his Buick station wagon. Today, however, he was not heading his normal direction north to this office at the bank, but the opposite direction on Highway 915 to Bedford Pond which lay 48 miles south. There he and his father would spend the entire day fishing, something the two of them had spoken of doing since early spring.

Two graduate students checked the completed passage for readability, ensuring all questions could be answered from the text materials. Additionally, they confirmed that none of the constructed-response posttest items were able to be completed without first reading the text.

To take into account possible order effects on how the story material was processed by subjects, a second version of the text was prepared that switched the order among odd and even-numbered paragraphs. Thus, in one version the initial paragraph discussed the father while the other version began with details about the son. The two story versions were used in equal numbers for the study.

The entire text was printed in 12-point helvetica on three 21.59 cm x 27.94 cm white bond sheets that were then stapled to form booklets. Each page contained four single-spaced paragraphs with a line of space between paragraphs. Paragraphs were centered on all but the first page which had its type offset to create a 6.67 cm wide margin on the left side. Both pictures were printed in this area, one on top of the other. Half the booklets had the pictures configured with the father placed above the son while the remainder had the picture positions reversed.

Non-picture adjunct. A common practice in past research on the influence of pictures in prose learning has been to give the "no- picture" group two exposures to the text materials than subjects studying text with pictures (Levin & Lesgold, 1978). A rationale for this strategy has been that it compensated subjects in a text-only treatment group for the additional content that others (in a text-pluspicture group) may have gained from an accompanying picture. However, with the exception of cued recall performance on questions derived from verbatim rewordings of the text, double exposures of text have generally not been shown to have the same influence on text learning as adjunct pictures.

Though a picture may provide information not found in an accompanying text, it is doubtful that an additional reading of the text will supply this information. For this reason, the current study rejected the practice of having the text-only treatment group read the experimental text twice. Instead, a list of keywords was generated to function as the linguistic equivalent of the picture condition in the study. Participants from the second of the two pilot groups previously mentioned individually listed all the features and characteristics suggested by each of the pictures. The lists were then analyzed to identify the most frequently used descriptors. From these, a keyword list was compiled for each story character containing eight items that were centered in 18-point palatino typeface below the character's name. Below the name "Carl" appeared the items, cap, glasses, happy, intelligent, shirt, short hair, smiling, and wrinkles. Under "Fred" the following keywords appeared: angular features, floppy hat, mustache, long sideburns, long gray hair, stern, T-shirt, and wrinkles. In the experiment, half the subjects viewed pictures while the remaining participants received the keyword lists as an alternative treatment.

Procedures

Subjects arrived for the study at one of three predetermined times during the course of a single day. The participants were assigned to staggered seating as they entered the room to prevent subjects from viewing materials other than those assigned to them. Following instructions from a scripted protocol, the experimenter distributed envelopes, representing the various experimental conditions, that had been previously shuffled to ensure random assignment of treatments.

Subjects were told they would be reading a short story and, after the 10 minutes allotted, that they would complete a series of short-answer questions about its content. The text booklets were then removed from the envelopes and the reading phase began. In virtually all cases, subjects finished the reading task between seven and eight minutes after which they returned the text materials to their envelopes.

Participants next solved a short page of simple addition problems to preclude recall of the story from short term memory. Following this, subjects completed test booklets that asked questions about the reading. The test booklets contained constructed-response questions that were derived from either verbatim or paraphrased rewordings of material in the story. One of each question type was developed for every paragraph resulting in 24 questions in total (see Appendix). Every question was printed on its own 21.59 cm x 4.76 cm sheet of white paper with the entire stack of sheets shuffled and stapled separately for each subject. Subjects were given 15 seconds to answer each question with time periods signaled by the experimenter. After completing the booklets, subjects returned them to the envelopes and were excused from the room.

Results and Discussion

Two graduate students answered all questions while referring openly to the text and these were compared to determine the correct responses for a particular question. Based on this, a grading criterion was established whereby subjects were awarded two points for each correct answer. In instances where subjects provided one word in response to questions that ideally required a multiple-word answer (e.g., "sandwich" versus "tuna sandwich") one point was awarded. Inspection of posttest responses revealed misinterpretations by subject on one verbatim and one paraphrased question. Consequently, these questions and two corresponding ones (comprising a topical category) were discarded leaving a total pool of 20 questions, 10 verbatim and 10 paraphrased. The posttest scorers then graded 10 randomly- selected packets, compared scores, and resolved scoring differences until they reached an interjudge agreement of 95 percent.

Mean posttest scores on paraphrased and verbatim questions by the four between-subjects treatment groups (see Table 1) reveal that,

Table 1
Cued Verbal Recall as a Function of Type and Relative Position of
Two Hierarchically-Related Text Adjuncts

Question type ^a	Adjunct	
	Picture	Description
Congruent Configuration ^b		
Paraphrase		
<u>M</u> ^c	9.08	9.42
<u>SD</u>	3.32	4.32
Verbatim		
<u>M</u>	7.00	8.00
<u>SD</u>	3.79	3.33
Incongruent Configuration		
Paraphrase		
<u>M</u>	9.75	9.58
<u>SD</u>	1.96	4.29
Verbatim		
<u>M</u>	6.83	8.58
<u>SD</u>	2.25	3.63

Note. The values represent mean raw posttest scores.

^aQuestions derived from paraphrased and verbatim rewordings of the target text (10 items each).

^bCongruent Configuration = father depicted above son.

^cMaximum possible score = 20.

with the exception of performance on verbatim questions by the picture group, an incongruent configuration of picture or keyword adjuncts led to better text recall, not worse as predicted. When the story was accompanied by pictures, subjects appeared to perform about the same or worse than when given a verbal equivalent (i.e., a keyword list). Subjects were notably more successful in answering questions that paraphrased sections of the text than ones that were verbatim rewordings of the story.

This last observation was substantiated by a 2 x 2 x 2 (Adjunct Type x Configuration x Question Type) analysis of variance. Table 2 shows significantly higher ($p < .01$) posttest performance was

Table 2

Analysis of Variance for Posttest Cued Recall Performance

Source	df	F
Between subjects		
Adjunct (A)		0.7
Position (P)		0.1
A x P		0.0
<u>S</u> within-group error	4	(16.48)
Within subjects		
Question (Q)		11.12
Q x A		0.1
Q x P		0.0
Q x A x P		0.3
Q x <u>S</u> within-group error	4	(7.42)

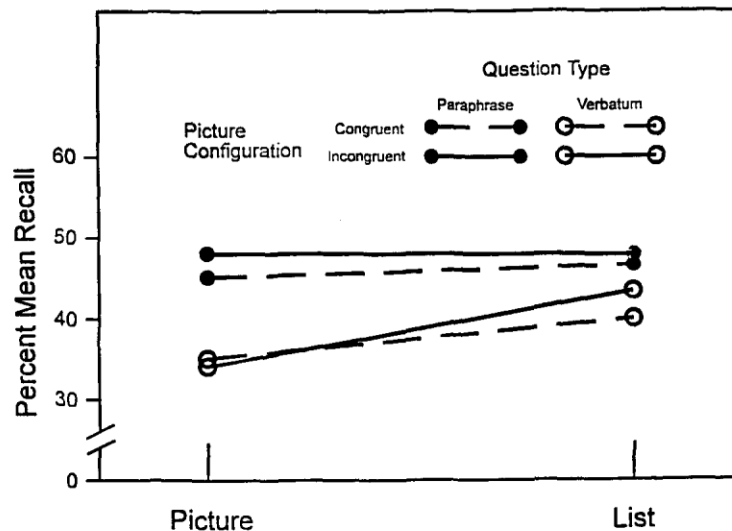
Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*p < .01.

achieved by subjects for paraphrased versus verbatim questions on the story. This criterion measure accounted for 7.10 percent of the variance in test scores. By contrast, there were no significant differences in performance due to the main effects of adjunct type or configuration. Similarly, there were no significant findings for the various interactions specified by the research design.

Figure 2 graphically depicts the relative success of subjects in answering paraphrased versus verbatim posttest questions. By itself,

Figure 2. Mean Percent Score of Verbatim and Paraphrased Questions on a Story Passage Accompanied by Pictures or Keyword Lists Arranged Either Congruently or Incongruently with Respect to Their Implied Hierarchy.



this was not a particularly surprising or valuable discovery since such differences in performance could be attributed to variations in question difficulty. The graph suggests, however, that these differences may have been greater for subjects studying a text accompanied by a picture rather than its verbal equivalent. An analysis of simple effects for question type at each level of adjunct type revealed significant variability in the dependent measure under the picture condition, $F(1,44) = 10.11, <.01, MSE = 7.42$, but not for the Verbal condition ($F = 2.36$).

Though unexpected, this differential performance due to question type by subjects who read the story with picture adjuncts may warrant further examination. It should be noted that other researchers such as Ruch and Levin (as cited in Levin & Lesgold, 1978) have reported relatively higher verbatim recall by subjects in a no-picture treatment group. Traditionally, such outcomes are explained as simply benefits from multiple exposures to the target text. In the current study, however, this method was not employed as an alternative treatment for the group that did not receive an adjunct picture. Further, the nearly identical performance on paraphrased questions by subjects, regardless of adjunct type, hints at decreased performance for verbatim questions on a story accompanied by a picture.

Given the assumption that processing a text with pictures evokes a dual coding strategy (Paivio, 1971, 1986), it is possible that the very act of switching between linguistic and imaginal codes places a small demand on working memory. Normally this type of residual processing demand is offset by the value a picture, diagram, or map provides in terms of processing efficiency. Because, in this instance, however, the illustrations provided little if any new information beyond the story itself, the benefits of the pictures may not have outweighed the memorial cost required to process them. Research on learning from maps suggests these displays are most effective in facilitating text recall when there is a partial, not total, overlap in the information conveyed by the two media (Kulhavy, Stock, & Kealy, 1993). Accordingly, the study of how text learning is supported by pictures according to their perceived information value may be an important area of future research.

One assumption of the current study that bears reexamination is that the effect of vertically configuring two hierarchically-related pictures is most evident when such a relationship is graphically ambiguous. In hindsight,

it may be that the converse is true(the impact of spatial metaphors such as "kings are above their subjects" may only be realized in a graphical context when kings are visibly distinct from subjects. Evidence for this possibility is suggested by a recent study in which subjects perceived a cause-effect relationship between diagram labels arranged in a left-to-right configuration, but only when the labels used were meaningful English words. The same arrangements failed to elicit a sense of causality when the labels were nonsense words (Winn & Solomon, 1993). To date, no research has been conducted to determine whether similar spatial-semantic dynamics may be translated to the domain of pictures.

The effect of picture configuration on accompanying texts that are ambiguous or conceptually confusing is yet another area of potential research interest. Textbooks, for example, often combine two conceptual ideas into one story such as the biography of a famous chemist presented along with an important principle the chemist may have discovered. Integrating two themes, as the text in the current experiment does, into one body of text has been shown to give readers greater difficulty at recall than when information about each category is presented separately (Bill, 1986). Whether the spatial configuration of pictures presented in concert with such combined thematic passages will enhance their conceptual distinction and, hence, their memorability remains to be seen.

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Appendix

Constructed-response items used in the study¹

Verbatim questions

- ¶1/2² What office does Fred normally drive north to reach?
What door did Carl hang the "gone fishing" sign on?
- ¶3/4 What tan object did Fred get when he popped open the trunk?
What did Carl grab before he scouted for a good place to fish?
- ¶5/6 What did Fred stroke as he tiptoed to the noise in the bush?
What did Carl, in his excitement, nearly lose in the lake?
- ¶7/8 What did Fred drink when he rested on the soft lush grass?
What did Carl have when he took a break from his fishing?
- ¶9/10 What did Fred retrieve from his lunchbox to eat?
What did Carl pull out of a paperbag to eat?
- ¶11/12 How many more fish did Fred catch as the afternoon waned?
How many more fish did Carl pull in, though all were too small?

Paraphrased questions

- ¶1/2 What kind of vehicle did Fred drive?
What kind of vehicle did Carl drive?
- ¶3/4 What kind of bait did Fred use?
What kind of bait did Carl use?
- ¶5/6 What kind of fish did Fred catch?
What kind of fish did Carl catch?
- ¶7/8 What kind of program did Fred listen to?
What kind of program did Carl listen to?
- ¶9/10 What kind of beverage did Fred have?
What kind of beverage did Carl have?
- ¶11/12 What did Fred wear on his head?
What did Carl wear on his head?

¹ Note: response items shown are arranged according to the order of related target information in the experimental text.

² ¶1/2 = target information in either first or second paragraphs (based on random assignment of subjects to experimental treatments).