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ABSTRACT

One of the most consistent findings of research on discourse is that important text information is better learned than less important information because readers devote more attention to the important information. There is now very good reason to believe that questions cause readers to attend selectively to question-relevant information and that a process supported by the extra attention causes more of the question-relevant information to be learned. However, despite superficial appearances, attention does not lie on the causal path between the interest value of a sentence and the learning of this sentence. Children do pay more attention to interesting sentences and they do learn more interesting sentences. However, a deep analysis suggests that the extra attention is a secondary phenomenon. So far, research on whether attention plays a part in the learning of information important in the light of a reader's perspective has been inconclusive. The problem may not be so much with the concept as with the method of assessing the level of cognitive effort using discrete secondary task probes. (HOD)

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ALLOCATION OF ATTENTION DURING READING

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Abstract

This paper examines the theory that important text information is better learned than less important information because readers devote more attention to important information. Previous research showing that more attention is paid to important information is inconclusive because the extra attention could be an epiphenomenon. New research indicates that attention is on the causal path between adjunct questions and learning, but is not on the causal path between the interestingness of the material and learning.

Allocation of Attention During Reading

Perhaps the most consistent finding of research on discourse is that any factor that would be said to make a text element "important" leads to better learning and recall of that element. An attractive theory to explain this fact is that readers selectively attend to important elements. The following is a simple version of this theory:

(1) Text elements are processed to some minimal level and graded for importance.

(2) Extra attention is devoted to elements in proportion to their importance.

(3) Because of the extra attention, or a process supported by the extra attention, important text elements are learned better than other elements.

For shorthand reference, I will call this Theory 1. The essential point of Theory 1 is that the importance of a text element influences learning because it influences attention. Evaluating Theory 1 is the major purpose of this paper.

Before proceding, I wish to acknowledge that my thinking about attention has been influenced by the work of many other scientists, notably Daniel Kahneman, Bruce Britton, Ernst Rothkopf, and David Navon, who was a visitor at the Center for the Study of Reading last year. I particularly wish to acknowledge the important role played by my collaborators, Larry Shirey, Paul Wilson, and--especially--Ralph Reynolds.

Rivals to a Theory of Selective Attention

The first thing to recognize is that the importance of a text element may affect other processes instead of, or in addition to, influencing attention. Specifically, important text elements may be more retrievable than less important text elements. This possibility is especially plausible when a segment of text is "important" because of its role in a story schema (Yekovich & Thorndyke, 1981), an author's high-level organization of a text (Britton, Meyer, Simpson, Holdredge, & Curry, 1979), or any other schema that a reader has somehow been induced to bring to bear on a text (Anderson & Pichert, 1978). There is now considerable support for a theory that says that readers use their schemas for top-down searches of memory. In this theory, the typical schema is assumed to be a hierarchical structure. Important text information is represented at high-level nodes in the structure and is, therefore, very likely to be retrieved in a top-down search. Less important information is represented at lower nodes, the search path is longer, and the information is less likely to be turned up.

Thus, one rival to Theory 1 is that the importance of a text element affects retrieval. In addition, Theory 1 has at least one plausible rival with respect to learning. I have previously called this rival "ideational scaffolding" theory in deference to David P. Ausubel (1963, 1968), one of the pioneers in theorizing about cognitive structures. The essential idea in this theory is that the schema to which a text is being assimilated contains slots, or niches, for certain kinds of information. What a reader tries to do is find the information in the text that fills the slots or fits into the niches. Ordinarily, the theory further supposes, to identify that a text element goes in a slot is tantamount to learning this information. In other words, whereas Theory 1 supposes that learning is a capacity-intensive process, the ideational scaffolding idea, as I have elaborated it, is one realization of the position that salient or distinctive information can come to be stored in long-term memory with little expenditure of cognitive resources.

Consider an illustration of how ideational scaffolding might work. To assimilate the following vignette, it may be supposed that readers would employ a "Who Done It" schema.

> Detective Lieutenant Bill Roberts bent over the corpse. It was apparent the victim had been stabbed. Roberts searched the room looking for evidence. There, near the foot of the bed, partly covered by a newspaper, he discovered the butcher knife.

The question is whether extra cognitive capacity will be devoted to processing the important information expressed by the butcher knife. Presumably, the Murder Weapon occupies an important slot in the Who Done It schema. Furthermore, the second sentence of the text constrains the murder weapon to a sharp instrument and a knife is a good example of a sharp instrument. The fact that the definite article in the phrase the butcher knife strikes most readers as acceptable usage is an additional indication that a knife can be presupposed as given information. Thus, there is a slot established in the schema for which a knife is a leading candidate by the time the butcher knife is mentioned. As a consequence, it does seem as though the information about the knife ought to be readily assimilated. In accord with ideational scaffolding theory, there does not appear to be any good reason why the information ought to require, or will receive, extra attention.

Another alternative to Theory 1 has been formulated by Kintsch and van Dijk (1978). They have theorized that important propositions are maintained in working memory throughout more processing "cycles" than less important ones. This is a kind of selective attention theory, since Kintsch and van Dijk hypothesize that important propositions are more memorable because of the greater amount of processing they receive. However, the extra attention is not given when the proposition is initially encountered, but rather is said to come later, when subsidiary propositions are being processed.

Related Research

Attention during reading is currently a very active area of inquiry. I will not attempt an exhaustive review. Instead, I will discuss only a few studies, ones that bear on Theory 1 and the more general issue of whether both encoding and retrieval processes need to be postulated to explain the effects of importance on recall.

Rothkopf and Billington (1979) conducted three experiments that clearly invite interpretation in terms of a simple selective attention theory such as Theory 1. They asked high School students to memorize highly specific learning objectives before studying a 1,500-word passage on oceanography. Readers got either five or ten objectives, each relevant to a single readily identifiable sentence in the passage. For instance, one of the learning objectives was, What is the name of the scale used by oceanographers when recording the color of water? The sentence in the text that satisfied the objective was, Oceanographers record the color of the ocean by comparison with a series of bottles of colored water known as the Forel scale. The data confirmed that students who read with objectives in mind spent more time on sentences relevant to these objectives and less time on ones not relevant to the objectives than did students who read without objectives. In the third experiment, patterns of eye movements were found to be consistent with the reading time results. In each study subjects learned and remembered substantially more information relevant to assigned objectives These experiments produced exactly the results that would be expected on the basis of Theory 1.

Cirilo and Foss (1980) have reported two experiments that are also consistent with a selective attention theory. Time to read sentences was assessed when the sentences were of high importance in one story and low importance in another. The sentence He could no longer talk at all was highly important in a story in which it described the effect of a witch's curse on a wise king. The same sentence was of low importance in a story in which it described the momentary reaction of a simple soldier upon hearing that he would receive a large reward for finding a precious ring. In both experiments Cirilo and Foss found that readers spent more time on a sentence when it played an important role in a story.

Other investigators have collected data that suggests that readers selectively invest cognitive capacity to integrate the information in higher-order units of text. Haberlandt, Berian, and Sandson (1980) found that, after discounting variations in wording and syntax, readers spend extra time at the beginning and the end of story episodes. These results imply that readers have tacit knowledge of an episode schema and that they use the schema as a guide for allocating attention. In a parallel vein, Just and Carpenter (1980) studied the eye movements of people reading expository texts. Gaze durations were longer on sections marked as important in a simple text grammar. For instance, the eyes rested longer on phrases expressing a Definition, Cause, or Consequence than on phrases expressing Details. Again, the implication is that readers possess textual schemas that assist them in determining where to pay close attention.

One study that has yielded results inconsistent with Theory 1 was completed by Britton, Meyer, Simpson, Holdredge, and Curry (1979). They used two versions of a text on the energy crisis. In one, according to Meyer's (1975) analysis, a paragraph on the breeder reactor was high in the content structure; the passage said the fast breeder reactor is the solution to energy problems. In the context of the other passage, the paragraph was low in the content structure; the breeder reactor is only one of five possible solutions to the energy crisis. Subjects recalled more information from the critical paragraph when it was of high importance. However, they took the same amount of time to read the critical paragraph and the same amount of time to react to secondary task probes regardless of the paragraph's importance. Hence, the selective attention hypothesis was not supported.

Britton and his collaborators theorized that the superior recall of the critical paragraph when it was of higher importance was due to a memory process. However, this negative inference is sound only if it is assumed that the process of selectively encoding text information is necessarily capacity-intensive, and this assumption must be rejected if possibilities such as the ideational scaffolding hypothesis are entertained.

In summary, most of the available evidence is consistent with a simple selective attention theory such as Theory 1.

Does Attention Cause Learning?

Causal arguments have a nasty tendency to crumble in your hands when you examine them closely. Even the strongest evidence in support of Theory 1, say the Rothkopf and Billington (1979) data on learning objectives, falls short of being decisive. Objectives did influence measures of attention and objectives did influence learning, but this does not prove that attention was on the causal path between objectives and learning. The causal theory can be diagramed as follows:

Objectives ⟶ Attention ⟶ Learning.

The problem is, as Rothkopf and Billington carefully noted, that the evidence is also consistent with the interpretation that the effect of objectives on the measures of attention is an epiphenomenon. The rival interpretation can be diagramed in the following manner:

Objectives ⟶ Attention
Objectives ⟶ Learning

Neither the Rothkopf and Billington studies, nor any of the other studies reviewed in the preceding section, permit a data-driven choice between the interpretations of the type represented in the two diagrams.

There is widespread slackness in evaluating causal arguments in psychological and educational research. The general case is the claim that an independent variable, _x_, causes changes in dependent variable, _y_, because of an influence on a mediating variable, _m_. There are at least four entailments of a causal argument of this form. Other things being equal, the causal argument implies:

(1) _x_ is related to _y_

(2) _x_ is related to _m_

(3) _m_ is related to _y_

(4) when the relations of _x_ to _m_ and _m_ to _y_ are discounted, _x_ is no longer related to _y_.

Customarily only entailments (1) and (2) are evaluated. Then, if the outcome is positive, a conclusion is reached, almost always in favor of the causal argument, based on the "weight of the evidence" and the failure to take seriously the possibility tnat the relation of _x_ to _m_ could be an epiphenomenon. In the research summarized in the next sections of this paper, my collaborators and I attempted to evaluate Theory I in terms of all fcur of the entailments on a causal theory listed above.

The Concept of a Volume of Attention

Kahneman (1973, p. 25) has remarked that ". . . much of our mental life appears to be carried out at the pace of a sedate walk." One advantage of a "sedate walk" is that it requires less effort at any moment in time than a brisker pace. One disadvantage is that it takes longer to reach a destination if you walk than if you jog or sprint. Extending this analogy, no doubt people sometimes are willing to race their minds in order to save time or complete mental work within available time. Indeed, for just this reason it is commonplace in research on attention to place subjects under time pressure. Reading, however, is naturally a self-paced activity, and placing readers under time pressure may fundamentally alter the phenomenon. A better policy is to face directly the fact that a reader may be able to maintain the volume of attention needed to comprehend a text by varying either amount of cognitive effort or the duration of processing.

One purpose of the research summarized in the following sections was to examine the utility of the concept of a "volume" of attention. The crux of this idea is that the total amount of attention a reader brings to bear is a joint function of duration, reflected in reading time, and level of cognitive effort, reflected in time to perform a secondary task. A minimum first requirement, if the approach is to have any value, is for the two measures to be at least somewhat independent. It is not obvious that they will be, since both are measures of time.

An implication of the volume concept is that there can be trade-offs between duration and effort paralleling those between speed and accuracy. A reader who extends the duration of processing can keep the level of cognitive effort low. Conversely, a reader who invests a great deal of effort can reduce duration.

Overview of Method

Three lines of research will be summarized in the following sections. Each investigated whether the effects of a factor that made certain text elements important could be explained in terms of selective attention.

The three factors for inducing importance were adjunct questions, the interestingness of the reading material, and the assignment of perspectives prior to reading. The definition of importance was deliberately broad in order to provide a quick route for establishing, or rejecting, a parsimonious general theory.

It is a safe bet that many levels of linguistic analysis make demands on cognitive capacity (Graesser, Hoffman, & Clark, 1980; Just & Carpenter, 1980). Thus, in a program of research such as the present one, it is essential to control for such factors as lexical difficulty, syntactic complexity, and text cohesion. In the adjunct question an' perspectives studies, this was done by counterbalancing; what was an important text element under one condition was unimportant under anot er. Counterbalancing was not possible in the interest study; in this case, variables affecting language difficulty were factored out using regression techniques.

In the present studies, subjects read from the screen of a computer terminal. The first measure was reading time, which is assumed to reflect duration of attention when other things are equal. The computer made possible accurate measurement of time to read text segments. The second measure was time to perform a secondary task. Subjects were told that comprehending the text was their primary task. They were also told to depress a key as quickly as they could whenever a tone sounded through earphones they were wearing. We made the conventional assumption that variations in time to respond to the secondary task probes reflected the extent to which the mind was occupied with the primary task. In other words, probe time was taken to be a reflection of the proportion of cognitive capacity being devoted to reading.

Secondary task probes appeared during the reading of about 50% of the text segments. Placement of the probes was a problem since subjects read at their own rate (except in two conditions in the adjunct questions experiment). It is well known that there are large individual differences in reading rate, as well as systematic and not so systematic changes in rate throughout a text. Getting a secondary task probe to occur in a certain place during the processing of a certain text segment can be likened to throwing a dart at a moving target. Our solution was to program the computer to present the probes on the basis of a continuously updated calculation of each subject's reading rate. This works fairly well if the criterion is simply to get a probe to occur within the boundaries of a reader's processing of a given text segment.

Adjunct Questions and Attention

It is well established that occasionally asking people questions while they are reading has both a strong "direct" effect and a small but reliable "indirect" effect on the learning of text information. The direct effect is simply the improvement in performance observed when the questions are repeated on the posttest. The indirect effect is so called because readers do better on new posttest items even when the answers cannot be deduced from the adjunct questions. For instance, knowing that a bathescaphe is a special type of submarine used in oceanographic research cannot directly help in determining that a thermister chain is an instrument that records water temperature at all depths while being towed behind a vessel. Nonetheless, Rothkopf and Bisbicos (1967), and a number of subsequent investigators, have shown that when questions of a readily identifiable type are asked during reading, performance improves on test items that are of the same type but that do not overlap in specific content.

The leading explanation for the indirect effect of questions is that readers pay more attention to segments of the text that contain information of the type addressed by the questions. The best available explanation of the direct effects of questions is that the questions permit mental review and further rehearsal. Presumably some of the direct effect is also attributable to increased attention to sections of the text containing question-relevant information.

There is experimental evidence consistent with a selective attention interpretation of the effects of adjunct questions. Reynolds, Standiford, and Anderson (1979) showed that subjects who received questions of a certain type spent more time on parts of the text containing information of this type than subjects who received questions of other types or subjects who read without questions. Britton, Piha, Davis, and Wehausen (1978) found that people who received questions took longer to respond to secondary task probe, in addition to taking longer to read.

While the results of two studies just reviewed are consistent with Theory 1, neither provides decisive evidence. Reynolds and Anderson (in press) sought to provide a stronger test, one that could distinguish between the theory that attention is on the causal path between questions and learning and the possibility that the deflection in measures of attention is an epiphenomenon. Seventy-seven college students were asked either questions that could be answered with a technical item, questions that could be answered with proper names, or no questions after every four pages of a 48-page oceanography text. Students who received questions did significantly better when the same questions were repeated on the posttest, and also did significantly better on new posttest items that tested information from the same category as the adjunct questions but that were otherwise unrelated. Thus, the study replicated the direct and indirect effects of questions observed in many previous studies. Furthermore, subjects who received questions had significantly longer reading times and probe reaction times on the secondary task when processing segments of the text containing question-relevant information.

Most important, Anderson and Reynolds squeezed their data to provide an answer to the question of whether selective attention to question-relevant text segments caused differential learning of question-relevant information. Two variables exhausted the information in the probe time measure were included in analyses of posttest performance.[1] These were total probe time and the difference in probe time between question-relevant and question-irrelevant text segments. The differential probe time variable had a substantial effect, as Theory 1 predicts. It accounted for 7.7% of the variance of new posttest scores and 23.8% of the variance of repeated posttest scores, both significant effects. These analyses satisfy the third entailment of a causal theory set forth earlier.

Examined next, in order to evaluate the fourth entailment of a causal theory, was what happened to the differential effect of questions on learning when the differential probe time variable was entered into the analysis. In the case of the new posttest items, the variance explained by the question factor dropped from a significant 8.3% to a nonsignificant

2.4%. In the case of the repeated posttest items, when the differential probe time measured was entered first, the amount of variance attributable to the effect of questions fell from 63.6% to a still large and significant 39.9%. These analyses rule out the interpretation that the change in attention was an epipheromenon. The conclusion is that a model that puts selective attention on the causal path between questions and learning can account for all, or most, of the indirect effect of questions and some, but not all, of the direct effect.

With respect to the volume-of-attention concept, a major worry is that reading time and probe time might tap essentially the same underlying factor. That is, it could be that summing the increments in time on the many small intervals sampled occasionally by the secondary task would yield total reading time over a broad interval. However, the data from the Reynolds and Anderson study suggest that probe time and reading time are independent. The average intercorrelation between the two measures within four-page sections of text was only .04, whereas the average intercorrelations of the same measure recorded from adjacent four-page sections were .46 and .64 for probe time and reading time, respectively. Moreover, there were striking differences in the behavior of the two measures from the beginning to the end of the text. The best fitting functions are plotted in Figure 1.

There was no change in the proportion of text information learned over the course of the text, a fact that is readily understandable in terms of a two-facet theory of attention: The increase in probe time over the course of the text, reflecting an increase in cognitive effort, compensated for the drop in reading time. Therefore, the total volume of attention devoted to the text can be construed to have remained approximately constant, and no change in the probability of learning text information was to be expected.

The strongest and most interesting form of the volume-of-attention concept requires cognitive effort and duration to have joint effects on learning as well as separate effects. Evidence corroborating this strong prediction was found in an analysis of the repeated posttest scores. When entered into a regression analysis successively, differential probe time, differential reading time, and the product of these two measures all accounted for significant variance in learning. However, a comparable analysis of new posttest scores was inconclusive, perhaps because the indirect effects of questions on learning are not very strong.

In order to test the idea that there can be trade-offs between level of cognitive effort and duration, Reynolds and Anderson placed two groups of subjects under time pressure, allowing them either about 70% or about 40% of the time that an average subject would take to read a typical text segment. The expectation was that readers under time pressure would increase cognitive effort in order to maintain comprehension, and that this would be reflected in an increase in probe reaction time. This expectation was not fulfilled; there were absolutely no differences in probe time among the self-paced group and the two externally paced groups. Maybe level of cognitive effort during reading is not easily brought under executive control, or perhaps there was not an adequate incentive for working hard in this experiment. The hypothesis that attention comes in volumes is not mortally embarrassed by this outcome, since there were decreases in learning corresponding to the decreases in time to read; still, it is not the outcome that an advocate of the hypothesis would like to see.

Interest and Attention

If one were to ask school teachers why they prefer to use reading material that children find interesting, they would say "because the children will pay more attention and learn more." Thus, this is a case in which the common sense view is identical with Theory 1. While the results may not surprise a school teacher, Larry Shirey, Jana Mason, and I were surprised to discover in two studies involving 350 third graders the very strong effect that interestingness has on children's learning. It accounted for over four times as much variance as several measures of difficulty included in "readability" formulas used for grading children's texts and stories.

Briefly summarized here is an additional experiment that sought to determine whether attention is on the causal path between interest and learning. The subjects were 30 fourth graders who read 36 sentences. Reading times and probe times were collected. The measure of learning was the percentage of content words in the sentences that could be recalled to a gist criterion immediately after reading, given the subject noun phrases as cues.

Interest value was operationalized as the mean rating of interest assigned by a group of third graders. The mean rating on an abritrary six-point scale was 3.7, and the standard deviation was .9. Two and one-half units on this scale encompassed the observed range of ratings. Below are two examples of sentences that children find very interesting, followed by two they find uninteresting:

The hungry children were in the kitchen helping Mother make donuts.
The huge gorilla smashed the bus with its fist.
The old chair sat in the corner near the wall.
The fat waitress stirred the coffee with a spoon.

While I do not know for sure, because I have not done the research, I am willing to take bets right now that these sentences vary primarily in their capacity to arouse interest in a 9- or 10-year-old child, and not with respect to some other property, say, image-evoking value. Even though the children were reading from a computer terminal, wearing earphones, under the supervision of a strange adult, we frequently heard oohs, ahs, giggles, and chortles as the children read sentences they found funny, scary, or impressive.

Interest value had significant relationships to percentage recall, reading time, and probe time. For each unit increase in interest value, recall increased 5.3%, reading time increased 12 msec per syllable (or 180 msec per sentence), and probe reaction time increased 44 msec. These results satisfy the first two entailments of a causal theory.

The third entailment proved impossible to satisfy in the case of the probe time measure. It accounted for nil variance in recall and, in fact, the sign of the regression coefficient was negative. However, reading time did have a significant positive relation to recall. Each 100 msec per syllable increase in reading time was associated with a 4.3% increase in recall (which needs to be interpreted in light of the fact that the standard deviation of reading time was 118 msec per syllable, after an adjustment to remove between-subjects variance).

Finally, we asked whether the effect of interest value on recall would vanish when reading time was entered into the analysis. It did not. Reading time captured only a small, nonsignificant amount of the variance otherwise explained by interest value and the effect of interest value was still highly significant. Each unit increment on the interest scale is worth 4.8% in recall when reading time is in the equation as compared to 5.3% when it is not in the equation. The conclusion is that attention plays a negligible causal role in the effects of interest on learning.

It is important to emphasize that the analyses that have just been reported were completed with the entire matrix of 30 subjects x 36 sentences minus 19 missing cases = 1061 observations. If the data had been aggregated by sentence as, for instance, Just and Carpenter (1980) have done, it would have been impossible to reject Theory 1. What the results show is that, while children pay more attention to interesting sentences and also learn more interesting sentences, for most children the set of interesting sentences to which attention is paid and the set of interesting sentences that are learned do not overlap very much. Thus, the pause to savor an interesting sentence is not the pause that supports the process that gives birth to learning.

With respect to the concept of a volume of attention, it was again found that reading time and probe reaction time are independent. The correlation between reading time and probe reaction time computed from the sentences in the odd and the even serial positions averaged .32, while the correlations of the measures with themselves were .87 for reading time and .62 for probe reaction time. It was also found again that there were sharp differences in behavior of the two measures over the course of the task. The best-fitting functions are plotted in Figure 2. In this study, unlike the adjunct question study, recall was an increasing linear function of serial position. Each advance in position was associated with a .5% increase in recall.

There are several possible explanations for the changes in reading time and probe time from the beginning to the end of the task that have now been observed in both the question study and the interest study. A plausible one is that subjects changed their priorities from an initial emphasis on the secondary task to a later emphasis on reading.

Perspective and Attention

A number of studies in my laboratory have examined the effects of the reader's perspective on comprehension, learning, and recall (Anderson & Pichert, 1978; Anderson, Pichert, & Shirey, in press; Pichert & Anderson, 1977). A story that has figured prominently in our research is about two boys skipping school. Before reading the story, subjects are directed to take either the perspective of a burglar or someone interested in buying a home. Our research has consistently shown that subjects recall more of the information that is important in the light of their perspective. Furthermore, we have found that when subjects shift perspectives and recall the story a second time, they recall new previously unrecalled information important to the new perspective but unimportant to the perspective operative when the passage was read. For instance, subjects who shift to a burglar perspective become more likely to recall information such as that the side door was always unlocked, whereas subjects who shift to the home-buyer perspective are likely at that point to remember that the roof leaked or that the place had attractive grounds. In several experiments employing this paradigm, from 65% to more than 80% of the subjects have recalled at least one additional piece of information important to their new perspective.

These results strongly implicate a retrieval process; however, our results to date are equivocal about whether the schema operative when a passage is read also influences encoding. The purpose of the first experiment I shall describe here was to determine whether a reader's schema has both encoding and retrieval effects. Two hundred and fifteen high school students were instructed to take one of two perspectives before reading a passage. After reading, half of the subjects shifted to the other perspective and then all subjects recalled the passage. Table 1 presents mean proportion recalled as a function of the importance of the information to the two perspectives. A significant effect was obtained for the importance of information to the first perspective, operative when the passage was read, which suggests an encoding benefit. Also significant was the importance of information to the second perspective, operative during recall, which indicates a retrieval benefit.

The conclusion that a schema induced after reading affects retrieval is irresistable. However, the explanation for the effect of a perspective assigned prior to reading may appear to be less certain. One would suppose that ordinarily people maintain the same schema when recalling a passage as when reading it. Thus, the influence of a schema induced beforehand might also be attributable to a retrieval process instead of an encoding process. A close look at the data, however, suggests that the reading perspective does affect encoding. Presumably, a perspective shift disables the schema operative during reading, thereby preventing this schema from influencing retrieval. Consistent with this assumption is the fact that there was a sharp drop in recall of information that had been important to the reading schema but became unimportant when the perspective shifted. On the other hand, recall of this information was still superior to the recall of information unimportant to both the reading and the recall perspectives, a superiority that can be most plausibly accounted for in terms of an encoding process.

In three further experiments, we have sought to determine whether the possible encoding benefits of a perspective could be explained in terms of selective attention to perspective-relevant information. In all three experiments there was a trend toward longer reading times when subjects were processing text elements that contained information important to their perspective, a trend that was significant in two of the three cases. It should be noted in passing, though, that Grabe (1981) has failed to find longer reading times on perspective-relevant material. We assessed probe time in two of the experiments. In one, there was a marginally significant trend for longer probe times when subjects were processing perspective-relevant text elements; in the other; the data were completely flat. This research has been plagued by procedural problems. We are not yet confident of our results, so we have not attempted a deep analysis of the possible causal role of attention.

Summary

The purpose of the research described in this paper was to evaluate the simple theory that important information is better learned than less important information because readers pay more attention to important information. This theory was confirmed in an experiment on adjunct questions. There is now very good reason to believe that (a) questions cause readers to attend selectively to question-relevant information, and that (b) a process supported by the extra attention causes more of the question-relevant information to be learned. However, despite superficial appearances, it does not appear that attention lies on the causal path between the interest value of a sentence and the learning of this sentence. Children do pay more attention to interesting sentences and they do learn more interesting sentences. However, a deep analysis suggests that the extra attention is an epiphenomenon. So far, research on whether attention plays a part in the learning of information important in the light of a reader's perspective has been inconclusive. The final conclusion is that Theory 1 fails as a general explanation of the effects of importance on learning.

Reading time and probe time proved to be independent measures in this research, which satisfies a first requirement of the concept of a volume of attention. Otherwise, except in the adjunct question study, the concept did not prove very valuable. However, the problem may not be so much with the concept as with the method of assessing level of cognitive effort using discrete secondary task probes.

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Footnotes

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[1] Reading time measures were included in subsidiary analysis only, because reading was self-paced for only a third of the subjects in this experiment.

Table 1

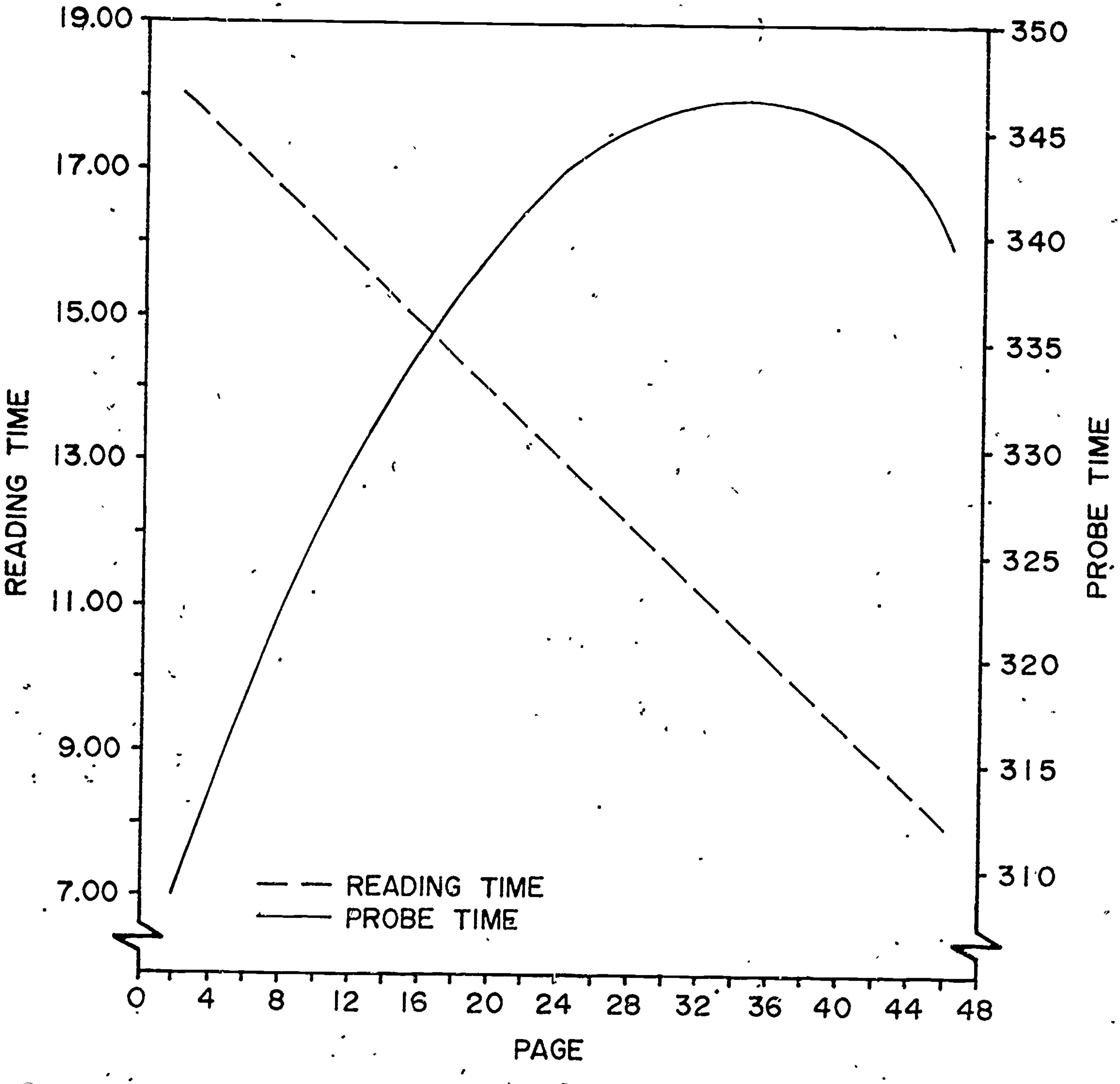
Mean Proportions of Text Elements Recalled

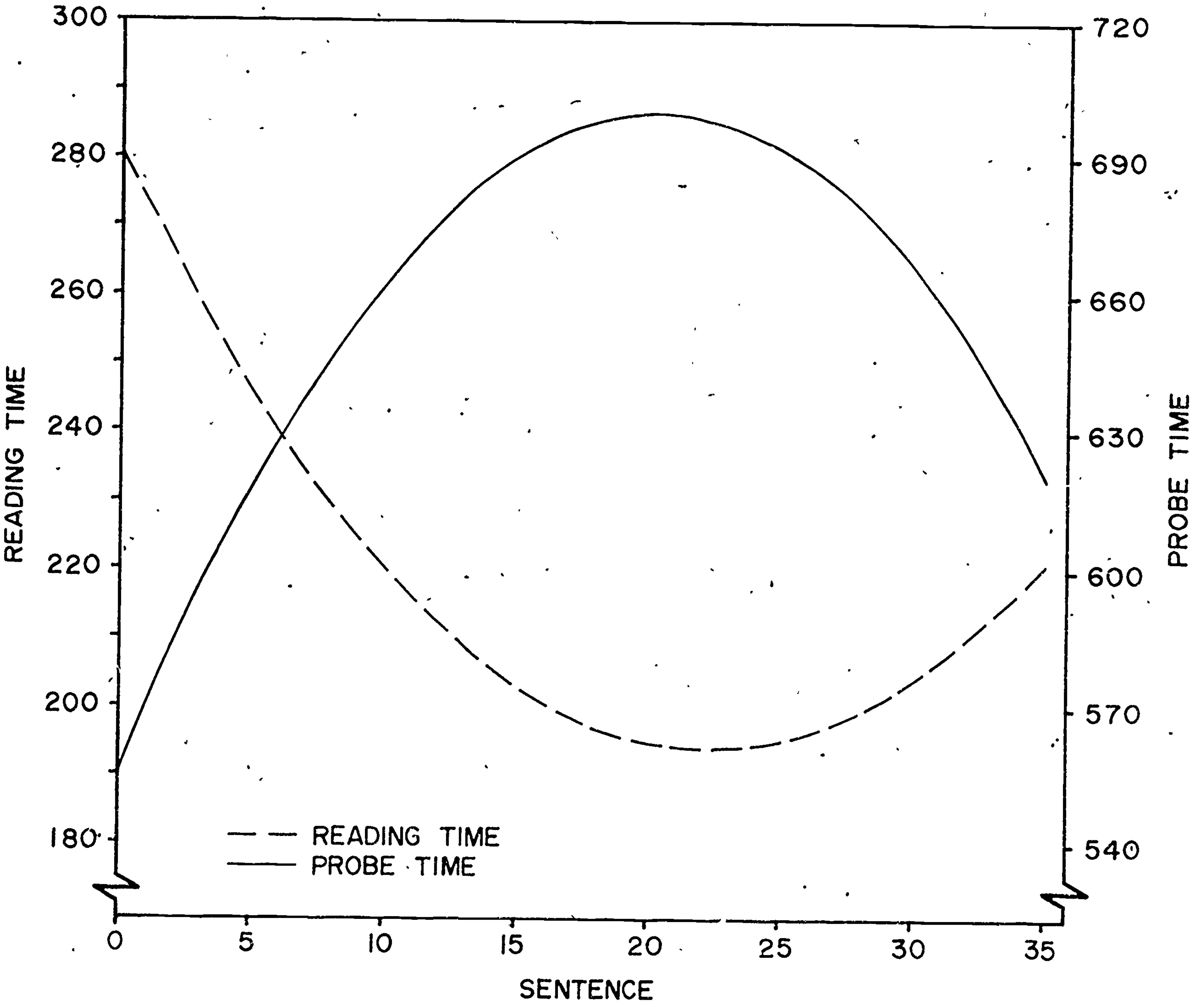
Importance to Recall Perspective	Importance to Reading Perspective	
	Low	High
High	.41	.51
Low	.32	.43

Figure Captions

Figure 1. Reading Time (in sec. per four line segment) and Probe Time (msec) as a Function of Page in the Text

Figure 2. Reading Time (msec per syllable) and Probe Time (msec) as a Function of Serial Position of the Sentence


19.00
17.00
15.00
13.00
11.00
9.00
7.00
READING TIME
350
345
340
335
330
325
320
315
310
PROBE TIME
READING TIME
PROBE TIME
0 4 8 12 16 20 24 28 32 36 40 44 48
PAGE


READING TIME
PROBE TIME
300
280
260
240
220
200
180
720
690
660
630
600
570
540
0
5
10
15
20
25
30
35
SENTENCE
READING TIME
PROBE TIME