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AUTHOR	Reynolds, Ralph E.; Anderson, Richard C.
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ABSTRACT

When 77 college students were asked a certain type of question after every four pages of a 48-page oceanography text that they were reading, it was found that the text information relevant to questions was learned better than text information irrelevant to questions. Furthermore, reading times and probe reaction times on a secondary task were longer when subjects were processing text segments containing information of the type addressed by questions. These results can be accounted for by a "volume of attention" theory asserting that readers selectively allocate a greater volume of attention to question-relevant information, and that a process supported by the additional attention causes more of the information to be learned. This theory was found to account for somewhat more than two-thirds of the indirect effect of questions and one-third of the direct effect of questions. (Author/RL)

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CENTER FOR THE STUDY OF READING

Technical Report No. 183

INFLUENCE OF QUESTIONS ON THE ALLOCATION OF ATTENTION DURING READING

Ralph E. Reynolds and Richard C. Anderson
University of Illinois at Urbana-Champaign

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University of Illinois
at Urbana-Champaign
51 Gerty Drive
Champaign, Illinois 61820

Bolt Beranek and Newman Inc.
50 Moulton Street
Cambridge, Massachusetts 02138

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Abstract

Readers were asked a question of a certain type after every four pages of a 48 page oceanography text. Text information relevant to questions was learned better than text information irrelevant to questions. Furthermore, reading times and probe reaction times on a secondary task were longer when subjects were processing text segments containing information of the type addressed by questions. A good account of these results is provided by a theory which asserts that readers selectively allocate a greater volume of attention to question-relevant information, and that a process supported by the additional attention causes more of the information to be learned.

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Influence of Questions on the Allocation of Attention During Reading

One consequence of periodically asking readers questions is that they learn more of the information in a text. For many years investigators have believed that this improvement in learning is attributable to an increase in attention caused by the questions. Until recently, though, the evidence for an interpretation in terms of attention was entirely circumstantial. It consisted of demonstrations that questions asked after the sections of the text containing the information needed to answer them have an "indirect" influence on learning. The influence is indirect in the sense that readers do better on posttest items even when the specific knowledge required by the items cannot be deduced from the earlier questions and their answers. For instance, knowing the date on which the first wireless message was sent across the Atlantic allows no inference about the depth of the ocean off the coast of Labrador. Yet, several studies, beginning with Rothkopf and Bisbicos (1967), have shown that when questions that always require numbers as answers are asked during reading, performance improves on test items that also require number answers but are otherwise unrelated.

Results such as those obtained by Rothkopf and Bisbicos might be due to increased attention, but at least one other explanation comes readily to mind: It could be that questions lead readers to differentiate the questioned category of text information from the rest of the text, and that such differentiation is in itself a sufficient condition for improved learning. A direct test of the attention hypothesis would be to measure indicators of attention and determine if they vary depending upon whether questions are asked. This was the strategy employed in the present research.

There were two operational measures of attention. The first was the amount of time a subject spent reading segments of the text. It was assumed that this measure reflects the extent or duration of attention. Reading times have been collected in a number of previous question experiments (cf. Anderson & Biddle, 1975). Times tend to be longer when questions are asked; however, in the early studies the effect was not very strong nor entirely consistent, partly because of crude measurement techniques, such as having subjects write the elapsed time on the bottom of each completed page.

The second measure employed in the experiment reported in this paper was reaction time in 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. The idea is that when the mind is occupied with the primary task, there will be a slight delay in responding to the secondary task. The key assumption is that a person has a fixed amount of cognitive capacity. Ordinarily, there is spare capacity when a person is doing mental work such as reading. However, when a reader puts extra effort into processing a text element, this places peak load demands on the cognitive system. The assumption is that at this moment there is little capacity left over to process the probe and respond to it.

Thus, the reaction to the probe is delayed until capacity becomes available. Our working assumption is that probe time primarily reflects the intensity of the attention that a reader is devoting to a text element.

The secondary task procedure has a considerable history in research with simple tasks. The rationale for the procedure and representative empirical results have been presented by Kahneman (1973) and Posner (1978) among others. The procedure was first used in research on text processing by Britton and his associates (cf. Britton, Westbrook, & Holdredge, 1978). They have completed one study on the effects of questions in which probe time was assessed, which we shall review shortly.

Attention is a hypothetical construct that is imperfectly reflected in any operational measure. In a relatively uncharted area such as the processing of lengthy meaningful texts, the risk is high that extraneous factors will introduce bias or overshadow what are possibly subtle effects. For instance, people with high verbal ability (Hunt, 1978) or well-developed prior knowledge of the content of a text (Steffensen, Joag-dev, & Anderson, 1979) probably are able to process a text more efficiently and rapidly than other people. In the present research, a partly within-subject design was employed in order to discount individual differences in the comparisons of major interest. No doubt the attentional demands of text segments will vary according to lexical difficulty, syntactical complexity, local text cohesion, and overall text structure (cf. Graesser, Hoffman, & Clark, 1980). In the present study, variability due to such factors was handled by employing a counterbalanced design in which the text segments containing information relevant to questions under one condition were not relevant to questions under other conditions.

Precisely how should questions influence attention? There appear to be at least two answers. According to the first, questions lead to a focusing of attention on text segments containing information from the category that the questions are about. According to the second, questions result in a nonspecific heightening of vigilance. These can be called the <u>selective</u> and <u>nonselective</u> attention hypotheses, respectively.

Reynolds, Standiford, and Anderson (1979) tested these hypotheses in an experiment completed with a computer system that permitted accurate monitoring of subjects' reading time on small segments of a modified version of the oceanography text used by Rothkopf and Bisbicos. Subjects moved from one text segment to the next by pressing a key. This erased the segment on the screen and caused the next one to appear. The time between key presses indicated segment exposure time. By hypothesis, the measure reflected the duration of the subject's attention to this text segment. Independent groups periodically received a question of one of three types--ones that could be answered with either a technical term, proper name, or number. On the posttest, subjects who had been questioned during reading did better than controls, who had not been questioned, on items requiring information from the same category as the earlier questions but which differed in specific content. The most interesting and important finding was that questioned subjects spent significantly more time than controls reading text segments that discussed information of the type : !ressed by the questions. For instance, the group that received questions that required numbers as answers spent more time reading text segments containing numerical information. The results of the experiment supported the version of the attention hypothesis which says that readers selectively engage in further processing of text information identified as relevant to questions.

In another recent study, Britton, Piha, Davis, and Wehausen (1978) found that people who received questions every three pages took longer to respond to a secondary task probe on subsequent sections of the text than people who received no questions. They also found increases in reading time when questions were asked. Thus, the study provided two kinds of evidence that questions affect the amount of attention readers invest. A second experiment ruled out the possibility that the extra attention is required to recover from the disruption of having to stop to answer questions; a group that received questions irrelevant to any of the material in the text showed no greater probe reaction time than the control group which did not answer questions. Britton, Piha, Davis, and Wehausen endorsed the general, nonselective form of the attention hypothesis to explain their results. However, they did not distinguish between this and the selective attention interpretation, nor did they design their experiments in such a fashion that the results bear on which of the two interpretations is correct.

The first purpose of the present research was to provide a further and stronger test of the idea that questions facilitate learning by leading readers to change their allocation of attention. The two possibilities outlined earlier were considered: Readers might selectively allocate attention to text segments that contain information from the questioned category, or they might nonselectively increase attention to most aspects of the text. Both reading time and probe reaction time were measured. Based on the results of Reynolds, Standiford, and Anderson (1979), it was presumed that the reading time measure would suggest selective attention. If the world were simple, the probe reaction time measure would point in the same direction. But this was not a foregone conclusion. It is entirely plausible that questioning increases a reader's general vigilance. The probe measure might be more sensitive to this aspect of attention than the reading time measure.

The second purpose of this research was to explore the usefulness of the concept of a volume of attention (see Britton, Westbrook, & Holdredge, 1978). The idea is that the total amount of attention brought to bear is a joint function of duration (reflected in reading time) and intensity (reflected in probe time). One implication of the volume concept is that there can be trade-offs between duration and intensity. 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 cognitive effort can minimize duration. Under the assumption that amount of attention relates directly to amount of learning, the present research provided an experimental test of the volume-of-attention idea. The rate at which some

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subjects read the text was externally paced, restricting the duration of processing. According to the theory, in this circumstance either learning ought to suffer or there ought to be a compensatory increase in probe reaction time.

Method

Subjects

The subjects were 77 college students enrolled in an introductory educational psychology course. They participated as part of a class requirement and also received $2.00.

Apparatus

The experiment was run on the PLATO system at the University of Illinois. Three PLATO V terminals were used. Each included a screen that displayed the text and a keyboard upon which responses were made. Subjects sat in individual cubicles and read the experimental material wearing earphones. At certain points in the text, the computer sounded a tone through the earphones. When this happened, the subject was to depress a key as quickly as possible. The time the subjects spent reading each text segment and their reaction times to each probe were automatically recorded by the computer. The main computer's internal clock, accurate to about 100 msec, was used for text segment reading times. The terminal microprocessor clock, with a much greater accuracy, about 1 msec, was used to measure the subjects' probe reaction times.

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Materials

The text was a revised version of the section from Rachel Carson's book The Sea Around Us, previously used by Rothkopf and Bisbicos (1967), Britton, Piha, Davis, and Wehausen (1978), and Reynolds, Standiford, and Anderson (1979). It consisted of 48 PLATO-length pages (each about 3/4 of a normal typed page) divided into 12 four-page zones. There were four short-answer questions for each zone, drawn mostly from Rothkopf and Bisbicos, two each of two types--questions that could be answered with a technical term, or with a proper name. Half of these were used as adjunct questions and also appeared on the posttest (hereafter referred to as "repeated" items). The remaining 24 questions were used only on the posttest (hereafter referred to as "new" items).

Each of the 12 four-page zones was divided into 24 segments of about 33 words in length. The text had been rewritten so that each segment contained information that directly pertained to only one type of question. In other words, if a segment introduced a technical term, it did not contain any proper names. Reynolds, Standiford, and Anderson (1979) have provided illustrations of text segments and questions of each of the types.

There were from three to six segments of each type per zone, with the remaining 12 to 18 segments occupied by filler material. The text was edited so that each zone contained the same number of segments relevant to each type of question. In addition, each zone was arranged so segments containing the same type of target information were always separated by segments with information of other types. This arrangement ensured that no subject ever saw consecutive segments containing the same type of information.

Design and Procedure

Question type and pacing condition were manipulated in a factorial design. Subjects received technical term questions, proper name questions, or no questions. The pacing factor was defined by the rate at which the subject received the segments: self-paced, machine paced at 10 sec/segment, or machine paced at 6 sec/segment. There were two within-subject factors: type of information featured in the segment or test item (technical term or proper name) and zone (four-page blocks of text numbered 1-12 in order of occurrence). Finally, two subject characteristics were measured, vocabulary knowledge and simple reaction time. The dependent variables were reading time (in the self-paced condition only), probe reaction time, and proportion correct on the new and repeated posttest items.

Based on previous experience with this experimental text and this population of subjects, the 10 sec/segment rate is estimated to have allowed the average subject about 70% of the time that he or she would spend on a typical text segment. The 6 sec/segment rate allowed about 40% of average time.

When the subjects arrived at the experimental area, they were seated at the terminals and told how to advance the text, respond to the tone, and answer questions using the computer keyboard. They were then given instructions for the experiment.

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Subjects were told that the experiment was about how students learn from text. They were also told that they would be given a comprehensive short-answer test when they finished reading. It was emphasized that each text segment should be read carefully, since once a person had moved forward, he or she could not return to the previous segment. The probe task, responding to the tone, was represented as secondary to the reading task, but important nonetheless. Subjects were first given a four-page practice passage, and then the 48-page experimental passage, both presented on the computer screen. Students in the question groups were asked a question after reading each four-page zone. The answer to the question was always contained in the immediately preceding zone. No feedback was provided about whether answers to questions were right or wrong. Subjects in the control group were told to pause a moment at the locations where subjects in the other groups received questions. The computer recorded the answers to questions, the time taken to read each text segment, and the reaction time for each probe.

Following the reading of the experimental passage, subjects were given a 5-minute interpolated task consisting of the first 40 items from the Wide Range Vocabulary Test (French, Ekstrom, & Price, 1963), presented in paper and pencil form. The simple reaction time measure consisted of average time to respond to a block of five probes presented when the subject was not reading. The same posttest was administered to all subjects in paper and pencil form. The test contained 48 questions (24 repeated items and 24 new items) in a single random ordering.

Either zero, one, or two probes were presented within the boundaries of individual text segments. Probes appeared in 130 segments or 45% of all segments. Each zone contained 11 probed segments, except the first, which contained 9. Care was taken to ensure that probes appeared in equal proportions of each type of segment (technical term, proper name, and filler) so that subjects could not differentiate among the types of segments because of variation in density of probes. The placement of the probes within each segment followed two probe maps. Single probes occurred when the reader was estimated to have read either 35% or 65% of the target segment. If a segment entailed a 35% probe on the first probe map, one occurred at 65% on the second probe map, and vice versa. Segments that contained two probes always involved one at about 35% of the segment and one at about 65%. For the self-paced groups, precise placement of the probes was determined in a calculation based upon reading speed. The computer kept a running average of reading speed over the six most recent segments for each subject. The updated estimate of reading speed was used to compute the exact point at which the probe should occur. This method was used because it was necessary to be sensitive to changes in subjects' reading speeds within the text (see Reynolds, Standiford, & Anderson, 1979). Subjects in the paced conditions received the probes at either 35% or 65% of the time that the segment appeared on the screen. Subjects responded to probes by pressing a key on the terminal console.

Responses on the posttest were scored by two different methods. The first permitted misspellings and the substitution of meaning preserving words and phrases (plankton for planktonic shrimp). The second, more lenient, scoring system allowed slight meaning changes. The results were the same regardless of which method was used.

Results

Table 1 summarizes the regression analyses. In these analyses, vocabulary score and the measure of simple reaction time were entered first. Entered next were variables coding the question and pacing conditions. These were represented as pairs of orthogonal contrasts, since the sets of conditions comprised factors in only the nominal sense. As a measure of effect size, the percentage of variance explained by each variable is inlcuded in Table 1. The figure is a percentage of either between- or within-subject variance. Scores on the posttests piled up near the bottom of the scale, forming roughly Poisson distributions. Furthermore, the variance of raw posttest score residuals was positively related to predicted score. Therefore, both the new and repeated posttest scores were subjected to the transformation, $\underline{y}' = \sqrt{\underline{y}} + \sqrt{\underline{y} + 1}$, which eliminated the problems. Tables 2 and 3 contain mean performance as a function of the factors that made a difference. Raw score means are presented. Covariance adjustments in these means were minor.

Insert Tables 1, 2, and 3 about here.

The row in Table 1 labeled Information Type x Question Type contains the results of major theoretical interest in this experiment. It represents the difference in performance on question-relevant as compared to question-irrelevant material. As can be seen, in each case the interaction was significant and accounted for a substantial amount of variance. This interaction was also significant in an analysis of the reading times of the self-paced group, $F(1,25) = 13.56$, $p < .01$.

On the basis of the hypothesis that questions increase attention in a nonselective manner, one would have expected questions to have a general influence on probe time, reading time, and posttest performance. However, in the case of each measure, the observed effects of receiving questions were due entirely to a specific influence on question-relevant material. As can be seen in Tables 2 and 3, there was no nonspecific effect of questions on question-irrelevant material. A separate analysis of probe time during the reading of filler segments confirmed the conclusion that there is no general effect from questions, $F(1,70) = 2.50$.

Self-paced subjects performed better than externally paced subjects on both the new and repeated posttest items. Among subjects who were externally paced, those who read at a 10 sec/segment rate did slightly better than those who read at a 6 sec/segment rate, a trend which was significant in the case of the new posttest items. It is noteworthy that there is not even a hint of an influence of pacing on the probe time measure.

The analyses reported thus far involved scores pooled across the entire text. Reported next are subsidiary analyses involving the 12 four-page text zones. These analyses were performed separately since, in the case of the posttest, there was just one item of each of the types per zone. Therefore, each observation took on a value of either 1 or 0, and the meaning of the tests of significance might be regarded as proble-

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matical. Neither new posttest nor repeated posttest scores showed any relationship to zone, both Fs < 1. Probe time, however, proved to be an increasing function of zone. Both the linear and quadratic aspects were significant, $F(1,75) = 20.51$, $p < .01$, and $F(1,74) = 9.51$, $p < .01$ respectively. In contrast, among self-paced subjects, reading time was a sharply decreasing function of zone. This relationship could be represented satisfactorily with a straight line, $F(1,25) = 724.02$, $p < .01$. The probe time and reading time functions are plotted in Figure 1.

Insert Figure 1 about here.

The two- and three-way interactions among all variables on all measures were examined. Included were the interactions involving the curvilinear aspects of the multi-valued variables (vocabulary, simple RT, zone). In order to prevent an egregious increase in the likelihood of rejecting the null hypothesis when it is true, the interactions were grouped into logically related sets. The significance of an interaction within a set was examined only if the set as a whole proved significant. This policy is analogous to Fisher's protected t test. When broken down by zone and information type, there were 24 observations per subject on each measure; however, these observations were not independent. We took the position for within-subject tests of significance that the number of independent degrees of freedom equaled the number of subjects. In no case did these conservative policies lead to the supression of a nominally significant interaction of intrinsic interest or one which complicated the interpretation of any other effect reported herein.

The Simple RT x Zone interaction was significant in the analysis of probe time, $F(1,62) = 13.97$, $p < .01$, new posttest performance, $F(1,62) = 4.61$, $p < .05$, and repeated posttest performance, $F(1,62) = 5.18$, $p < .05$. On all three measures, the performance of subjects with long reaction times decreased, relative to subjects with shorter times, from the beginning to the end of the passage. A sensible explanation is that the attention of slow subjects flagged over the course of the text and, as a result, they learned less of the information in the later sections of the text.

The Pacing vs. No Pacing x Zone interaction was significant in the analysis of scores on new posttest items, $F(1,62) = 6.39$, $p < .05$. The advantage from setting one's own reading pace was somewhat larger at the beginning than at the end of the text. Nonsignificant trends in the same direction appeared in both the probe time and repeated posttest analyses.

Finally, in the analysis of repeated posttest scores, significant interactions appeared between Questions vs. No Questions x Zone, $F(1,62) = 4.27$, $p < .05$, and Information Type x Question Type x Vocabulary, $F(1,148) = 19.82$, $p < .01$. With respect to the former effect, the advantage of receiving questions increased slightly toward the end of the text. The latter interaction appeared because the higher a person's vocabulary score, the greater was the increment in performance on question-relevant items as compared to question-irrelevant items. There was no hint of this interaction in the probe time or the new posttest analysis, so attention is not implicated. An explanation is that smart people benefitted more from the rehearsal opportunities provided at the junctures where questions were asked during reading.

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Did selective attention to question-relevant text segments cause differential learning of question-relevant information? To help in answering this question two attention variables which exhausted the information in the probe time measure were included in analyses of posttest performance. 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. It accounted for 7.7% of (within-subject) variance of new posttest scores, $F(1,74) = 7.14$, $p < .01$, and 23.8% of the (within-subject) variance of repeated posttest scores, $F(1,74) = 56.9$, $p < .01$.

More important is what happened to the differential question effect (i.e., the Information Type x Question Type interaction) when the differential probe time variable was entered into the analysis. In the case of the new posttest, the variance explained dropped from a significant 8.3% to a non-significant 2.4%, $F(1,74) = 2.26$. In the case of the old posttest items, when differential probe time was included, the amount of variance attributable to the differential effect of questions fell from 63.6% to a still large and significant 39.9%, $F(1,74) = 94.45$, $p < .01$. These analyses show that a model that puts selective attention on the causal path between questions and learning can account for somewhat more than two-thirds of the indirect effect of questions and one-third of the direct effect.

Discussion

A simple theory can explain the major results of the present experiment: (a) Questions cause readers to selectively attend to question-relevant information; and (b) a process supported by the extra attention to question-relevant information causes more of this information to be learned. The data are clearly consistent with the first part of the theory. Probe reaction times were significantly delayed when subjects were reading text segments containing question-relevant information. Presumably this means that a greater proportion of cognitive capacity was being utilized in text processing at these moments. Furthermore, in the self-paced group reading times were significantly longer on text segments containing question-relevant information. The assumption is that this means that the duration of processing was extended. Considering the two results together, it makes sense to say that readers were allocating a greater volume of attention to target than to nontarget information.

The second part of the theory is harder to establish, but several facts from the present study are worth considering. First, the pattern of performance on the posttest exactly mirrored the behavior of the measures of attention. Second, the amount of variance in performance on new posttest items due to asking questions went from a significant amount to a small and nonsignificant amount when the portion attributable to attention was removed. The obvious interpretation of this fact is that attention, or a process supported by attention, lies on the causal path between questions and learning. Third, if questions lead to increased attention, which leads to increased learning, it ought to be possible to trace the influence at the level of the individual reader studying specific text segments and later responding to the test items keyed to these segments. Computed

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for each subject in the experiment was the correlation between right or wrong on the new posttest items and probe time on the particular segments of the text containing the answers. The mean correlation over all subjects was .12 ($p < .10$). At this level of analysis, the measures are highly unreliable and affected by important uncontrolled factors such as variations in test item difficulty, so it is not surprising that the relationship is small. The important point is that the trend is in the right direction.

Selective attention was not the whole story in the learning of answers to repeated questions. When the effect due to attention was removed, the variance attributable to questions fell to a smaller but still substantial and significant amount. Moreover the mean within-subject correlation between probe time on specific text segments and performance on repeated posttest items based on these segments was only .04. Evidently another process, not mediated by attention, is partially responsible for the learning of the information required by repeated items. This process is most probably rehearsal occasioned when the questions are encountered during reading (see Anderson & Biddle, 1975).

The hypothesis that questions result in a nonselective heightening of attention did not fare well in the present experiment. Probe time on filler and question-irrelevant text segments was only slightly higher in the questioned groups. Total probe time was completely unrelated to performance on either new or repeated posttest items.

The concept of a volume of attention is useful in interpreting the results of this research. It enables one to understand why learning dropped when the reader's progress was externally paced even though there was no decline in probe time. It also provides an interpretation of another phenomenon. Like most studies that have measured reading times in intervals across lengthy texts (cf. Carmichael & Dearborn, 1947; Reynolds, Standiford, & Anderson, 1979; Rothkopf, 1966), the present experiment showed that readers start slowly and accelerate over the course of the text. However, there was no comparable change in the probability of learning information from the beginning to the end of the text. These facts embarrass a one-dimensional theory of attention, which must predict a decrease in learning to match the decrease in reading time. But the results are readily understandable in terms of a two-facet theory: There was an increase in probe reaction time over the course of the text to compensate for the drop in reading time. Therefore, the total volume of attention devoted to the text can be construed as having remained approximately constant, and no change in the probability of learning text information was to be expected.

There are several criticisms of the concept of a volume of attention that might be raised. One is that reading time and probe time may be measures of essentially the same underlying factor. It might be that summing the increments in time on the many narrow intervals sampled occasionally by the secondary task procedure would yield roughly the total increment in time observed over the broader interval represented in the reading time measure. However, the data suggest that probe time and reading time are independent. One piece of evidence for this was just recounted, namely, the fact that, over the course of the text, reading time went down whereas probe time went up. Also noteworthy is the fact that the average intercorrelation between the two measures within zone was only .04. This figure should be interpreted in the light of the average intercorrelation of the same measure recorded from adjacent zones, .46 and .64 for probe time and reading time, respectively.

The concept of a volume of attention invites multiplication of probe time and reading time (cf. Britton, Westbrook, & Holdredge, 1978). The resulting product has peculiar statistical properties. It has no intrinsic meaning because the scaling of the constituents is arbitrary. More serious, a linear transformation of either of the constituents will affect the correlation of the product with other measures (Althauser, 1971). For instance, if reading time were expressed in, say, milliseconds per syllable instead of seconds per segment, the relationship between learning and the product of probe time and reading time would change. This problem can be surmounted within the framework of regression analysis. The correlation between a variable and the product of two other variables is invariant over linear transformations of the constituents of the product when the constituent variables are partialled (Cohen & Cohen, 1975, p. 295). This amounts to partitioning the variance represented in the product into main effects and the interaction of the constituent variables.

The strong form of a theory that says attention comes in volumes requires probe time and reading time to have joint effects beyond any they may have singly. This did happen in a regression analysis involving the self-paced group. When entered into the equation successively, differential probe time, differential reading time, and the product of these two measures all accounted for significant variance in performance on

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repeated posttest items. It must be noted, however, that a comparable analysis of performance on new posttest items was inconclusive, perhaps because the results were rather flat and residual error variance was high.

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Table 1

Summary of Regression Analyses

Factor	Probe Time		New Posttest		Repeated Posttest	
	% Variance	*F*	% Variance	*F*	% Variance	*F*
Between-Subject						
Vocabulary	2.3	2.92	24.4	29.32**	12.8	16.62**
Simple RT	39.3	50.36**	1.1	1.26	.1	.07
Questions vs. No Questions	3.3	4.42*	4.3	5.10*	12.8	16.65**
Question Type	.3	.37	1.5	1.85	10.4	13.52**
Pacing vs. No Pacing	.0	.02	6.7	8.04**	8.7	11.31**
Ten Seconds vs. Six Seconds	.2	.27	3.7	4.45*	1.5	1.92
Within-Subject						
Information Type	.9	1.02	10.0	9.19**	5.3	12.82**
Information Type x Question Type	34.7	40.48**	8.3	7.58**	63.6	153.40**

*$p < .05$, ** $p < .01$

Note: The degrees of freedom are 1/70 for between-subject tests and 1/75 for within-subject tests. The percentage of variance attributable to a factor is a percentage of between-subject or within-subject variance for between-subject and within-subject factors, respectively. New and repeated posttest scores transformed, $y' = \sqrt{y} + \sqrt{y+1}$

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Table 2

Mean Probe Time and Reading Time as a Function

of Question Condition and Type of Information

Question Condition	Type of Information					
	Technical Term		Proper Name		Filler	
	Probe Time	Reading Time	Probe Time	Reading Time	Probe Time	Reading Time
Technical Term Questions	385	12.28	356	11.26	334	10.25
Proper Name Questions	309	12.34	341	13.94	298	10.98
No Questions	294	12.97	290	12.16	283	10.90

Note: Probe time in msec and reading time in sec per text segment. The reading time measure is based on the performance of only the subjects in the self-paced condition.

Table 3

Mean Proportions Correct on New and Repeated Posttest Items as a Function of Question Condition and Type of Information

Question Condition	Type of Information: Technical Terms, New Items	Technical Terms, Repeated Items	Proper Name, New Items	Proper Name, Repeated Items
Technical Term Questions	.21	.37	.10	.08
Proper Name Questions	.18	.19	.19	.46
No Questions	.16	.13	.09	.10

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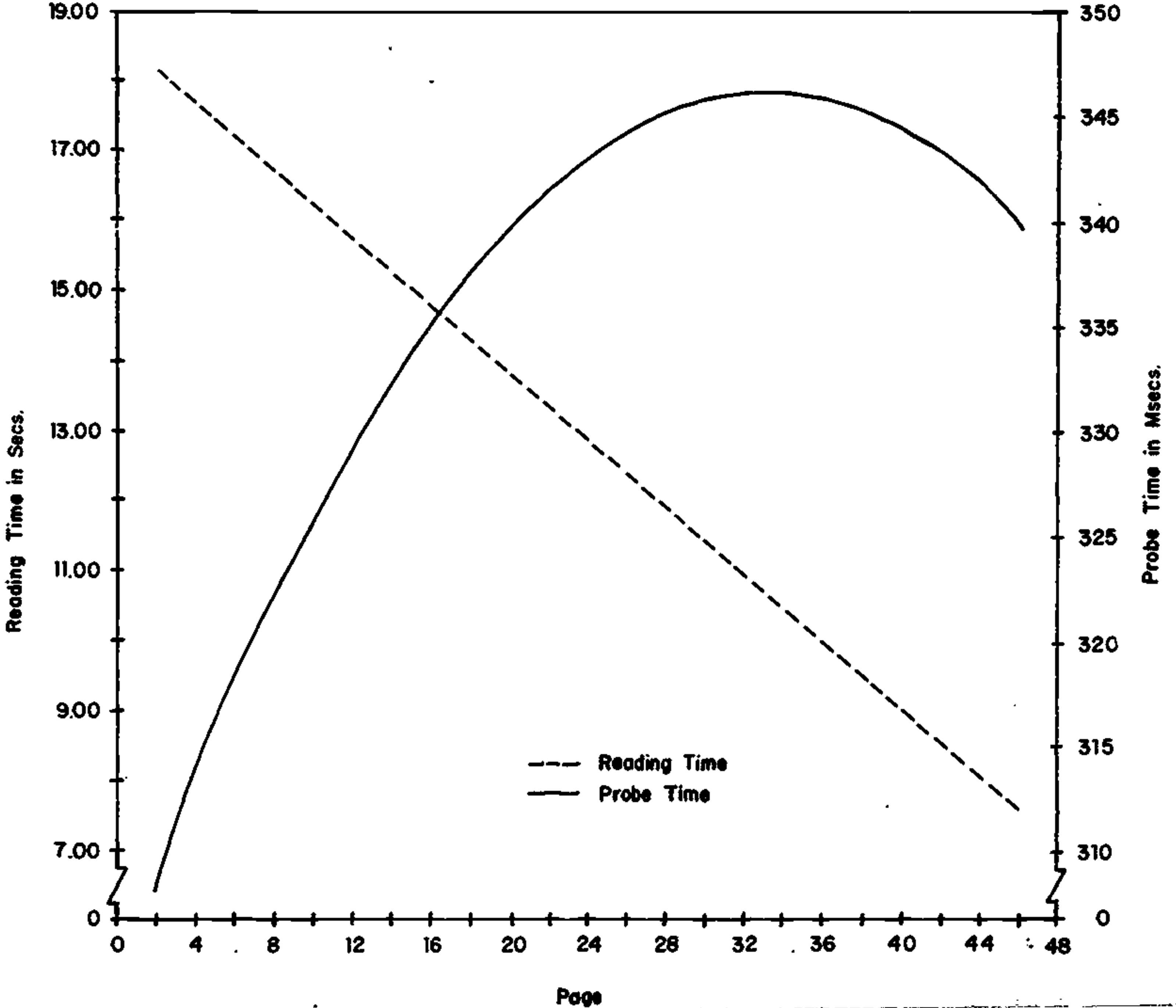
Figure Caption

Figure 1. Reading time and probe time as a function of page in the text.


19.00
17.00
15.00
13.00
11.00
9.00
7.00
0
Reading Time in Secs.
350
345
340
335
330
325
320
315
310
0
Probe Time in Msecs.
0 4 8 12 16 20 24 28 32 36 40 44 48
Page
Reading Time
Probe Time

34

35

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