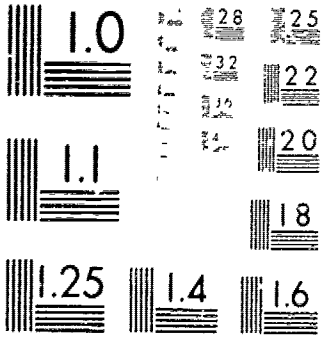

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ABSTRACT

Forty-three college students read a specially prepared text either with or without inserted questions. The text and the questions were presented on a computer terminal to allow measurement of reading times on short segments of material. Question groups performed better, relative to controls, on posttest items that repeated inserted questions and also on new posttest items from the same categories as the inserted questions. While there was no overall reading time difference between the question and no-question groups, subjects who received inserted questions spent more time on the parts of the text that contained information of the type needed to answer the questions. The results are consistent with a selective attention interpretation of the indirect effect of inserted questions. (Author)

CENTER FOR THE STUDY OF READING

Technical Report No. 83

DISTRIBUTION OF READING TIME WHEN QUESTIONS ARE ASKED ABOUT A RESTRICTED CATEGORY OF TEXT INFORMATION

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Distribution of Reading Time when Questions are Asked About a Restricted Category of Text Information

The purpose of the research reported in this paper was to take an additional step in tracing the processes by which periodic, inserted questions influence learning from text. The focus was on the indirect effect of questions, so called because subjects are observed to do better on new posttest items constructed in such a way that simply learning the answers to the inserted questions could not produce the improvement. Literally dozens of studies involving the indirect questioning effect have been completed in recent years. Nonetheless, very little more is known today about the inner workings of the mechanism giving rise to the effect than when Rothkopf (1966) conjectured in the mid 1960's that it probably was an "attention-like" process.

Rothkopf and Bisbicos (1967) have obtained the best evidence that the indirect effect of questions may be attributable to an attentional process. They used a 9600 word selection from The Sea Around Us. For one group, the inserted questions required proper names or measured quantities as answers. This group did substantially better than other groups on new posttest items, different from the questions inserted in the text, that also required knowing proper names and measured quantities. Similar but weaker results were obtained with a group asked inserted questions that called for technical term and common word answers. In a study employing the same paradigm, Quellmalz (1972) found that subjects did markedly better on new proper name posttest items when proper name questions had been

inserted in the text, and also markedly better on posttest items that required identifying a new example of a concept or principle, when that was the sort of question which had been asked.

The research to date indicates that readers who encounter questions that can be answered on the basis of an easily discriminable type of text information will later perform better on any item testing information from the category. An economical explanation for this phenomenon is that the reader selectively attends to information in the questioned category. The evidence for such an explanation is entirely circumstantial, however.

We sought to obtain a proximate indicator of selective attention. The technique was to measure the amount of time subjects spent on short segments of text. These segments occasionally contained "target information," that is, information of the type required to answer inserted questions. If questions cause the reader to selectively attend to target information one might expect more time to be spent on segments containing such information than on other segments. At least, we dare say that a poll of research workers in the area would show this to be the predominant opinion.

Upon close examination, however, it turns out that there aren't completely compelling reasons why readers should spend more time on target information. One's intuition that readers ought to take extra time is bolstered by the ways attention is talked about in ordinary language: attention has temporal extent, therefore, "paying more attention" implies spending more time. This is not a line of reasoning; it's semantic drift.

A guarded formulation of the selective attention hypothesis is that inserted questions cause readers to process target and nontarget information differently. Different processes need not take different amounts of time. The process by which target information is encoded might be time-intensive, but it is almost equally plausible that the process is more efficient and, hence, less time consuming. Whether readers will spend extra time on target information is an empirical question. An expectation stated in advance of looking at data is a hunch rather than a prediction.

That there is reason for a cautious approach to interpretation of questioning effects is suggested by research on directed forgetting, in which similar issues have arisen. This research has established that informing people that they may forget some of the material that has been presented results in substantially improved memory for the remaining material. The first theory proposed to explain this phenomenon was that the cue to forget allows the subject to stop rehearsing the to-be-forgotten items and devote all subsequent attention to the items that must be remembered (Bjork, 1972). There is some subtle evidence consistent with a selective rehearsal interpretation (cf. Martin & Kelly, 1974; Timmins, 1974). Nevertheless, this seems to be a small part of the story. "More striking," in the words of Jongeward, Woodward and Bjork (1975, p. 51), is "the incredible ability of Ss . . . to differentiate to-be-remembered and to-be-forgotten items . . ." which appears to be "much more important as a mechanism of directed forgetting than either selective search [of memory] or selective rehearsal." The point we are trying to make

is that a comparable statement might be true of questioning effects. Target information could be better learned and remembered just because it is differentiated from other information. The indirect effect of questions need not be mediated by quantitatively more of a time consuming process.

The amount of time subjects spend reading text has been assessed in a number of questioning experiments. However, gross measures typically have been employed. For instance, in several studies subjects have been instructed to write the time they began a page at the top and the time they finished reading at the bottom. For what it is worth, previous research indicates that groups that receive questions usually spend more time in total than control groups; however, the differences are generally small, seldom statistically significant, and not entirely consistent (Rothkopf, 1974).

More important, questions about a restricted category of information may not affect total time. Readers could spend more time on text segments containing target information and slightly less time on other text segments. Despite changes in the distribution of reading time there would then be no overall difference in time spent on a page of text.

The present research employed an already-developed program on the PLATO IV computer system (Smith & Sherwood, 1976), which made possible accurate measurement of the amount of time students spend on small chunks of text. Subjects read text displayed in four-line segments on the PLATO viewing screen. They advanced to the next segment by pressing a key on the console. This

caused a new segment to appear on the screen and also erased the previous segment. The time between key presses directly indicated exposure time, and indirectly reflected study time.

Preliminary research has suggested that people quickly adapt to reading text from a PLATO screen and that the system intrudes very little on normal reading activities. An unpublished study pointing to this conclusion involved groups that read a text printed on paper or presented on PLATO. The results indicated no differences in amount learned, time spent, or apparent study strategy.

Method

Materials

The text was a revised version of the section from The Sea Around Us used by Rothkopf and Bisbicos (1967). It consisted of 48 PLATO-length pages (each about three quarters of a normal typed page) divided into 12 four-page zones. There were six short answer questions for each zone, drawn mostly from Rothkopf and Bisbicos. Among the six questions were two of each of three types--questions that could be answered with either (1) a technical term, (2) a number, or (3) a proper name.

Three questions for each zone, one from ea classification, were used as inserted questions and also appeared on the posttest. The remaining 36 questions were used only on the posttest. Below is a sample of each type of question. The underlined word was left blank to be supplied by the subject.

The newly developed marine instrument which records water temperature at all depths while being towed behind a vessel is called the thermistor chain.	Technical term question
In 1860, the surveying ship Bulldog pulled it's sounding line up from a depth of 1260 fathoms and found starfish clinging to it.	Number question
The building of the bathyscaphe was first proposed by the Swiss physicist, Professor Auguste Piccard.	Proper name question

Each of the 12 four-page zones was divided into 24 segments of about 33 words in length. The text was rewritten so that each segment contained information which pertained directly to only one type of question. In other words, for example, if a segment contained technical terms it did not contain numeric information or proper names. There were some "filler" segments which did not contain information directly relevant to any of the categories of questions.

The text was rearranged so that each zone contained the same number of segments relevant to each type of question. For instance, one zone might have three technical, numeric, and proper name segments while the next zone might contain five of each type. The range was three to six of each type per zone.

Design and Procedure

Independent groups of subjects received inserted questions of one of the three types. A control group read without inserted questions. Type

of text segment (technical term, number, proper name, and filler) and zone (numbered 1 to 12 in order of occurrence) were within subjects factors. In addition to reading time, the measures were proportion correct on post-test items that repeated questions inserted in the text and proportion correct on posttest questions that did not repeat inserted questions. The experiment was conducted in a laboratory equipped with 31 PLATO terminals spaced three to five feet apart. The terminals were arranged so that students could see only their own displays.

The order of events was: an explanation of procedures for using the computer system, instructions for the experiment, a four-page practice passage, the 48-page experimental passage, and the posttest. Subjects were told that the experiment was about how students learn from text materials. They were told they would be given a comprehensive short-answer test when they had finished reading. It was emphasized that each segment should be read carefully since once a person had moved forward s/he could not return to the previous segments. Students in the question groups were asked a question after reading each four-page zone. The question could always be answered on the basis of information presented in the immediately preceding zone. Answers were typed on the computer console. No feedback about the correctness of answers was provided. Subjects worked through the materials at their own pace. The computer recorded answers to questions, and the time per text segment with an estimated accuracy of about 100 milliseconds.

The posttest was not administered on PLATO but rather in paper-and-pencil form in a nearby classroom. The test contained two subtests

presented in counterbalanced orders. One of the subtests was composed of the 36 questions no subject had seen before. The other subtest repeated the 36 questions that had been inserted in the text for one or another of the three questioned groups. Upon completing the posttest subjects were debriefed, thanked for their cooperation, and dismissed.

The posttest was scored according to a scheme that permitted spelling errors, substitution of synonymous words and phrases (plankton for planktonic shrimp), and rounding of numerical answers. Also tried was an even more lenient scoring procedure, and a more strict scoring procedure in which the expected answer had to be reproduced exactly. The findings were invariant across scoring methods.

Subjects

The subjects were 43 students enrolled in introductory educational psychology classes. They participated in the study for class credit and also received $2.00. One other subject was dropped because, based on answers to the inserted questions (e.g., "This is boring," "What am I doing here?"), it was judged she was not cooperating.

Results

Table 1 contains mean proportion correct on posttest items that matched the inserted questions. Significant ($\alpha = .01$ for all tests of significance) effects appeared for zone, $F(10,390) = 4.98$, and the interaction of inserted question group and type of posttest item, $F(6,78) = 17.35$. No consistent trends were noticed when the means were arrayed

by zone. It is apparent that the interaction is attributable to the superior performance of subjects on the items they were repeating.

Insert Table 1 about here

Table 2 shows mean proportion correct on new posttest items. The significant effects in an analysis of these data were posttest item type, $F(2,78) = 15.94$; zone, $F(10,390) = 12.86$; and the interaction of inserted question group and type of posttest item, $F(6,78) = 3.45$. Examination of the data again failed to reveal any orderly trends as a function of zone. The interaction appeared because subjects did better on items that tested information from the same categories as the inserted questions that they had received.

Insert Table 2 about here

An analysis of reading times (not including time on the inserted questions themselves) showed a strong effect for zone, $F(10,390) = 43.14$. Figure 1 shows that there was a steady decline in time per text segment from the beginning to the end of the passage. Subjects read the first zone at a rate of 145 words per minute. They read the last zone at a rate of 230 words per minute.

Insert Figure 1 about here

Table 3 summarizes the time data according to the type of information in the text segment. There was a significant effect for type of text

segment, $F(3,117) = 37.61$, because of the comparatively small amounts of time on filler segments. More interesting and important was the significant interaction between inserted question group and type of text segment, $F(9,117) = 10.54$. This appeared because subjects spent more time on segments containing what for them was target information. Relative to the control group there was an increase of about 1.4 seconds per target segment. Relative to other questioned groups on nontarget segments (not including filler segments) the increment in time on target segments amounted to 1.9 seconds.

Insert Table 3 about here

A subsidiary analysis turned up another interesting effect on study time. Readers spent more time on the segment immediately following a question (considering just nontarget segments) than did the control group, $t(41) = 3.48$. As can be seen in Figure 2, there was no elevation of times on other segments in the neighborhood of question breaks.

Insert Figure 2 about here

It should be emphasized that when time taken to answer questions is included the total time expended by questioned groups was slightly though not significantly greater than the time expended by the control group, $t(41) = .96$. Over the entire passage and the twelve inserted questions the questioned groups averaged 62.8 minutes whereas the no question group averaged 57.2 minutes on the passage alone.

Discussion

Subjects in this study did substantially better on posttest items that repeated questions asked while the text was read. This is the well-established direct effect of questions. Also observed was a smaller, though still significant, indirect effect. Questioned subjects were more accurate than control subjects on posttest items different in specif content but from the same categories as the inserted questions.

Subjects spent more time on text segments containing target information than on other text segments. The extra time cannot be attributed to peculiarities of the language or content of the segments involving target information since a counterbalanced design was employed; what was target information for one group was nontarget information for the remaining groups. The time increment appeared consistently on most text segments from the point questions were first introduced to the end of the text. The effect was consistent across target segments containing information related to the three different kinds of inserted questions. These data provide the first really direct support for the version of the selective attention hypothesis that says that the indirect effect of inserted questions is mediated by a time-intensive process engaged at the points in the text where question-relevant information is encountered.

Nevertheless, it must be acknowledged that the data do not prove that a time consuming process is responsible. Consider that people's processing activities during reading probably are quite elastic. Within limits, essentially the same process probably can squeeze into a short interval or may spill over into a longer one. People may slow down in

the vicinity of target information for no functional reason. Or they may spend the extra time in activities that are intended to be functional but which in fact have a negligible influence upon whether the target information will be learned and remembered. For instance, a reader might engage in the relatively ineffective activity of repeating the target information to him/herself. The point is that the additional time people spend on target information could be an epiphenomenon, not time used in the service of the causally-effective, instrumental process. Therefore, while the selective attention hypothesis gives a very attractive account of our data, certain of the links in the argument required by the hypothesis remain to be established.

The following sorts of questions still need answers. What do people do with the extra time they spend on text segments containing target information? Is the process by which questions have an indirect effect necessarily time-intensive? Do all procedures associated with increased learning from text entail time consuming processes? If not, what distinguishes those that involve relatively more time from those that involve relatively less time? There has been some previous research attempting to answer these kinds of questions, but the findings must be regarded as preliminary (Corrozi, 1970; Peeck, 1970; Geiselman, 1977).

Two further caveats are in order. First, this study was constructed around the learning of simple facts, not because the authors believe that this is generally a worthy instructional goal, but rather because such information is easy to edit and rearrange, easy to write questions about,

and easy for readers to recognize. Our guess is that the findings would hold up in research extended to educationally more significant information and questions, provided the reader could figure out which aspects of the text to concentrate on in order to answer the questions correctly; but this remains to be shown. Second, the finding that questions affect the distribution of reading time, rather than total time, would be expected to hold only when the inserted questions are of a clear and distinctive type. If questions were of several types and ranged over a variety of text content, the influence on reading time would be more diffuse. Total reading time might go up relative to a control group under these circumstances, provided there were an incentive to correctly answer the inserted questions and background motivation were not too high (see Anderson & Biddle, 1975).

We turn finally to a consideration of the practical value of questioning techniques in the light of the present findings. A sometimes heated controversy has raged in educational research circles about the role of reading time in producing achievement gains when questions are asked. Carver (1972) has maintained that research on questioning is of no theoretical or practical significance since, as he suspected and we have clearly demonstrated, the increment in achievement attributable to questions is associated with increases in study time. His reasoning was that "the time prose material is presented, or the time engaged in learning by the learner, is an important determiner of retention" (p. 94) and further, that questions could be "simply acting as a stimulus for spending more time in the learning process" (p. 102).

It is very odd to conclude that an effect is theoretically uninteresting because time is taken to achieve the effect. Time itself is not a causal force. It is, as the maxim says, only an "empty vessel" that may support processes in a causal chain. Presumably every process takes at least a little time. Thus, there is no reasonable sense in which one could be said to have explained (or explained away) questioning effects by pointing to the fact that people who get questions spend more time.

As for practical significance, Faw and Waller (1976) have joined Carver in the belief that evaluation of an instructional technique requires weighing achievement "benefits" against time "costs." Faw and Waller propose as a decision making tool a sort of cost/benefit ratio: the mean achievement score of a group of students under a certain instructional regimen divided by the mean time the group took. Of course, if a questioning procedure were being evaluated, the calculation would include the time taken to answer the questions as well as reading time. Comparing the ratio of the group receiving the instructional procedure with the ratio of a control group is supposed to give an "index of efficiency."

This statistic surely will lead to poor educational decisions. The typical function that relates raw scores on a test over a passage to reading time probably looks about like that depicted in Figure 3. The figure is supposed to represent the relationship when the same readers (or groups of comparable readers) spend varying amounts of time on a passage. It does not reflect the relationship that would be observed if different

people were sorted according to reading time. Individual differences introduce still further complications.

Insert Figure 3 about here

The function represented in Figure 3 is negatively accelerated to reflect the fact that each increment in achievement usually takes a larger amount of time. This in turn may partly reflect the fact that different aspects of a text are seldom equal in difficulty and, other things being equal, that easy aspects tend to be learned first. We especially wish to emphasize that readers cannot be assumed to start with zero knowledge when studying meaningful text material. They may know specific information and concepts and, even when they don't, they are likely to possess generic knowledge that enables them to construct partly satisfactory answers and make informed guesses.

The Faw and Waller index relating achievement to time is systematically biased against effective but long treatments. Indeed, if the foregoing assumptions are correct, the most "efficient" approach would be to allow no time at all to read a text. This course of action could have an infinite index of efficiency!

Another problem with the time/achievement ratio is that "unit" increments in performance on achievement tests may have variable educational significance. The analogy with economic decision-making breaks down because, whereas one dollar is worth the same as any other dollar, a different value would be placed on, for example, capacity to select a

paraphrase of a major principle and the ability to identify the date of an historical event. Nonetheless, each correct answer ordinarily receives "one point." No objective scheme exists for weighting performance in terms of significance. And, no one would wish to claim that different sorts of achievement take study time in proportion to their value.

One may inquire in what sense student study time is an instructional "cost." Elementary and secondary schools are set up to provide instruction for approximately thirty hours a week; however, there are indications that the typical pupil spends only a small fraction of this time actively engaged in learning (Berliner & Rosenshine, 1977). There is a sense in which thirty hours of time per week represents a "fixed cost," a capacity already contracted by society. From this perspective, until the contracted capacity is exhausted, any in-school use of time that increases achievement also increases efficiency. From a more personal perspective, there are students of all ages who would regard a procedure that usefully directs their allocation of study time, or even induces them to gainfully spend more time, as a benefit rather than a cost. Putting this another way, for at least a few students on most occasions and for almost all students on some occasions, time is cheap, achievement is dear.

The moral is to eschew any composite index. It is foolish to presume that there is a simple index that can tell whether good educational value is being received for time invested. Practical educators deserve to be protected against such number magic. There is less risk of misguided decisions if one follows the conservative course of considering achievement

and time separately. In particular, the fact that questions inserted periodically in a text can produce gains in achievement should, for practical purposes, be evaluated independently of effects of questions on study time.

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Table 1

Mean Proportion Correct on Posttest Items that Matched Inserted Questions

	Type of posttest item			
Inserted question group	Technical term	Number	Proper name	All types
Technical term	.37[a]	.26	.14	.26
Number	.15	.36[a]	.16	.23
Proper name	.17	.18	.48[a]	.28
No questions	.15	.15	.17	.16
All groups	.20	.28	.24	.23

Note. Does not include questions based on zone 1.

[a]Items that actually repeated inserted questions.

Table 2

Mean Proportion Correct on New Posttest Items

	Type of posttest item			
Inserted question group	Technical term	Number	Proper name	All types
Technical term	.39[a]	.23	.14	.26
Number	.33	.30[a]	.14	.26
Proper name	.32	.20	.24[a]	.25
No questions	.22	.20	.20	.21
All groups	.32	.24	.18	.24

Note. Does not include items based on zone 1.

[a]Items based on segments containing target information.

Table 3

Mean Reading Time in Seconds Per Text Segment

Inserted question group	Type of text segment				
	Technical term	Number	Proper name	Filler	All segments
Technical term	14.6[a]	12.2	12.7	11.4	12.7
Number	11.2	12.9[a]	11.0	10.0	11.3
Proper name	12.4	11.6	13.8[a]	10.8	12.2
No questions	12.5	12.4	12.3	10.7	12.0
All groups	12.5	12.3	12.4	10.7	12.0

Note. Does not include segments in zone 1.

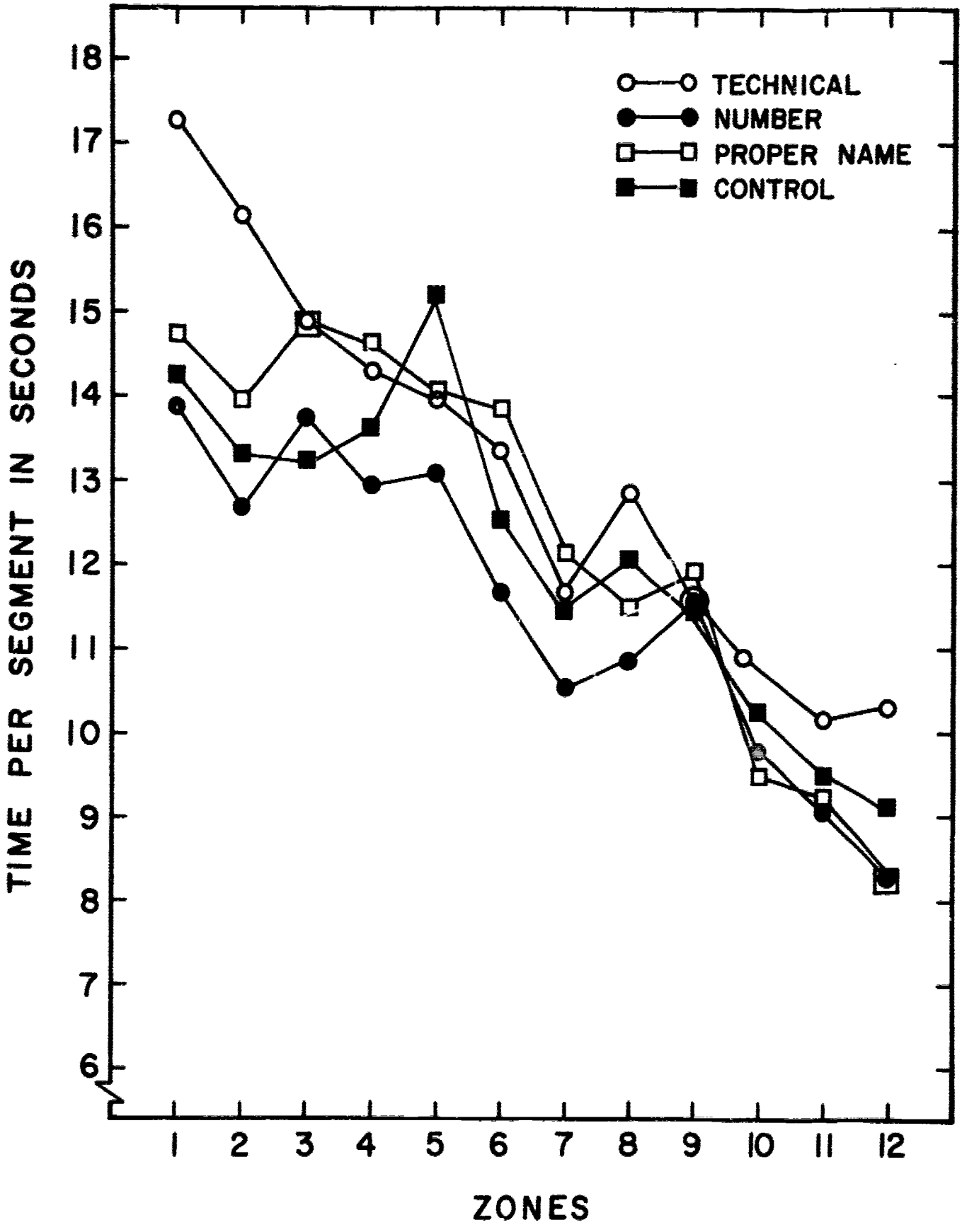
[a]Segments containing target information.

Figure Captions

Figure 1. Mean reading time by zone.

Figure 2. Mean reading time on text segments in neighborhood of inserted questions.

Figure 3. Hypothesized relationship between reading time and achievement.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CONTROL
TIME PER SEGMENT IN SECONDS
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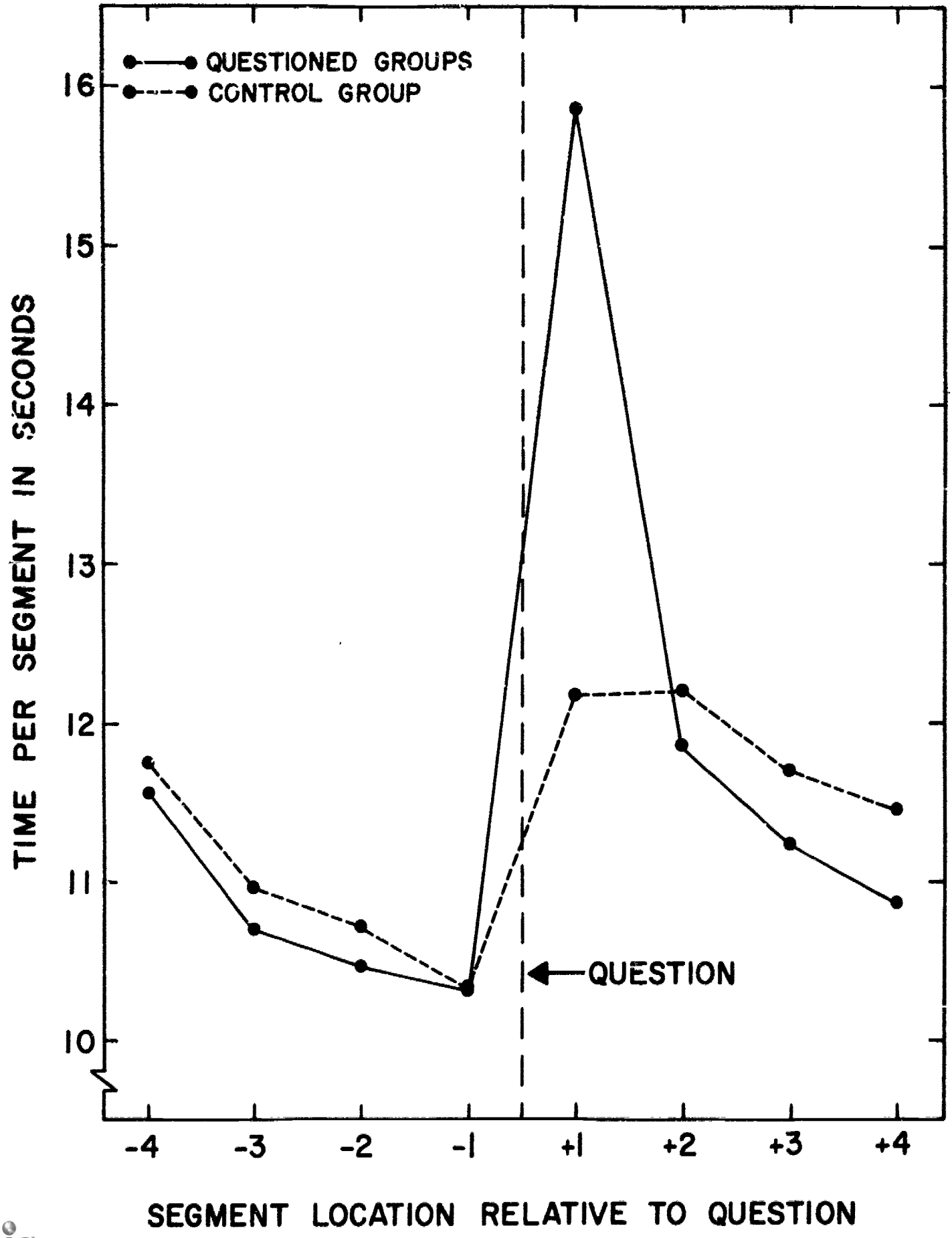
ZONES


QUESTIONED GROUPS
CONTROL GROUP
TIME PER SEGMENT IN SECONDS
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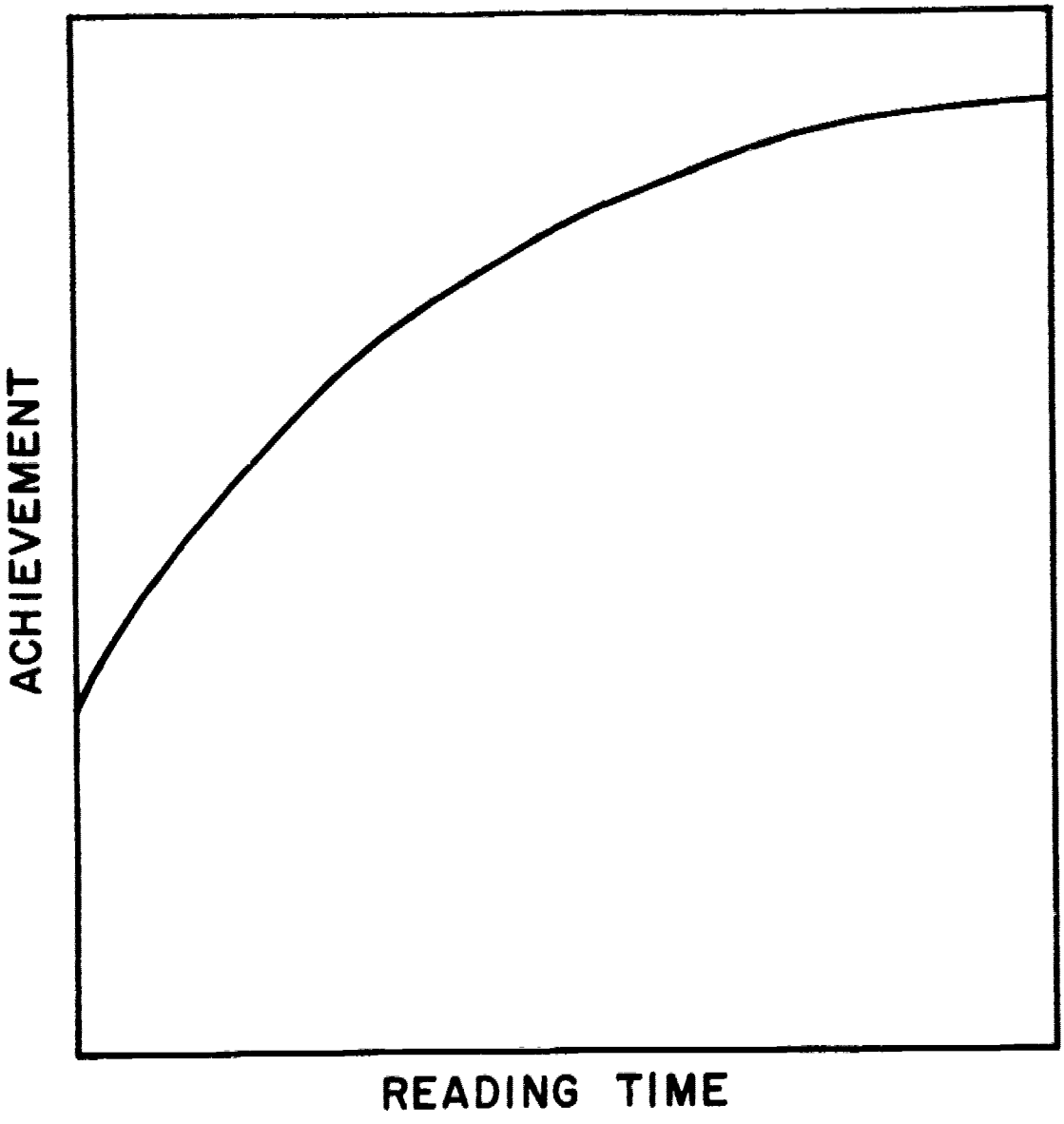
SEGMENT LOCATION RELATIVE TO QUESTION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