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ABSTRACT

A study was conducted to evaluate reading strategies by contrasting regression results of 10 fast versus 10 slow readers. At the word level the lag effect was evaluated. At the text level, the few-argument strategy versus the many-argument strategy and the physical and the syntactic strategies were evaluated. The absolute proportion of the lag effect was small but was greater for fast than for slow readers. If readers exhibited lagged processing for words, there was an expectation that some higher level processes would also occur with a lag. Analysis showed that there was no difference between reader groups in the processing of new argument nouns. Reading times for both fast and slow readers increased with the number of new argument nouns in the sentences. There was a trade-off between reading speed and comprehension. In every experiment and every condition, the retention scores were poorer for the fast readers than for the slow readers. There were specific reading patterns in fast readers that were not reflected in the average profile of readers. Results demonstrated how important it is to examine comprehension strategies for different reader groups. Results indicated that readers do not necessarily pause at clause and sentence boundaries. (Seven figures are included.) (MG)

Readers differ both in reading speed and in reading time patterns

Karl Haberlandt

Paper read at 30th Annual Meeting of the Psychonomic Society, Atlanta, GA, Nov 12, 1989.

My interest in reading speed began when I was a college student, long before I did reading research of my own. In the early sixties, it was a widely publicized fact that President Kennedy had taken a speed reading course and that he read several papers each day cover to cover. Sometime later, Senator Proxmire argued that speed reading was an important national goal. The person credited with developing a successful method of speed reading was Evelyn Wood. Evelyn Wood franchises sprung up all over the country. Even colleges and corporations used speed reading programs.

If you consider the claims for speed reading, the wide interest in it should come as no surprise. The most appealing benefit was that speed reading presumably increased the reading speed with no loss in comprehension. Some extraordinary individual feats of speed reading were claimed: reading rates of 2000-10000 words per minute were reported by several investigators. This compares to a reading rate of 250 words per minute for "normal" readers.

Now 30 years later, we do not hear much about speed reading any longer. But as a reading researcher, I have been impressed over the years with the largest source of reading time variance. This is the absolute difference in the reading times of fast and slow readers. The specific question I address today is whether there are differences in the reading time profiles of fast and slow readers, in addition to the difference in absolute reading times. Figure 1 contains the outline of my talk today.

Insert Figure 1 about here

A reading time profile is the pattern of word reading times generated by a reader. One straightforward hypothesis is that fast and slow readers differ by a constant amount for each word of the text.

Insert Figure 2 about here.

However, my colleagues and I knew of no processing theory that would predict such an outcome. Rather, we formulated reading strategies in fast and slow readers. These hypotheses were culled from the speed reading literature and the research literature. The hypotheses concern differences in the reading profile of fast versus slow readers. The term <u>reading profile</u>

refers to the effect of a specific predictor variable on the reading times of a set of words. In some analyses, the set of words includes all of the words read by the readers, in other analyses it includes a subset of the words.

Let us consider for a moment the following question: **How do speed readers read?**

In speed reading courses, students are instructed to "process" groups of words rather than individual words. This was based on the notion that more information would be extracted in a given eye fixation. Students were also taught a number of physical strategies. They were taught to:

- o scan down the center of a page
- o to scan diagonally across the page
- o to skim along the edges of the page

It is not clear where these techniques originated, but perhaps early speed reading teachers observed that skimmers spontaneously engaged in some of these strategies.

Shortly, I'll describe three sets of strategies used by fast versus slow readers. My colleagues and I evaluated these strategies in the Moving Window situation using word reading times as the dependent variables. Because the strategies refer to a general framework of reading let me first sketch that framework and the analyses used in this research.

Reading framework

(i) According to the general framework, readers generate a text representation of the text's meaning. The representation is updated dynamically with new information form the text. Many processes contribute to the representation, ranging from letter recognition to intersentence integration.

(ii) These processes operate within the constraint of a limited working memory. This limit motivated the buffer-integrate-purge model of comprehension introduced by Jarvella. The model assumes that critical text-level information is accumulated in Working Memory until a "convenient" processing unit like a sentence is complete. At the sentence boundary, the current information is integrated with the text representation and the buffer is purged.

(iii) What is the "critical information" buffered in Working Memory? It is the NEW information in the text as measured by the number of new argument nouns. A New Argument Noun is a noun occurring for the first time in a given text (see Figure 3).

Insert Figure 3 about here

Multiple regression analyses
Word reading times were used as dependent variables in multiple regression analyses. The predictor variables included word length, word occurrence frequency, clause boundaries, and the cumulative number of new arguments per sentence or per line. There were also coding variables to indicate the beginning and end points of lines. Finally, we coded a task variable for reader groups experiencing different tasks. The analyses yielded a slope or regression coefficient for each factor, and the R^2 coefficient for the entire equation.

The results for average readers have shown that word reading times increase

1. for longer words
2. for infrequent words
3. at clause and sentence boundaries
4. and at line boundaries

There were also new argument effects. Reading times at non-boundary locations increased as a function of the number of new argument nouns. This reflected the buffering of new information in working memory. At the end of the sentence, reading times were proportional to the number of new argument nouns in the sentence. This reflected the integration of new information with prior information in LTM. Given this background, I can now describe three sets of reading strategies of fast versus slow readers and report some data, first from experiments 1 and 2.

Comparison of fast and slow readers
In experiments 1 and 2, we defined fast and slow readers empirically according to the total reading time they chose to devote to the experimental passages. Fast readers were defined as the 10 fastest readers, and the slow readers were the 10 slowest readers in each task condition.

We assumed that the reading pattern of our fast readers should reflect some of the strategies taught in speed reading courses, at least to some extent.

We formulated three sets of hypotheses, one at the word-level and two at the text-level. We evaluated the strategies by contrasting regression results of fast versus slow readers.

At the word level, we evaluated the lag effect.

At the text level, we evaluated (a) the few-argument strategy versus the many-argument strategy

and (b) the physical and the syntactic strategies.

Lag Effects

One of the strategies emphasized in speed reading courses is the chunking strategy. Readers are encouraged to process adjacent words as groups rather than to process them individually. The chunking strategy would mean that at least two words would be processed during a given episode. As the reader processes the current word, some processing of the prior word is expected to continue. As a result, the reading times of word N should be influenced to some extent by features of word N-1.

Because the lag effect is a word-level effect, we evaluated it by analyzing only word-level features. We measured the lag effect by the R^2 coefficient in an equation with only two predictor variables. These were the length and occurrence frequency of the previous word. The dependent variable was the reading time of the current word.

The absolute proportion of the lag effect was small. But importantly, the lag effect was greater for fast than for slow readers, just as predicted. The lag effect is shown in the next figure.

Insert Figure 4 about here

I have just described a lag effect for word-level processes. Remember, however, that word reading times reflect higher level processes as well. If readers exhibit lagged processing for words, we may expect that some higher level processes will also occur with a lag. We will see this below for intersentence integration.

Many-Argument versus Few-Argument Strategy

Another strategy taught in speed reading courses is to focus on the most important information and to ignore detail. In terms of new arguments, fast readers should extract fewer new arguments from a text unit, whereas slow readers should work through every idea, every detail, every new argument noun. As a result of this processing difference, the new-argument effect should be greater for slow readers than for fast readers.

However our analyses showed that there was no difference between reader groups in the processing of new argument nouns. Reading times of both fast and slow readers increased with the number of new argument nouns in the sentences.

We still suspect that fast readers may favor the few-argument strategy for texts longer than the 275-word passages we used. Reading each of our passages only takes between 1 1/2 and 2 minutes. We would expect that in longer passages, say, of about 1000 words, the predicted few-argument strategy would emerge.

Physical versus Syntactic Strategy

We know that "average" readers pause at certain locations in the text in order to integrate new information with previous information (Haberlandt et al., 1986; Just & Carpenter, 1987). The locations that readers slow down at include both syntactic and physical locations. Because physical locations are more readily detected in superficial reading of a text than syntactic locations, fast readers would be expected to pause at those locations. Students in speed reading courses are instructed to identify the "edges of the print," the line boundaries and use these as "landmarks." The alternative strategy is to pause at syntactic locations, namely at clause and sentence boundaries, and use them for intersentence integration. My colleagues and I assumed that slower readers would prefer this strategy.

You should note that these two strategies are not mutually exclusive. They should be viewed as preferences.

I evaluated the strategy contrast in multiple regression analyses using coefficients for line versus sentence boundaries. These boundary locations were coded and entered as a predictor variable in the equation, along with other variables named above. Again regressions were computed for individual readers. The standardized regression coefficients were then analyzed in ANOVAs. The analyses showed that fast readers did more processing at line boundaries, whereas slow readers did more processing at sentence boundaries.

Integration effects at sentence versus line boundaries

Faster and slower readers tended to pause at different locations. But how do we know that new-argument integration takes place at these locations? We evaluated integration by calculating the new argument coefficients at these specific locations. These analyses do not involve the entire set of words read by readers. According to the predictions, slow readers integrate at the end of the current sentence, whereas fast readers integrate at the line boundary. Since processing is lagged, as we saw earlier, fast readers are expected to integrate the new arguments at the beginning of the next line. As Figure 5 shows, this is what took place.

Insert Figure 5 about here

Buffering effects relative to sentences versus lines

From research based on "average" readers we know that buffering of new argument nouns takes place at non-boundary locations. Because slower readers integrate at sentence boundaries, they presumably buffer new argument nouns in terms of sentences. By contrast, faster readers were expected to buffer new arguments in terms of lines. So we cumulated new arguments both in terms of sentences and in terms of lines for both groups of readers. We found that in slow readers, the cumulative new argument effect was greater for sentences. On the other hand, in fast readers it was greater for lines. Thus, both the integration and buffering results show that fast readers favor a physical line-oriented strategy whereas slow readers favor the syntactic strategy.

Experimenter control of reading strategies

Interesting as the results are that I presented so far, they were based on post-hoc analyses. Faster and slower readers were selected after they had completed the experiment. It was up to readers whether they read quickly or slowly. Experiment 3 was designed to explore to what extent the different reading strategies could be induced through experimenter instructions. Readers assigned to a "slow" group were instructed to read the text very "carefully." The "fast" readers were requested to read as fast as they could. Our instructions separated the reading speed of the two groups. The mean word reading times of the fast and slow groups were 375 ms and 495 ms respectively ($p < .01$).

As for reading time patterns, in experiment 3 all the essential findings of the two previous experiments were replicated: Fast readers exhibited the lag effect at the word level. They tended to pause at line boundaries, rather than at sentence boundaries. They integrated new argument nouns to a greater extent at the beginning of a new line, and they buffered relative to lines rather than relative to sentences. And, once again, there was no difference in the overall new-argument effect. Thus, experiment 3 has shown that experimenter instructions influence reading speed and reading strategies.

Conclusion

First let us consider the level of comprehension attained in fast and slow reading. Unfortunately, there was no "free lunch" here. There was the trade-off between reading speed and comprehension predicted by Crowder (1982) and Just and Carpenter (1987), although not by speed reading advocates. In every experiment and every condition, the retention scores were poorer for the fast readers than for the slow readers.

Insert Figure 6 here

Of course, if only a certain minimum of retention is required fast reading may yield an adequate retention level, just as skimming does.

Second, there were specific reading patterns in fast readers that were <u>not</u> reflected in the average profile of readers. This result indicates how important it is to examine comprehension strategies for different reader groups. Classifications other than reading speed may be used as well: One can formulate processing differences for high versus low retention scorers, for high versus low reading span scorers, and for different groups defined by factorial combinations of attributes. An interesting contrast would illuminate processing at different levels of cognitive efficiency. In this comparison one would compare profiles of fast readers with high retention scores with profiles of slow readers with low retention scores.

Finally, one of the most interesting issues raised by this research is the "mapping problem." Standard texts cite the Graf and Torrey (1966) results that readers comprehend a text more readily when its physical layout agrees with the clausal or propositional structure (see top panel of Figure 7). These results were cited, e.g., Clark & Clark (1977) and John Anderson (1985)

Insert Figure 7 about here

On the other hand, our research has shown that readers do not necessarily pause at clause and sentence boundaries.

A similar result was recently reported by Sinclair, Healy, & Bourne (1989). These investigators found that readers' comprehension was better when they were given pauses in RSVP than when no pauses were given. According to Sinclair et al., readers use the pauses to integrate the information from the text. That pauses help was not surprising. What was surprising was that the location of the pauses was not important. In one of their conditions, the pauses coincided with phrase, clause, and sentence boundaries (see bottom panel of Figure 7). In another condition, the pauses occurred arbitrarily between words.

The puzzle is: How do fast readers map information from lines to the text representation? This question is important because it concerns the nature of the text representation. Major theories assume a propositional representation, either as the only representation, or in conjunction with a "situational" model.

If one abandons the notion of the proposition as the unit of processing then the results I described appear less contradictory. A finding from our earlier research calls propositions into question as well. In several of our earlier studies the number of new arguments was a better predictor of reading times than the number of propositions.

Thus it appears possible that a text is represented in terms of more molecular units such as argument nouns. However, it is difficult to see how those nouns would be linked to each other unless one assumes that every argument is linked to every other one by default. This is an idea reminiscent of recent models of memory. Alternatively, the representation might consist of a small number of macro-propositions and a relatively large number of argument nouns in text memory. Considerations like these make the mapping issue an important one and I expect to hear more about molecular text representations.

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Figure Captions

Figure 1. Outline of my talk

Figure 2. Hypothetical reading profiles for fast and slow readers for successive words of a sentence.

Figure 3. Sample passage and illustration of new argument nouns and word reading times.

Figure 4. Proportion of variance accounted for (R^2) in the reading times of the current word by attributes of the previous word in Experiments 1, 2, and 3.

Figure 5. New-argument effects at the beginning of the line versus the end of the sentence in fast and slow readers of Experiments 1, 2, and 3.

Figure 6. Retention of information in the two task conditions of Experiments 1, 2, and 3.

Figure 7. Sample materials to illustrate the location of breaks in texts.

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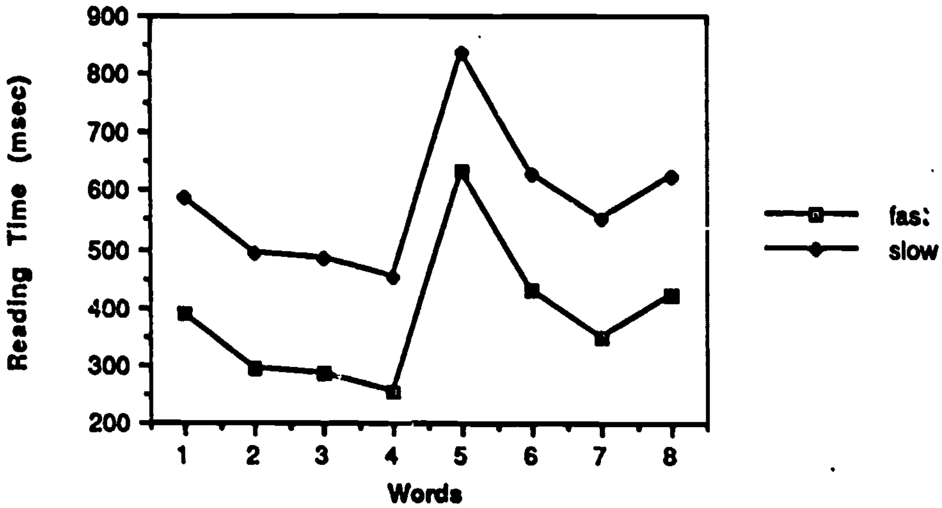
Comparison of different reader groups

The "mapping problem"

See Haberlandt, Graesser, & Schneider (1989) for a fuller version of this paper.

Support from NSF and NICH-HD

Hypothetical Reading Profiles



The first signs of Alzheimer's disease an insiduous malady of the elderly are small and puzzling. The memory lapses, confusion, dementia characteristic of the disease worsen. Eventually most patients must be placed in institutions....

New Argument Noun = Underlined
Repeated Argument Noun = Italic

The first signs of Alzheimer's disease an insiduous malady of the elderly are small and puzzling. The memory lapses, confusion, dementia characteristic of the *disease* worsen. Eventually most patients must be placed in institutions....

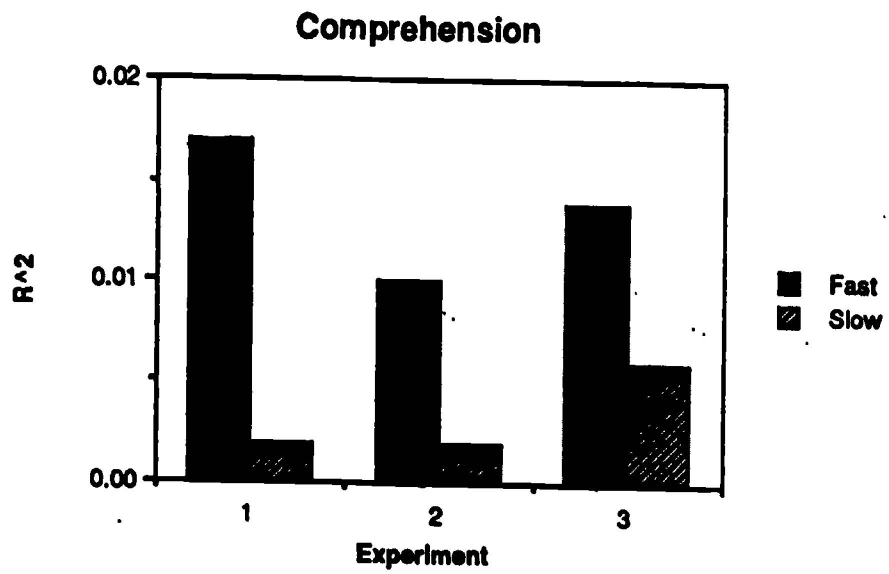
A data sample of word reading times:

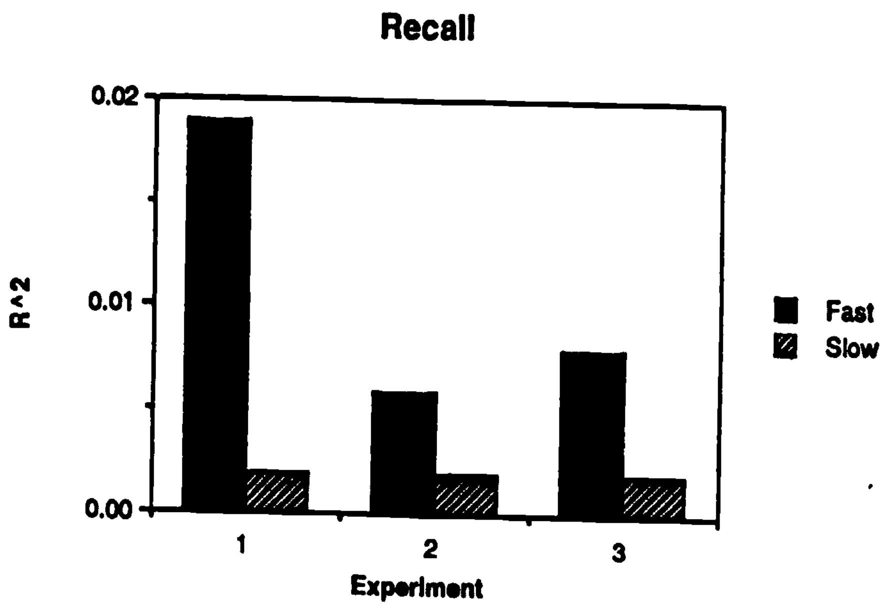
The first signs of Alzheimer's disease an
490 394 386 353 735 531 450

insiduous malady of the elderly are small and
523 513 456 418 623 415 411 383

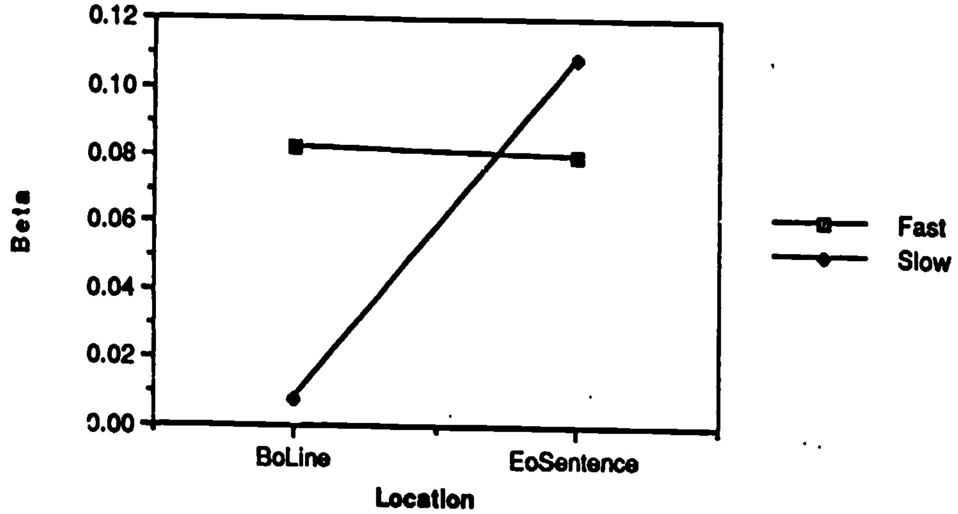
puzzling. The memory lapses, confusion, and
680 615 438 586 654 432

dementia characteristic of the *disease* worsen.
742 632 402 377 464 801

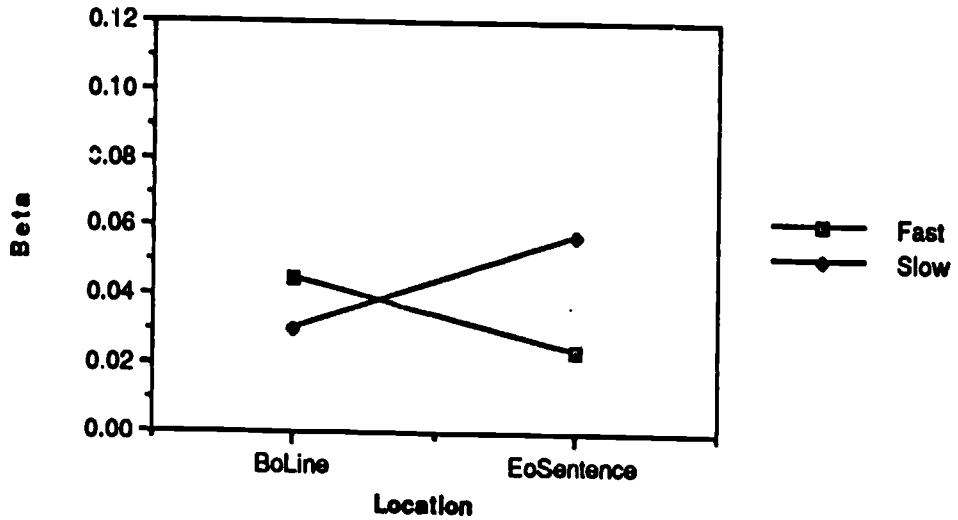

Comprehension
0.02
0.01
0.00
R^2
1
2
3
Experiment
Fast
Slow


Recall
0.02
0.01
0.00
R^2
1
2
3
Experiment
Fast
Slow

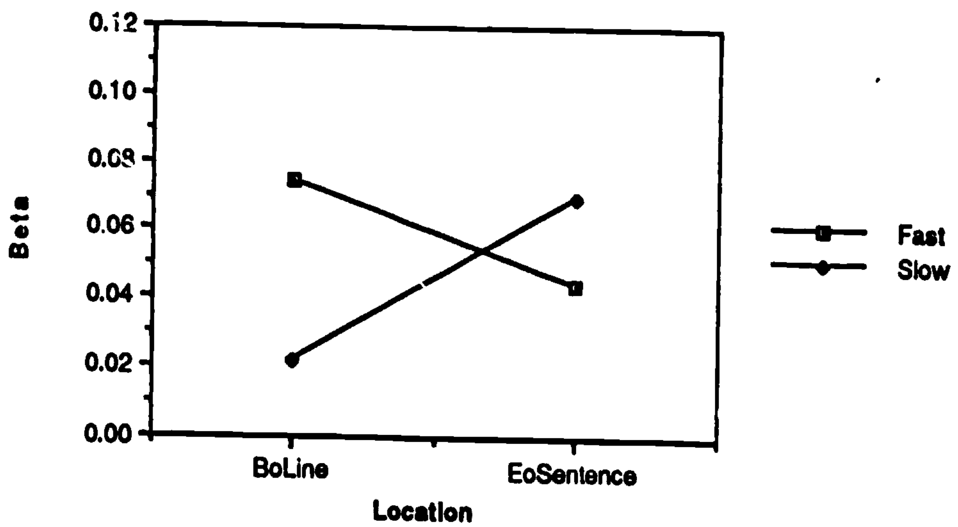
Experiment 1



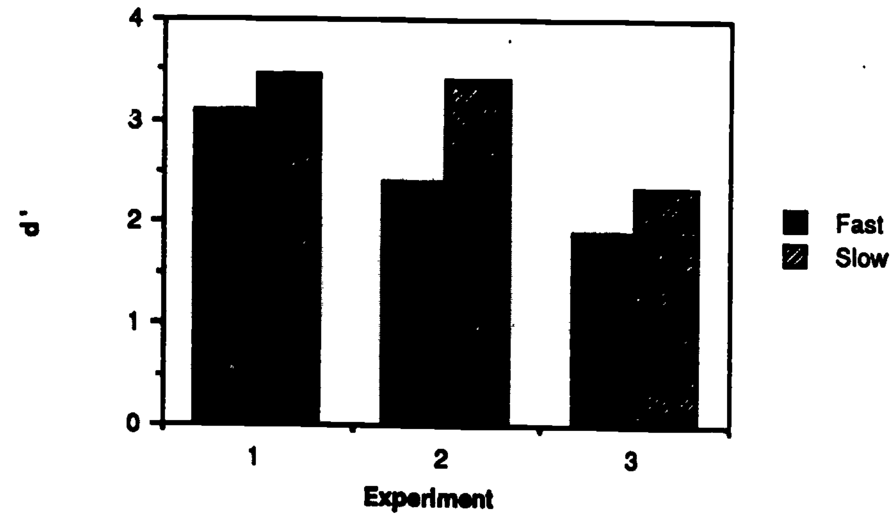
Experiment 2



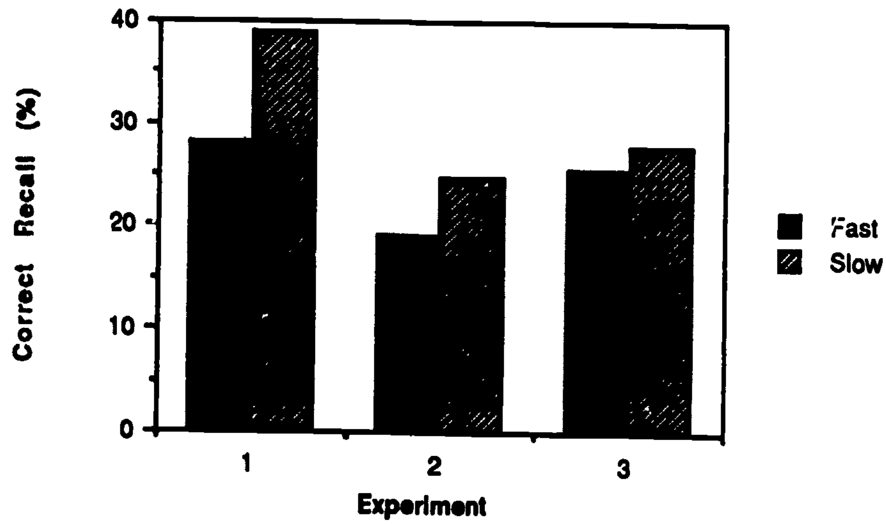
Experiment 3



Comprehension Conditions (d')



Recall Conditions (% correct)



Location of Breaks and Pauses in Texts

Graf & Torrey (1966) passage

"Good" version:
During World War II,
even fantastic schemes
received consideration
if they gave promise
of shortening the conflict.

"Bad" version:
During World War
II, even fantastic
schemes received
consideration if they gave
promise of shortening the
conflict.

Sinclair, Healy, & Bourne (1989)

Meaningful pauses:
Little Thunder
was an Indian boy.
One day
he saw a woodpecker ...

Arbirtray pauses:
Little Thunder was an
Indian boy. One
day he
saw a woodpecker on ...