The Psychology of Reading and Language Comprehension

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Speed Reading

One type of skilled reading that has drawn the interest of educators, professionals, and students is speed reading, a form of rapid reading that is reputed to increase reading speed by a factor of three to ten without much, if any, loss in comprehension. Speed reading came to public attention when it was rumored that President Kennedy read through many newspapers each day at a very fast pace; he credited Evelyn Wood, an early proponent of speed reading, for her method of instruction. And Senator William Proxmire has argued that speed reading is an important resource in America's accomplishment of its national and international goals. In addition, countless numbers of conscientious people in the academic and business worlds have received speed-reading instruction. Since speed reading has such widespread appeal and potential pedagogical importance, it is useful to examine objectively the psychological processes that differentiate speed reading from nor- mal reading, as well as the degree to which it lives up to its reputation.

Overview In this chapter, we will begin with a brief review of some of the existing research on the eye fixations and comprehension levels attained by speed readers in a section called **The Processes in Speed Reading**. The central point of this discussion is that readers can increase their reading speed by sacrificing the amount they understand from a text; faster speed usually implies lessened comprehension, a trade-off. Consequently, the evaluation of speed reading requires assessing just how much information the speed reader misses.

In the main part of the chapter, we will present a detailed report of an experimental investigation of speed reading, done in our laboratory in collaboration with Michael Masson (Just, Carpenter, & Masson, 1982); this section is called **A Study of the Eye Fixations and Comprehension of Speed Readers**. The experiments assessed how speed readers scan a text and what they understand about that text. The speed readers are compared to normal readers and to students who skim the text. The study argues that the speed readers' advantage comes not from better perceptual processes but from better conceptual-level processes.

Finally, in the third section we will describe another technique for rapid reading, **RSVP Reading-Rapid Serial Visual Presentation**. As the name suggests, the words of a text are presented at a rapid rate. We will compare this technique to speed reading, pointing out the primary differences.

The Processes in Speed Reading

To understand speed reading, we need to know about the processes that occur during speed reading and about the resulting information that the speed reader acquires. As in the study of other types of reading, eye-fixation studies are likely to be particularly informative about the processes in speed reading. Unfortunately, only a few scientific reports describe eye fixations during rapid reading, and these re- ports usually lack an accompanying test of the speed readers' comprehension, so we do not know what has been comprehended. Finally, these studies have focused on very high reading rates, 2,000 to 10,000 words per minute (wpm), which are too far beyond the rate of normal reading to be of general interest.

Three studies are fairly typical. McLaughlin (1969) described a self-taught speed reader, reading at 3,500 wpm, who generally read a page of 260 words in 14 fixations distributed "in a rough zig-zag down the page," sometimes moving "back up the page to make a flattened loop" (p. 502). Most of this reader's fixations were about 250 milliseconds long.

Thomas (1962) described a speed reader with a reading rate of 10,000 wpm, who made an average of six fixations per page, scanning vertically downwards on the left-hand page and upwards on the right. The reader made no fixations on the bottom third of a page and had a mean fixation duration of 320 milliseconds. These studies had no formal measure of comprehension, so it is unclear what information the reader obtained from these fixations.

Finally, Taylor (1962) studied a group of 41 graduates from a speed-reading course who had an average rate of about 2,200 wpm. These readers entirely skipped some lines of print and made more than one fixation on other lines, producing an average of one fixation per line. The finding common to all three of these studies is that rapid readers skipped large portions of the text and their eye fixations generally traced a path that is very unlike the left-to-right path of normal readers.

The Comprehension Level of Speed Readers

When someone asks, Do speed readers lose anything by reading rapidly? they are implicitly comparing the possible loss of comprehension of speed readers to the comprehension level of readers who have read the text at a normal rate. However, in a situation in which an already skilled reader like a college student is reading a text that imparts a fair amount of new information (like the first reading of a text- book chapter in an academic course), one would naturally expect some decrement in comprehension performance with increased speed, as occurs in most complex cognitive tasks. The general term for the relation between speed and accuracy is

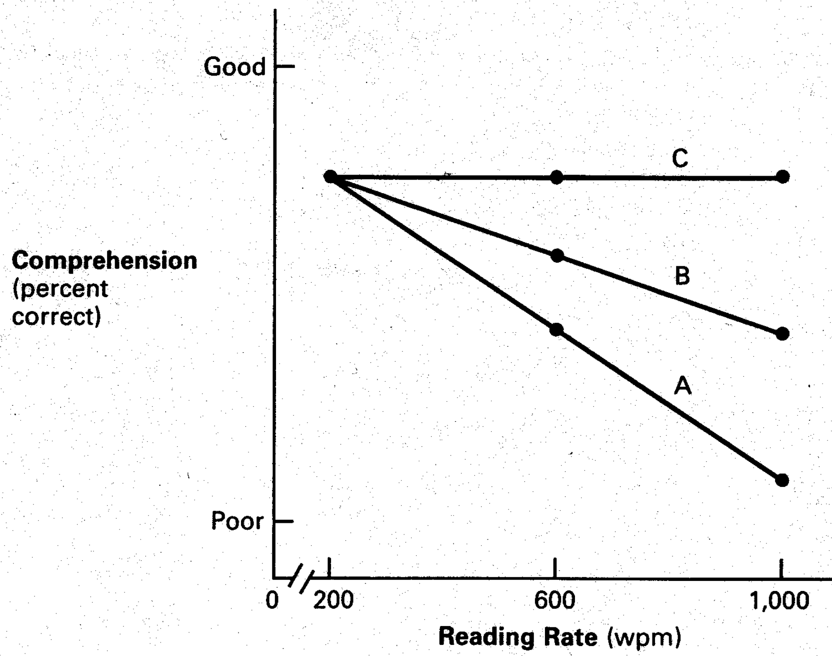


Figure 14.1 Three hypothetical curves showing how comprehension might be related to the speed of reading. In Curves A and B, comprehension level decreases with increases in reading rate, but at different rates. In Curve C, comprehension is consistently high, even if the reading rate is high; this is an unlikely relation, but some speed-reading courses claim that comprehension will not suffer at high reading rates.

trade-off, because people can trade away accuracy for more speed and vice versa, not only in reading, but in many other cognitive tasks. Figure 14.1 depicts some hypothetical curves relating reading speed to comprehension accuracy. Curve A depicts a typical speed-accuracy function for normal, untrained readers reading at both conventional speeds and high speeds, indicating the decrease in comprehension level as the reading speed increases (e.g., Juola, Ward, & McNamara, 1982). For convenience and simplicity, we will be primarily concerned with the middle range of the speed-accuracy function, as depicted,. in Figure 14.1, where comprehension is neither at the ceiling nor the floor levels, and the function is approximately linear.

The effects of training in speed reading can be assessed in terms of possible changes in speed-accuracy functions. The first possibility, a remote one, is that training in speed reading might allow a person to increase his reading speed with- out producing any decrease in comprehension. In that case, his speed-accuracy function would change from 'Curve A (before the training) to Curve C (after the training). Having a curve like C seems implausible, except under unusual circumstances, such as reading texts that contain little or no new information. A second, much more likely possibility is that speed reading produces a lower comprehension level than reading at conventional speeds; that is, the speed readers' speed-accuracy curves probably slope downward.

But it is important to ask how the comprehension of speed readers compares to that of the untrained rapid readers represented by Curve A. To put this question in terms of a trade-off, we can ask whether speed readers are able to increase their speed while making a smaller sacrifice of accuracy than untrained readers would have to make. In this case, the speed-accuracy function would change from Curve A (before the training) to Curve B (after the training). In the third and worst possible case, the training in speed reading would have no effect at all on a reader's speed- accuracy curve.

What Speed Readers Understand from a Text

Although the goal of speed reading is to gain information, curiously, researchers often overlook this purpose. Many studies of speed readers don't check what the speed reader learned, while others use poorly constructed tests, and still others fail to evaluate the speed readers' performance in comparison to the performance of an appropriate control group. For example, some studies use extremely easy tests to assess comprehension after speed reading. The problem is that the tests-usually multiple choice-were so easy that they yielded relatively high comprehension scores for subjects who never read the passages (Rauch, 197 1). For example, Liddle (1965) showed that speed readers could read at three times the rate of normal readers and still obtain a comprehension score of 68 percent. However, Carver (I 97 1) proceeded to demonstrate that comparable subjects who had never read the material scored 57 percent on the same test. Many existing studies do not systematically check what new information the speed readers learned.

Besides obtaining an overall estimate of how well a speed reader comprehends a text, more precise questions can be posed about the kind of comprehension produced by speed reading. In particular, one can ask whether certain types of in- formation within a text are more amenable to speed reading than others; similarly, one can ask whether certain types of texts are more amenable than others. An early study (Dearborn, 1906) reported the case of a

Harvard professor whose rapid reading skills produced rather poor comprehension of information that would be considered details but satisfactory comprehension of the main ideas or the gist of the passage. Similar findings have been reported from more recent studies of speed readers (Hansen, 1975). When normal readers and speed readers were given the same amount of time to read a passage, the speed readers naturally covered more of the material, and their recall indicated comprehension of the gist of the passage. The speed readers recalled more idea clusters than normal readers but recalled less detail about each idea.

Sometimes understanding the gist may be entirely sufficient for performing well in a task, in which case speed readers should have no disadvantage compared to normal readers. For example, one study required subjects to read a chapter of a social psychology textbook and then produce a written outline of the chapter (Barrus, Brown, & Inouye, 1978). Writing a satisfactory outline requires knowledge of the main points and their organization, but it does not require knowledge of details or subtleties. The study found that even though the speed readers (particularly proficient ones, in this case) read at a rate five and one-half times faster than the normal readers (1,800 wpm versus 320 wpm), they produced outlines that were judged to be as good as those of the normal readers.

It is likely that speed readers aim for a different type of comprehension than normal readers, a type that does not attend to details or to local coherence between ideas. In fact, if the local coherence is absent, speed readers do not even take notice. This was demonstrated quite dramatically when the graduates of a speed- reading course were asked to speed read a text in which, unbeknownst to them, every alternate line had come from one of two unrelated source passages (Ehrlich, 1963). They read the material three times, for an overall speed of 1,700 wpm, and reported that they had understood it to their satisfaction. They failed to notice that the material consisted of two unrelated texts. Ehrlich's study illustrates that speed readers have a different criterion for having understood a text, suggesting that their reading goals are different than those of normal readers.

It is plausible that speed reading is effective only if the reader has adequate background knowledge of the topic (Stevens & Oren, 1963). In that case, the reader has a pre-existing schema for the content and could proceed to fill in schema slots with information obtained from the text. Moreover, the reader might be familiar not only with the general content area but also with some of the specific content of the text. In studies of normal readers who have not had training, it is certainly the case that familiarity with a topic improves reading efficiency for topic-relevant texts (Dixon, 1951). Also, preliminary skimming of a passage to provide familiarity with the text structure and content produces faster reading of that passage without loss in comprehension (McClusky, 1934). If these results with normal readers generalize, one might expect topic familiarity to be an equally important determinant of the performance of speed readers. However, it has also been suggested that the special skills acquired in speed-reading courses can be effectively applied to texts on less familiar topics (McLaughlin, 1969; Wood, 1960). No substantial evidence has been provided for either viewpoint.

A Study of the Eye Fixations and Comprehension of Speed Readers

People often ask, Does speed reading really work? As we pointed out earlier, the answer depends upon what is meant by work. The following study found that the comprehension level of speed readers is below that of normal readers, yet for particular kinds of information, speed readers do better than untrained readers who are reading at the same rapid rate (Just, Carpenter, & Masson, 1982). Beyond these comprehension comparisons, a major goal of the study was to analyze the eye fixations of rapid readers and compare their pattern to those of normal readers.

The 11 speed readers who participated in the study had just graduated from a well-known commerical speed-reading course. Their eye fixations and comprehension levels were compared to 25 untrained readers from the same college population. Half of the untrained readers were asked to read normally (the normal group); the other half were asked to read quickly, using whatever strategies they felt comfortable with. These untrained readers will be referred to as **skimmers**, while the skimmers and speed readers will be collectively referred to with the general term **rapid readers**, to distinguish them from the **normal readers**.

In addition to this comparison of different groups, three of the speed readers were studied longitudinally, before and after they took the course. Before the course, they were comparable to the untrained normal readers when they were reading normally and comparable to the untrained skimmers when they were reading rapidly.

Training in Speed Reading

The speed reading instruction was given by Evelyn Wood Reading Dynamics, a large instructional corporation. The instruction focused on two aspects of reading: (1) making fewer fixations and (2) using previous knowledge to organize the information that is read. Both aspects were stressed during approximately fifty hours of practice at rapid reading. The training was distributed over seven weeks, with at least one hour of structured homework per day for six days a week, as well as a total of 17 hours of class time that included a fair amount of reading drill. Readers were given drills in which they read passages while being timed, and they were given progressively less and less time. In addition, their comprehension was some- times tested to determine if they were learning the content of the text.

The hand as a pacer To drive the reading to higher speeds, the readers were taught to use their hand as a pacer, moving it across the text at increasingly rapid speeds as training progressed. Several specific types of hand movements were taught and practiced. The most conventional was one in which the hand moved rapidly from left to right under each line of print, as if underlining it. This was also the only movement that was subsequently used by subjects in the experiment, who were permitted to choose their hand motions. The course included other hand motions that were less conventional because they did not maintain the left-to-right sequence of information inherent in the way a page is printed. For example, one motion zigzagged back and forth on successive lines: left-to-right on one line, right- to-left on the next, and so on. A third technique made something of an X across two pages, going from the upper left to the lower right and then from the upper right to the lower left. With these techniques, the speed reader would sometimes take in words and phrases in an order that not only violated English syntax but was out of order in terms of the story's structure.

The instructor and the students were under the impression that the main purpose of the hand motions was to guide the eye to fixation locations. However, informal observation of the relation between the hand motions and the eye motions of the speed readers in the experiment revealed a different but still interesting relation. The hand motion of the speed reader seemed to act more like a metronome than a pointer. The hand and eye beat out similar rhythms, in terms of the amount of time devoted to each line of print, but there was no close relation between the location of the hand and the eyes' point of regard within a line of print. The hand motion seemed to serve a temporal pacesetter function rather than a locative function. This observation is informal because there was no way of automatically recording the hand motions in conjunction with the eye fixations.

The advantage of using the hand as a pacer rather than directly trying to pace the eyes is that people have experience at making their hands move rhythmically, but they seldom try to control the rate or rhythm of their eye movements.

Study skills A second focus of the course was similar to that of other study-skills courses, as discussed in Chapter 13 on learning from text. The speed-reading course stressed the importance of using previous knowledge before, during, and after the high-speed reading. Before reading a text, readers were told to think explicitly about the text's organization and its likely content. For example, most college readers know how newspaper articles are organized; in other words, they have a text schema. The course stressed the use of text schemata (although they were not called by this name), explicitly teaching how to associate slot fillers with particular locations and cues in the text. The course dealt with the structure of different kinds of texts, such as textbooks, newspaper articles, and stories.

A similar approach stressed the importance of thinking about the likely con- tent of the text. For example, even nonspecialists in an area like biology have some knowledge that can be recruited before reading an article in biology. Actively recruiting previous knowledge of structure and content was to be supplemented by *prereading*-skimming the table of contents, titles, headings, illustrations, and so on for indications about the organization and content of the text.

All of this knowledge was to be applied to the information obtained during the rapid reading itself. Moreover, the knowledge was to be used again immediately after the reading to recall the information from the text. The recall often took the form of structured outlines or diagrams that organized the major points and their interrelations. The process of recalling the text provided a chance to rehearse and organize the information. While some of the specific techniques differ, this aspect of speed-reading training is very similar to the prereading and postreading parts of the Dansereau study-skills course and the various SQ3R courses described in Chapter 13.

The training sometimes included rereading the same passages at high speeds, such that the sample of words that was fixated during the speed reading could be processed in terms of what the reader had previously learned about that very passage. This gave the readers practice in making sense of a text on the basis of a combination of what they already know about the topic (from their previous reading of that passage) and a sample of the words from the text. Gradually, the students learned to read rapidly, without having read the text previously, by using alternative sources of knowledge, such as their general knowledge of the world.

A minor focus of the course was on test-taking skills, such as how to take true-false and multiple-choice tests and how to write answers to various types of essay questions. Many of these skills are already part of the repertoire of test-wise college students, and they are also often taught in courses on general study skills.

Experimental Procedure

The subjects read two kinds of texts-(1) relatively easy texts that had been excerpted from *Reader's Digest* and concerned generally familiar topics and (2) texts that had been excerpted from *Scientific American* and were on more technical and less familiar topics. All of the texts were long, 1,500-2,000 words, to allow speed readers to attain their full speed. The analyses of Comprehension and eye fixations focused on two passages: one from *Reader's Digest* and one from *Scientific American*. The *Reader's Digest* passage was a 2,004-word story that described the expeditions of John Colter, an early nineteenth-century explorer who traveled through the American West; it will be referred to as the **Colter** passage. The *Scientific American* passage was a 1,527-word excerpt describing what various space- exploration projects had revealed about the geological properties of the surface of Mars in relation to scientific theories about the planet's evolution; this text will be referred to as the **Mars** passage. Some of the passages were also used in the re- search on dyslexia, described in Chapter 12.

To assess the speed readers' ability to comprehend gist and details, 20 short-answer test questions were developed for each passage. Half probed for high-level information, corresponding to gist, and half probed for details. A sample question from the *Colter* passage is:

> *How did Colter hide from the Blackfeet who were chasing him?*

This refers to an entire episode in which Colter was concealed under some drift- wood in a river. An example of a detail question from the same story is:

> *How far behind Colter was the nearest brave when Colter first noticed him?*

This refers to a single, briefly mentioned fact. The questions were such that readers could not have responded correctly without having read at least some of the text. Two points were awarded for a completely correct answer, one, for a partially correct answer, and zero, for an incorrect answer.

Before reading each passage, all the subjects were given a one-sentence abstract of the passage, which was to provide a bit of prereading knowledge of the kind that the speed readers had been accustomed to acquiring by glancing at a text before speed reading it. For instance, the following abstract was provided for the Colter passage:

> *The following passage is about the adventures of an American frontiersman named John Colter.*

The text was presented on a video monitor, in conventional layout. Each screenful of text contained approximately 140 words. After reading a screen of text, the subject pressed a button and the next screen of text appeared. The reader's eye fixations were monitored remotely. The eye fixations were analyzed by determining the duration of the gaze on each word. After reading a passage, the reader gave an oral summary of about 100 words and then answered the 20 comprehension questions asked by the experimenter.

The speed readers were 11 graduates of the Reading Dynamics speed-reading course. The three speed readers who were studied longitudinally were among these I 1. The skimmers and normal readers were 25 students from the same college population, who were totally untrained in speed reading. The reading rate of the skimmers was determined by first asking them to read rapidly, measuring their rate during the reading of the early practice passages, and asking them to adjust their rate if it was much slower or much faster than the reading rate of the speed readers. This permitted comparison of the scanning patterns and comprehension performance of the two groups of rapid readers, the trained speed readers and the untrained skimmers.

The three speed readers who were studied longitudinally read a total of 18 passages before the course (that is, before they were speed readers) and 14 passages after the course. Some of these passages were for practice, to allow the readers to acclimate themselves to the speed, the type of passage, and the comprehension test. The remaining speed readers, as well as the skimmers and the normal readers, were given a subset of these texts.

Overview of Results

Speed readers covered the material three times faster than normal readers, while the skimmers were two and one-half times faster. The reading rates and frequency of fixations were essentially identical for Cotter and Mars, so we will present the means for both types of materials together. As Figure 14.2 shows, the normal readers read at a rate of about 240 wpm, the speed readers, at about 700 wpm, and the skimmers, at about 600 wpm. While the normal readers comprehended better than the two rapid-reading groups, it is clear that both groups of rapid readers had some understanding of the content. We will discuss the comprehension results in detail in a later section.

A small sample of the eye-fixation protocols (shown in Figure 14.3) on a *Colter* excerpt for a normal reader (the upper part), a speed reader (the middle part), and a skimmer (the lower part) illustrates several points. First, both of the rapid-reading groups fixated many fewer words of text than did the normal readers. Overall, the normal readers fixated 64 percent of the words, the speed readers, 33 percent, and the skimmers, 40 percent. Second, as shown in Figure 14.2, the normal readers spent more time on the words they did fixate than the speed readers and skimmers. The average gaze duration for normal readers was 330 milliseconds, for the speed readers, 233 milliseconds, and for the skimmers, 221 milliseconds. Third, the

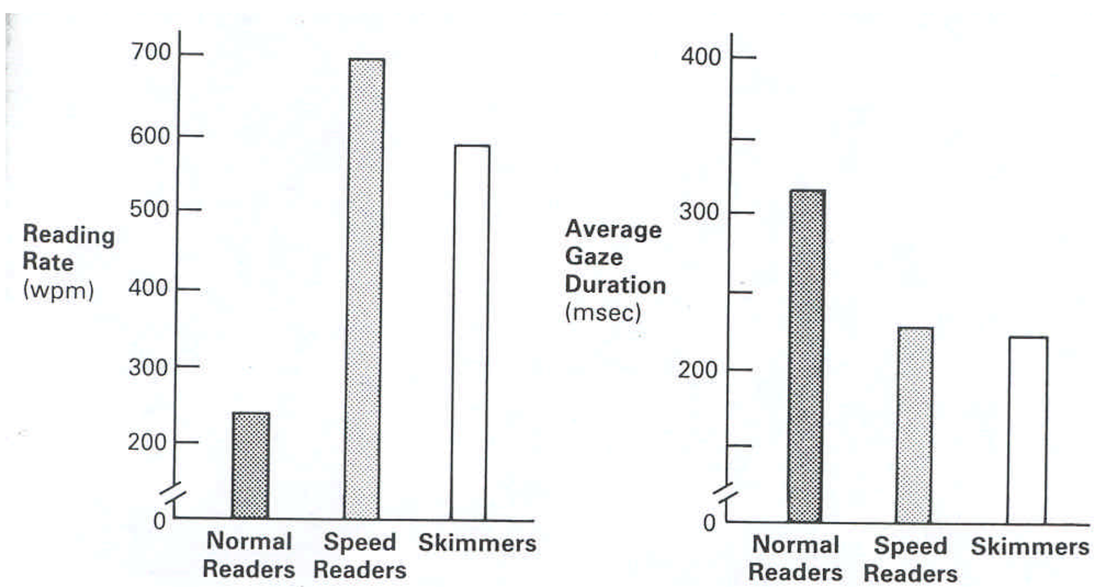


Figure 14.2 The normal readers naturally read more slowly than the speed readers or skimmers, as shown in the left-hand part of the figure. In part, the difference in reading rate occurred because normal readers spent more time on the words that they fixated, as shown in the right-hand part of the figure.

scanning pattern of all three groups of readers was invariably left-to-right and top-to-bottom. These results suggest that rapid readers save time both by looking at fewer words and by spending less time on those words that they do fixate.

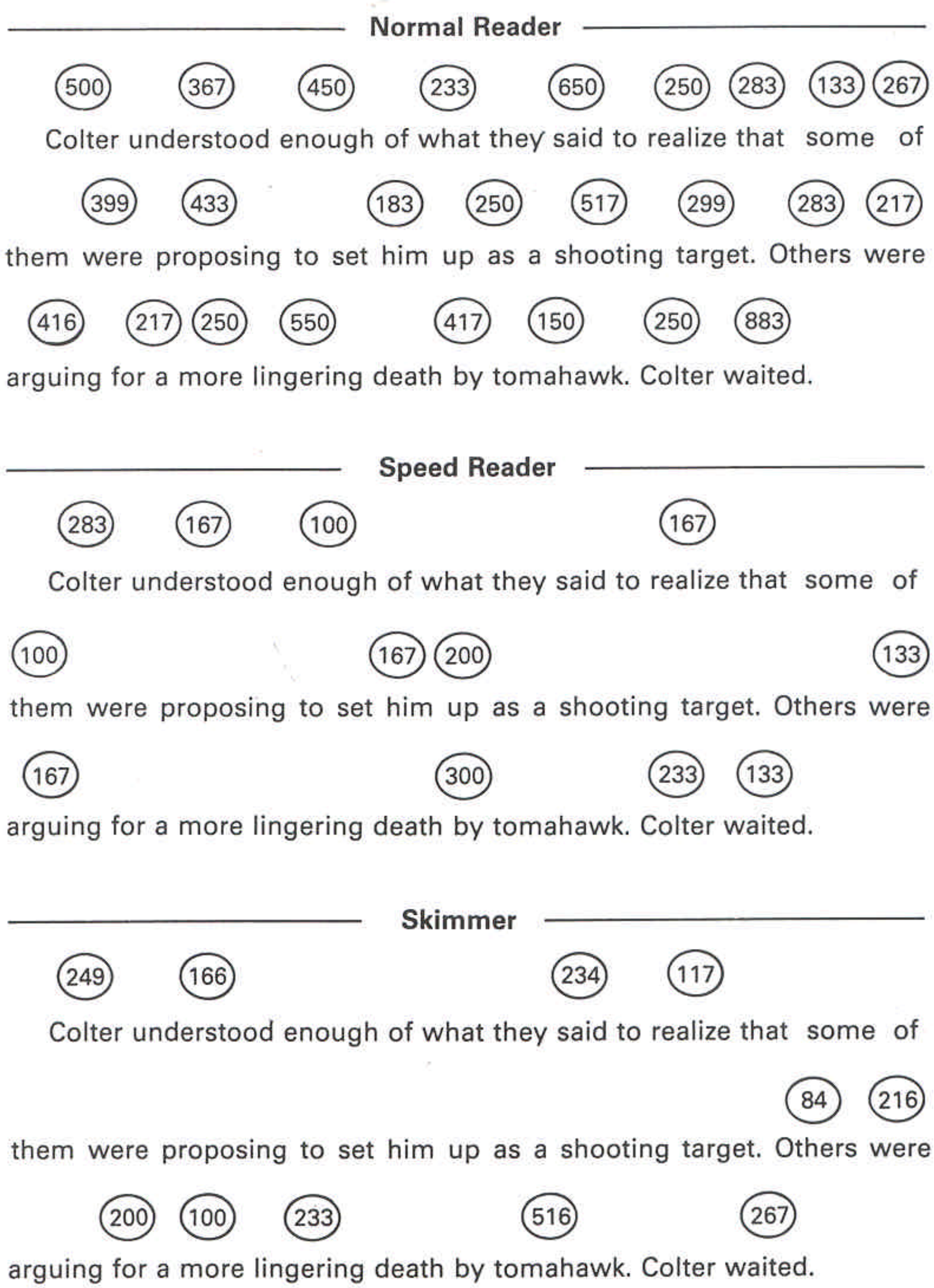


Figure 14.3 The pattern of gazes of a normal reader (top), a speed reader (middle), and a skimmer (bottom). Both the speed reader and the skimmer were much more likely than the normal reader to skip over several words in a row. They also spent less time on the words they fixated than did the normal reader. All the fixations shown in this figure are forward fixations, proceeding from left-to-right.

As the reading rate trebles from normal reading to speed reading, the pattern of eye fixations changes in several ways, as Figure 14.3 illustrates. The analyses below attempt to answer three main questions:

1. How do rapid readers select which words they will fixate?
2. What determines the amount of time readers spend on the fixated words?
3. Do rapid readers process the information from the words that they don't fixate?

Where Do Speed Readers Fixate?

Sampling algorithms At the heart of rapid reading is the question of how speed readers increase their speed. Early studies, along with the one we are discussing, show that rapid readers are fast, in part, because they fixate a smaller proportion of the words than do normal readers.

While the numbers above indicate what proportion of words was fixated, they do not indicate how the fixated words were distributed in the text. For example, did speed readers fixate 33 percent of the words by looking at every third line of print or by looking at every third word in the text? To better understand the sampling pattern that the rapid readers used, we counted the number of times each reader skipped exactly one word, or exactly two words, and so on to determine the frequency of each skipping pattern. For example, if a reader were fixating every third word in the text, then she would always skip exactly two words. If she were reading every third line, she would usually skip about 20 words (about two lines' worth). Thus, the number of successively unfixated words was counted using the same kind of analysis described in Chapter 2 on perceptual processes; the resulting analysis gave the frequency with which readers skipped no words, exactly one word, exactly two, and so on between words that they did directly fixate.

Figure 14.4 shows the results for the three groups of readers. The result for the normal readers for these long passages was similar to the previously reported result for a different group of normal readers described in Chapter 2. When normal readers moved their eyes forward in the text from one word to some other word, most of the time (89 percent), they fixated the next word or skipped over only one word. In the *Colter* passage, for every 100 words of text, on average, the readers fixated adjacent words in 36 cases and skipped only one word between consecutively fixated words in 20 cases, skipped two words in 6 cases, 3 words in 1 case, and almost never skipped more than three words. Readers tended to have similar patterns of runs of unfixated words for the *Colter* passage and the *Mars* passage, as shown in the two parts of Figure 14.4. The similarity in the distribution reflects the fact that normal readers read these passages at very similar rates.

In contrast to normal readers, both speed readers and skimmers were less likely to fixate adjacent words and more likely to skip several words between consecutive fixations. Figure 14.4 indicates that for every 100 words of text, speed readers fixated adjacent words in only 10 cases and skimmers, in about 15 cases. By contrast, both rapid-reading groups were much more likely to skip several successive words, including four or more words.

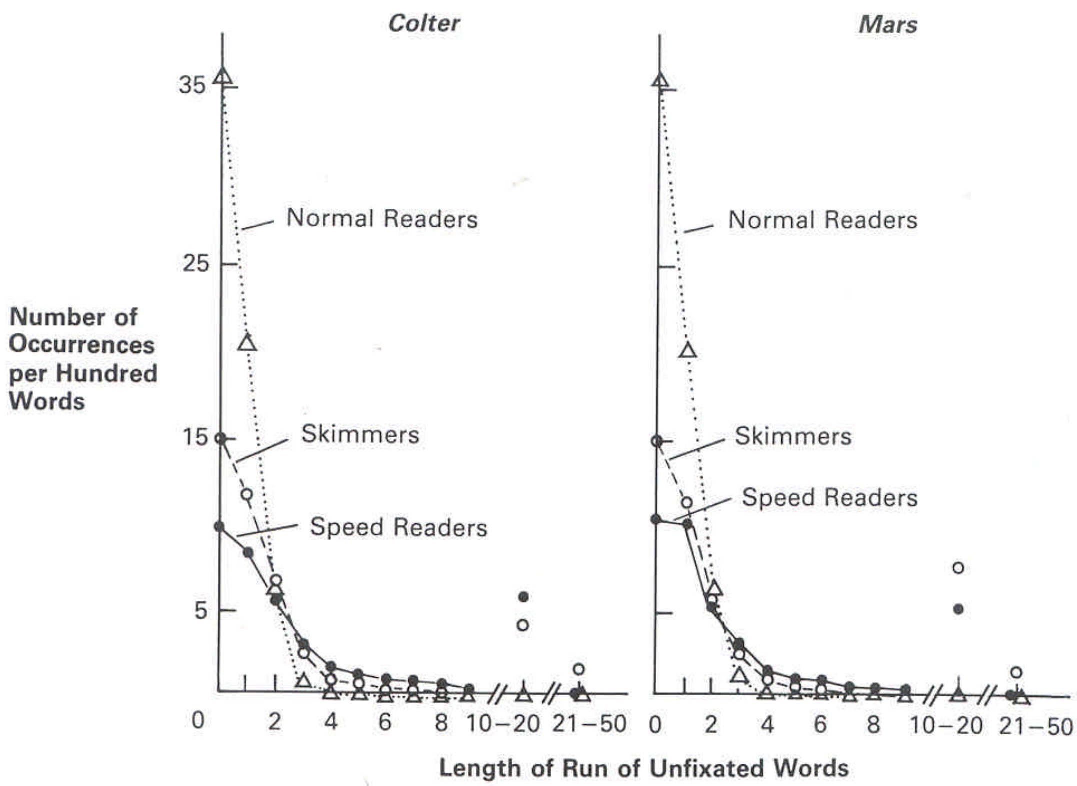


Figure 14.4 These curves show the proportion of times readers fixated adjacent words, or skipped over exactly one word between successively fixated words, or skipped over two words, and so on. Both the speed readers and skimmers were much more likely to skip over several successive words than the normal readers. The patterns are very similar for the *Colter* passage and the *Mars* passage.

Eye-fixation differences between speed readers and skimmers The major difference in the scanning patterns of the speed readers and the skimmers was that the speed readers sampled the text somewhat more uniformly than the skimmers. Analysis of the lengths of unfixated runs showed that skimmers sometimes skipped over large portions of text (more than 20 words) while sampling other portions more densely.

Another measure that reflected the greater variability in the skimmers' sampling scheme was the variance in the proportion of words fixated in each sentence. The normal readers had the lowest variance in this measure (because they always fixated a high proportion of words in a sentence); the speed readers were intermediate; and the skimmers had significantly higher variance than the speed readers for both passages. Thus, both speed readers and skimmers skipped more words than normal readers, but the sampling scheme was somewhat more uniform for the speed readers.

It is tempting to speculate that speed readers learn to target their fixations on the most important words of a text. However, the eye-fixation data disconfirmed this speculation. To quantify the relation between a word's importance and its probability of being fixated, an independent group of subjects rated the importance of each of the 1,318 content words in the *Colter* passage (on a four-point scale). Then the correlation between the importance rating of a word and the proportion of readers in the group who fixated it was computed. This correlation was low for both skimmers and speed readers, but the speed readers' correlation was slightly lower than the skimmers', indicating no special eye-fixation targeting skill on the part of the speed readers.

Fixations on content versus function words Normal readers fixated 77 percent of the **content words** (such as nouns, verbs, and adjectives) and about half as many **function words** (such as prepositions, conjunctions, and determiners). The higher frequency of fixation on content words is not simply due to the content words' tendency to be longer. Figure 14.5 shows that normal readers fixated three- letter content words like *ice, ran*) significantly more often than three-letter function words like *and*, *the*). If the reader fixates close to a short, frequent, and predictable word, such as these function words, he may on some occasions acquire information from that word without fixating it.

Speed readers and skimmers also fixated content words more often than function words, as shown in the left-hand part of Figure 14.5. However, the rapid readers' pattern can be explained by a tendency to fixate longer words. When only three-letter words were analyzed (as shown in the right-hand part of Figure 14.5), speed readers and skimmers did not fixate content words significantly more often than function words. Two related explanations can be offered for the rapid readers'

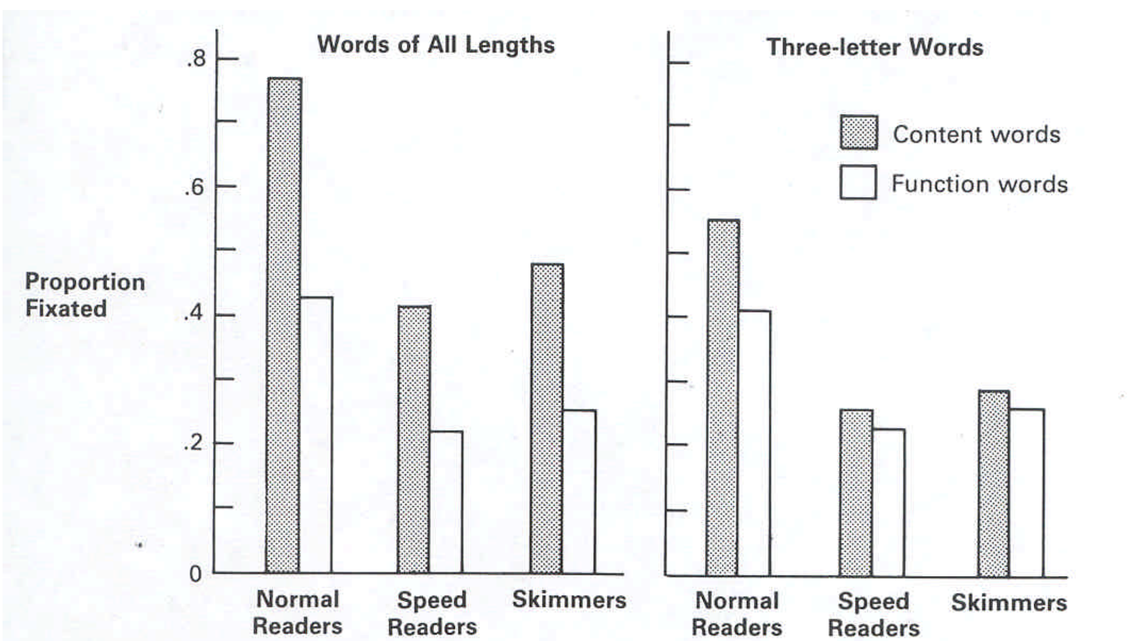


Figure 14.5 All three groups of readers were more likely to fixate content words (such as nouns and verbs) than function words (such as articles and prepositions), as shown in the left- hand part of the figure. However, as the right-hand part of the figure shows, only normal readers were more likely to fixate three-letter content words than three-letter function words.

lack of selectivity between content and function words, both of which are based on the fact that they are skipping so many of the words. First, skipping over words implies that the next word to be fixated is far away from the current point of regard. Since acuity drops off rapidly with distance from the fovea, the peripheral information from nonadjacent words is probably too degraded to permit a rapid discrimination between content and function words. The related explanation for the lack of selectivity is that the rapid readers' knowledge of only 33 percent of the words is too little to take advantage of syntactic dependencies among words. Although syntactic information can sometimes help predict something about the next word in a text when all the preceding words are known, it is almost impossible to predict any- thing about the third word from the current word, particularly if the reader only knows the current word and the word that occurred three words before. Thus, rapid readers have much less peripheral information and syntactic information than normal readers to help them decide which words to fixate.

Span of semantic processing The span of semantic processing, the area of a page from which a reader encodes words while fixating on one given word, is fairly small. In Chapter 2, we argued that in normal reading, the reader encodes and accesses the meaning of only the directly fixated word and sometimes a few letters to the right. The few letters of a word to the right may be sufficient to recognize a short, frequent, linguistically constrained word, often a function word like *the, and, of,* or *an*. We also argued that the constraints on the span are both perceptual (namely, limitations of visual acuity) and conceptual, due to the large attentional demands of processing a text.

The perceptual and conceptual limitations on the size of the semantic span may be different in speed reading. Bold statements have been made about the spans of rapid readers, but no supporting data have been provided. Some claim that speed readers can apprehend many words on each fixation (McLaughlin, 1969), while others claim that speed readers can apprehend only one or two words (Taylor, 1962). No one has actually measured the span of rapid readers, but various sources of evidence suggest that the span is unlikely to be a major locus of difference between speed readers and normal readers. A study of fast readers who had developed their skill without formal training found that their span did not differ from that of slow readers, although faster readers did better at encoding the information that was presented (Jackson & McClelland, 1975). Another kind of negative evidence comes from studies that attempt to train readers to increase their spans; the attempts generally have not been successful and the comprehension assess- merits have been equivocal (see Brim, 1968; Sailor & Ball, 1975). The speed-reading study described in this chapter makes it possible to evaluate the question empirically: Do speed readers develop a larger span that permits them to encode more words while fixating a smaller proportion of them?

To assess the size of the span of the rapid readers, we determined whether they ever learned a fact they did not fixate during their reading of the text. Since the performance of the speed readers and skimmers was indistinguishable in this regard, the two rapid-reading groups were analyzed together. The analysis focused on a particular subset of the comprehension questions, namely, those questions that interrogated a one- or two-word fact that was not common knowledge and could not be inferred from other parts of the text. During their reading of the passage, the rapid readers could have directly looked at the one or two words that contained the answer, or they could have skipped over them. In the 175 cases in which a rapid reader looked directly at the one- or two-word answer or within three character spaces adjacent to it, the correct answer was given about 20 percent of the time. In the 30 cases that a rapid reader did not look at or within three letters of the answer, the correct answer was produced only *once* (the fact was 1976-the year of the Viking Lander touchdown on Mars). This result strongly suggests that the speed readers and the skimmers obtain little, if any, information from the 60 to 67 percent of the-words of a text that they don't fixate. Like normal readers, trained readers and untrained skimmers have a relatively small span over which they process semantic information. Thus, the conjecture that training in speed reading increases the span in reading can be rejected.

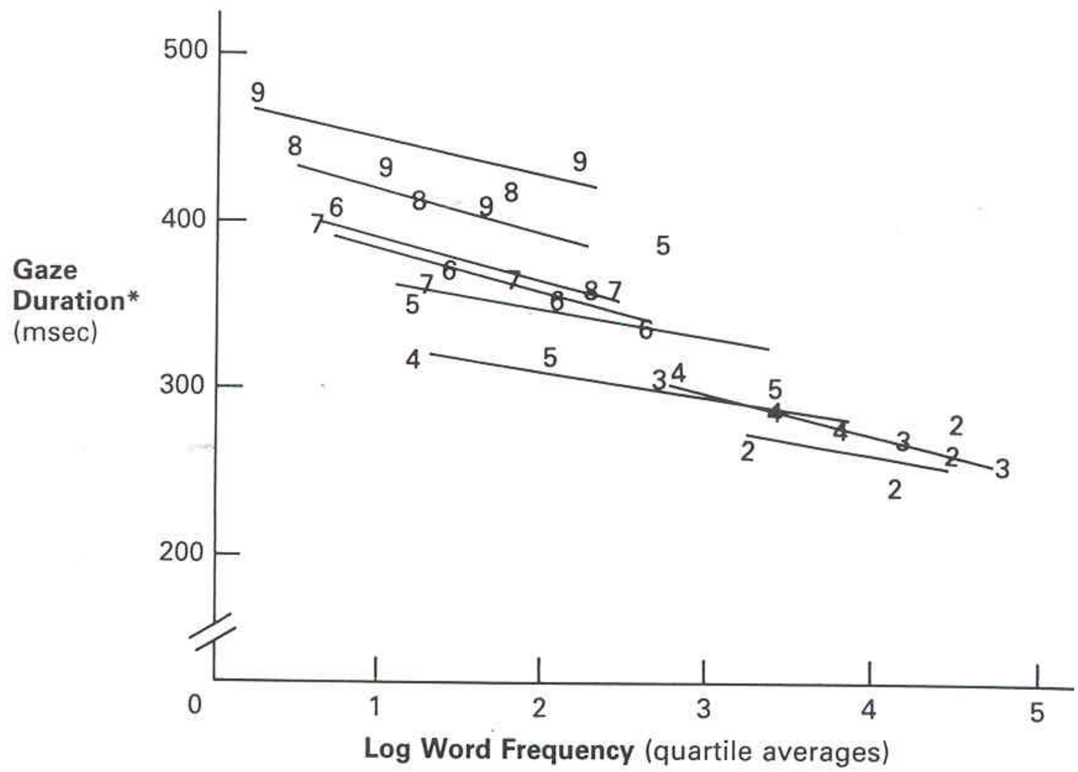
Analyses of Gaze Duration

Not only did the rapid readers fixate fewer words, they spent about one-third less time, about 100 milliseconds less, than normal readers on the words they did fixate. This difference is evident in the mean gaze durations in Figure 14.2. The gaze durations in Figure 14.2 were obtained by averaging the time spent on each word over only those readers who fixated that word. The rapid readers, unlike normal readers, had few very long gazes. Over 15 percent of the gazes of normal readers were greater than 490 milliseconds, but for skimmers and speed readers, only 4 percent and I percent (respectively) of the gazes were that long. In addition, rapid readers had many more short gazes less than 200 milliseconds) than did normal readers.

What determines how long readers spend on the words they fixate? An analysis of gaze durations indicated that rapid readers show many of the effects that normal readers show, but the sizes of the effects are usually much smaller. The presence of word-length and -frequency effects suggest that rapid readers, like normal readers, recognize words immediately as they encounter them, rather than use a wait-and-see strategy. Rapid readers' extra long pauses on novel words also provide evidence of immediacy.

Word-length and word-frequency effects The gaze durations of all three groups of readers were influenced by the word's length and frequency. Figure 14.6 shows the length and frequency effects for the normal readers for the *Scientific American* passage. The graph is reminiscent of the one presented in Chapter 3 on lexical access, which was based on the reading of short technical passages. The x- axis represents the logarithm (base 10) of the word's frequency. The four points for each word length were obtained by dividing the words of that length into quartiles on the basis.of frequency and then plotting the mean duration for each quartile against the mean frequency of the quartile (except for three-letter words, in which the word *the* constituted a tertile). Each line is the best-fit straight line for words of a particular length, from two to nine characters. The results here are very similar to those obtained in the reading of much shorter technical passages (Carpenter & Just, 1983; Just & Carpenter, 1980), indicating the reliability of the word-length and word-frequency effects on gaze durations.

Similar results were obtained for the *Reader's Digest* passage, with one interesting deviation; the duration on very infrequent six-letter words was exceptionally



*Gaze duration averaged over fixated words only

Figure 14.6 Normal readers spent more time on longer words and on less frequent words. Less frequent words are those with a smaller log frequency. The eight lines correspond to different word lengths, from two letters to nine letters. Word frequency has a similar effect on words of each length, as the downward slope of all the lines indicates. These results are for the normal readers who were reading the *Mars* passage.

short. It turned out that the infrequent six4etter word was *Colter*, because readers encountered this topic word so often, they were able to recognize it unusually quickly.

How the READER Model Would Speed Read

The differences between the speed readers' and the normal readers' performance can easily be explained in terms of the mechanisms in READER. The patterns of re- sults indicate fairly precisely which mechanisms change and in what ways. The first, most obvious change that would have to be made to READER is that it would have to sample every third word in the text and skip over the intervening two words.

A second important change in READER is indicated by a prominent clue in the data, namely, that the sizes of the word-length and word-frequency effects on gaze duration are smaller in speed reading. Although word length and word frequency reliably affected the gaze durations of all three groups of readers, the effects were considerably smaller in the case of the speed readers (as well as the skimmers). For example, although all three groups spent more time on longer words, the speed readers spent about 10 milliseconds less than the normal readers per each additional letter in the word. This result suggests that although the speed readers use the same mechanisms of word encoding and lexical access as normal readers, the time course of the growth of knowledge is different.

The READER model can account for the smaller effects of word length and word frequency in terms of increased activation weights for all the productions, using the REWEIGHT production to change them. Recall from Chapter 9 that activation weights are the fractional multipliers of the source proposition's activation level. Raising the activation weights would permit a production to increase a proposition's activation level at a faster rate, thus bringing it to threshold in fewer cycles. Moreover, as suggested in Chapter 9, faster reading may entail a relative decrease in the influence of the consistency-checking productions, which would be effected by a relatively smaller increment in their activation weights. Not checking for syntactic or semantic consistency makes a great deal of sense in speed reading when only one out of three words is being read.

The effect of larger activation weights on the lexical access mechanism would be that the activation level of a word meaning would reach threshold sooner (that is, after fewer cycles), while retaining the logarithmic relation to frequency. This is precisely the pattern obtained in the human data. Also, the decrease in the influence of the consistency-checking productions and the drastic reduction in the knowledge of preceding context (because only one-third as many of the preceding words would have been fixated) would make it more likely that a word would be given an incorrect interpretation. The speed readers' greater likelihood of selecting the wrong sense of a word could account in part for their poorer comprehension performance.

Similarly, if the word-encoding productions had higher activation weights, this might allow a word-percept to reach threshold when only some proportion of the letters of a word (say, 75 percent) had been encoded. This would diminish the size of the word-length effect correspondingly, as the data indicate.

A third modification to the READER model to simulate the speed readers is the imposition of a deadline-an upper limit on the number of cycles that could be spent on any fixated word, regardless of whether the processing had been completed. A time limit on each fixated word would explain why the speed readers never produced the extremely long gaze durations on difficult words commonly found among the normal readers.

These three changes to READER would have several side effects, which would be consistent with the results of the human speed readers. The low sampling density (one out of three words) would provide READER with much less information, and as a result, the representation of the text would be far less complete at all levels than in normal reading. In particular, the syntactic analysis would have a much diminished influence on choosing an interpretation because the sparse sampling of the text would provide impoverished syntactic information. Also, the lower amount of information would lead to errors of commission based on incorrect inferences and incorrect interpretations of individual words. Finally, READER's previous knowledge of the text content would have an increased influence on making an interpretation.

Thus, all the differences in performance between normal reading and speed reading can easily be accounted for in terms of simple modifications of READER's simulation of normal reading. Moreover, it seems plausible that these modifications correspond to the way that speed readers (and skimmers) change their normal reading processes when they read rapidly. This theoretical account of the differences between normal reading and speed reading illustrates the usefulness of the model in expressing variations in the way people read.

Changes in Reading Speed

All three groups read some parts of the text much faster than other parts. Figure 14.7 shows the reading rates per screen for the three groups. As shown in Figure 14.7, the fluctuations in reading rate across screens of text were large, especially

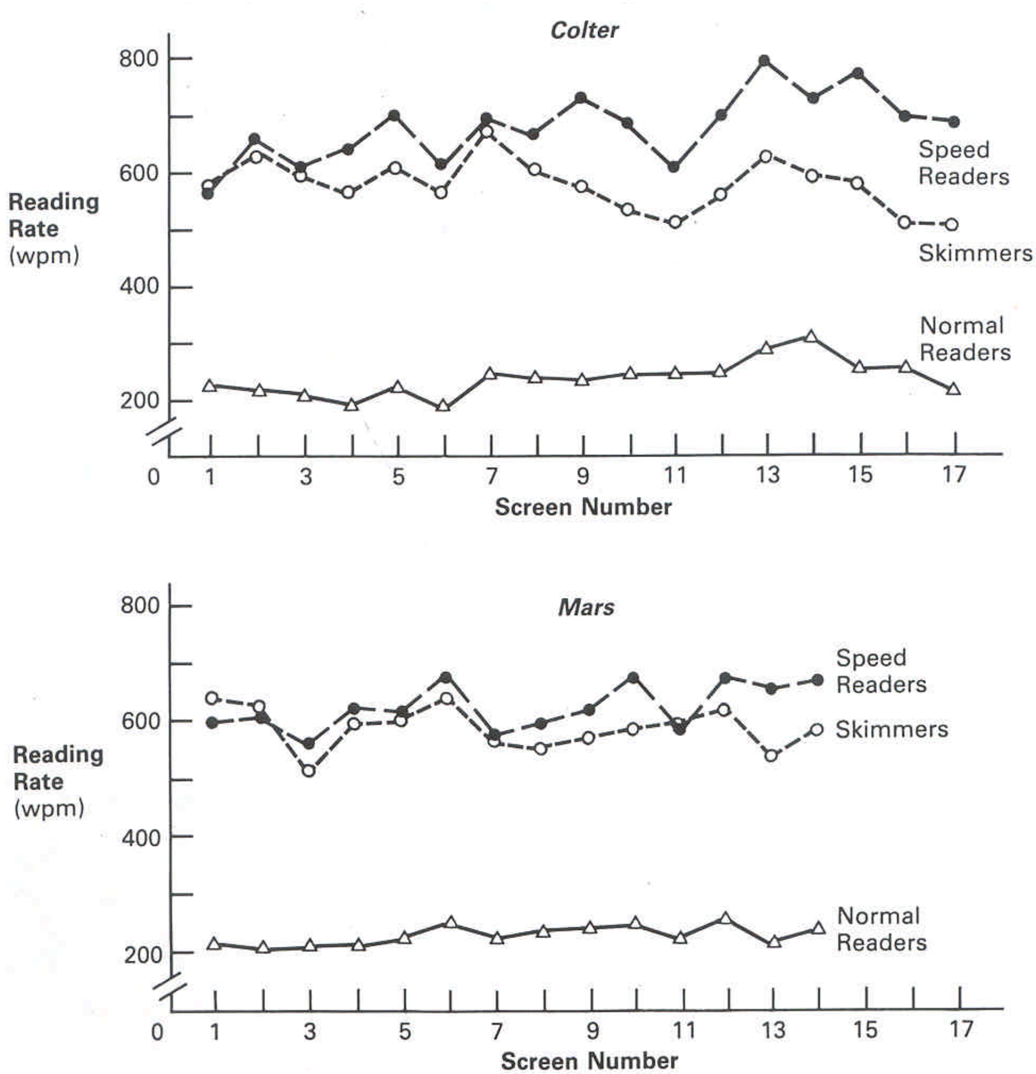


Figure 14.7 All three groups of readers tended to speed up and slow down their reading at similar places in the two passages. These two figures show the reading rates for successive sections of the two articles.

among speed readers, where the rate ranged from 564 to 786 wpm. The fact that the curves for the speed readers and skimmers were generally parallel to each other indicates that the two groups of rapid readers tended to slow down and speed up on the same screens of text. The normal readers did not change their reading rate quite as much, but the graph indicates that what changes they did make tended to follow the same pattern as for the rapid readers.

The rapid readers varied their reading rates across successive screens primarily by varying the proportion of words that they fixated, rather than varying the gaze duration. The reading rate for a screen was very highly correlated with the proportion of words fixated (a correlation of 0.9 for both the speed readers and the skimmers), whereas the reading rate was not as highly correlated with the mean gaze duration (a correlation of 0.6 for speed readers and 0.4 for skimmers). This suggests that rapid readers change their reading rate primarily by varying the proportion of words that they fixate.

What text properties produce modulations of reading rate? To address this question, we can first describe two plausible hypotheses that *did not* account for fluctuation in reading:

1. Readers slow down for certain categories of information, as described by a story-grammar analysis of the text.
2. Readers slow down for the paragraphs that are rated as important by independent judges.

By contrast, a third hypothesis that was supported is that much of the variation in reading rates across the segments of a long passage is due to local variables that are idiosyncratic to the text. If readers happen to encounter an important phrase or difficult construction, they may sample the text more densely in that vicinity. This point is exemplified by a paragraph in the *Colter* passage that was read particularly slowly by the rapid readers, at less than 500 wpm. The paragraph contains a number of features that together make it difficult to read. The critical paragraph is presented below (beginning with "Colter answered ambiguously. . . "), along with the paragraph that preceded it.

> *Finally, the chief came over to him and asked if he was a fast runner. Colter guessed that they were considering letting him run for his life. Some chance, with 500 braves on his tail, and him running naked and barefoot through the cactus-but a chance.*
>
> *Colter answered ambiguously, in his limited Blackfoot.- "The long knife is a poor runner and not swift.*
> [NEW SCREEN]
> *He is considered by the other long knives to be very swift, but he is not "A half-challenge.*

Several features contribute to the difficulty of the short paragraph that begins, "Colter answered ambiguously. . . " First, the paragraph begins with a response to a question, but the question and response are separated from each other by two sentences (containing 32 words) that describe Colter's thoughts. By the time the response is encountered, the representation of the question may no longer be in activated working memory, so it may be difficult to determine what the word *answered* is referring to. Second, Colter's utterance contains stilted phrases, referring to himself in the third person, using common words in unusual ways (e.g., *long knife*). Third, the paragraph ends with a enigmatic nonsentence (A *half-challenge*). Fourth, the utterance is interrupted by a screen boundary, much as a normal text is interrupted by page boundaries, that may have distracted the readers. The conclusion that the modulation of the reading rate over the passage is governed primarily by idiosyncratic properties applies equally to other paragraphs that were read slowly. The idiosyncracy can arise at any level of processing, such as the lexical level or the syntactic level.

The modulation in reading rate can be construed as a general type of context effect, such that a reader who encounters a difficult or important part of the text may sample the subsequent text more densely. This type of modulation can occur in the READER model if the processing of one part of the text can change the activation weights that are used in processing the text that follows.

The Comprehension Results

Normal reading led to much better comprehension than did speed reading or skimming. This was true both for the three readers who were studied before and after the course and for the cross-sectional comparison of the three groups of readers. The comprehension advantage varied across the two types of passages, the two types of questions (probing high-level or low-level information), and the two types of rapid reading; but the advantage of the normal readers was almost always present. The experiment showed that reading at a normal rate produces better comprehension than reading at a rapid rate, even if the readers have had training in speed reading. But it is important to keep in mind that the total reading time is consider- ably longer in the case of normal reading.

Figure 14.8 shows the question-answering accuracy for the normal group and the two rapid-reading groups; the top panels show the performance for the high-level questions and the lower panels, for the low-level questions. Two other comprehension results that were easily predictable are obvious in this figure. First, the readers' comprehension was better on the high-level questions that probed the gist than on the low-level questions that probed for details. Second, the comprehension performance was better on *Reader's Digest* passages than on *Scientific American* passages.

How did the speed readers perform compared to the skimmers, the untrained rapid readers? This comparison, involving the two rightmost columns in the four panels, reveals that the speed readers had an advantage, but only for one kind of information-the high-level, gist information for the easier *Reader's Digest* passage about Colter. The speed readers answered reliably more questions, in spite of an overall reading rate that was about 100 wpm faster than the skimmers. There was no other advantage, however; the speed readers performed similarly to the skimmers on questions about details and on the high-level questions about the technical, *Scientific American* passage about Mars.

A virtually identical pattern was found for the three readers who were studied longitudinally, before and after the speed-reading course. Their rapid reading with- out training before the course (that is, skimming) was compared to their speed reading performance after the course. The only improvements occurred for the high-level questions for the easier, *Reader's Digest* texts.

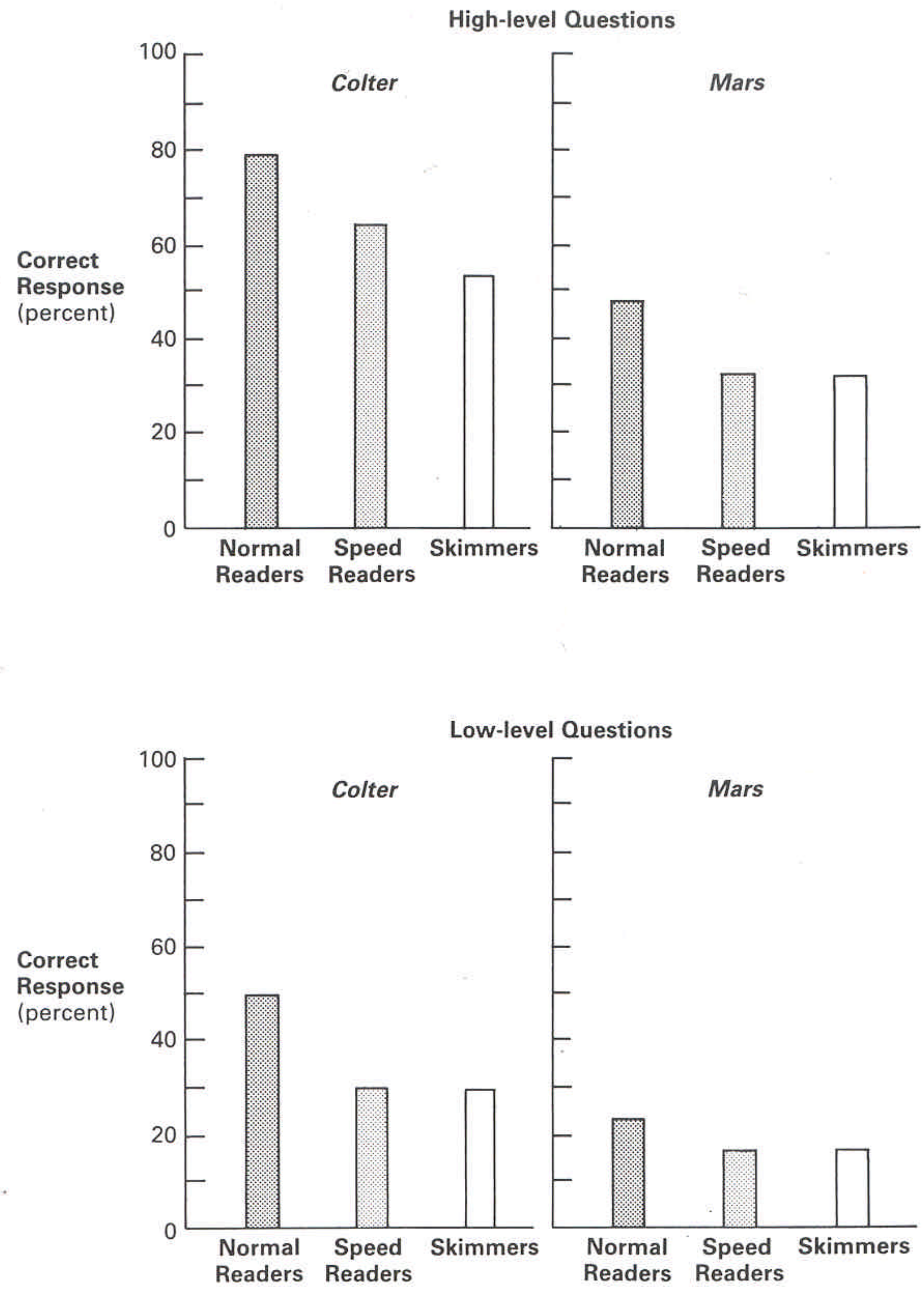


Figure 14.8 The only advantage of the speed readers in the comprehension test occurred on high-level questions that interrogate the gist of familiar, easy passages. The speed readers were able to answer more questions than the skimmers about the gist of the *Colter* passage. Speed readers had no advantage in answering questions about details or answering questions about the more difficult *Mars* passage. Neither group of rapid readers performed as well as the normal readers, showing that reading faster does lower comprehension.

This analysis, however, does not take into account the fact that the speed readers were reading faster than the skimmers. It is necessary to consider the trade-off between speed and accuracy for the speed readers and the skimmers. The interesting question concerns the effect of training on the nature of that trade-off.

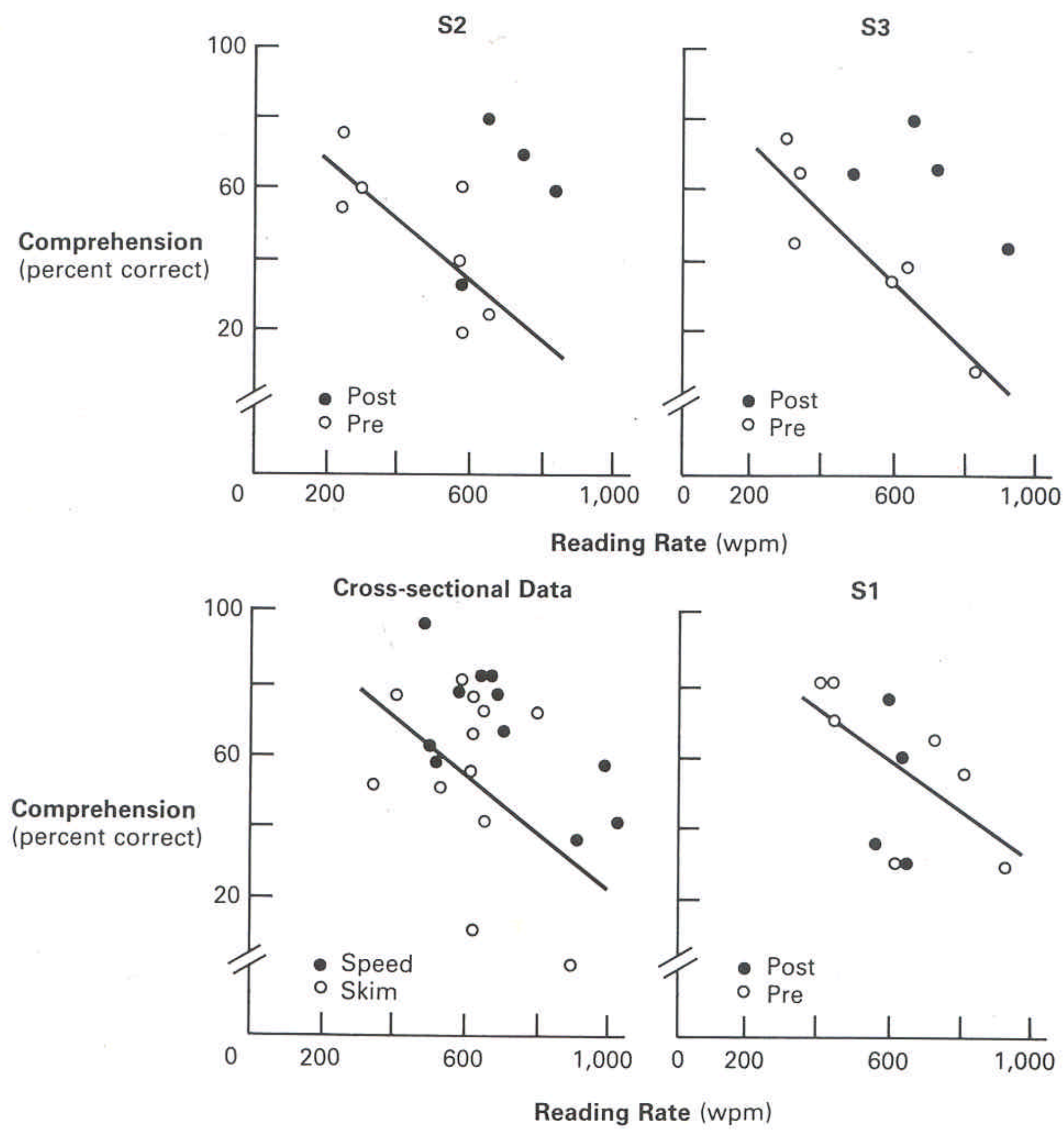


Figure 14.9 This figure shows the effect of training in speed-reading on the speed-accuracy trade-off, where *accuracy* refers to comprehension scores on the high-level questions on the *Colter* passage. The open circles and the downward-sloping lines that have been fit through them depict the speed-accuracy function obtained without any training, while the filled circles depict performance after training. The graphs for the three longitudinal subjects (S1, S2, S3) show the performance of the same people before and after training, while the bottom left-hand graph (cross-sectional data) compares the entire group of speed readers to the skimmers. To the extent that the filled circles lie above and to the right of the line, the data indicate that speed readers obtained higher comprehension scores than untrained skimmers reading at comparable rates.

When both speed and accuracy are considered, the speed readers' only significant advantage is with questions that probe for the high-level information from the easier, *Reader's Digest* text.

This advantage is shown in Figure 14.9, which depicts the speed-accuracy trade-off for the high-level information for the *Reader's Digest* passages. There are three panels for the three individual readers (S1, S2, and S3) who were studied be- fore and after they took the course; the bottom-left panel contrasts the entire group of I I speed readers with the skimmers. First consider S1, S2, and S3. The unfilled circles represent the speed-accuracy relation for the *Reader's Digest* passages that were read before the course. The downward slope of the best-fit straight lines indicates that comprehension generally deteriorates as reading speed increases. The filled points represent the speed-accuracy relation after the course. For two of the readers (S2 and S3), the filled points tend to fall above the line; this indicates that after the course, these readers were able to read rapidly without sacrificing as much comprehension as before the course. In terms of the hypothetical curves shown in Figure 14. 1, these two readers have shifted from a curve like A to one like B. For S1, who even before the course read faster and had better comprehension than S2 and S3, there was no improvement, indicating no change in the speed- accuracy function. Thus, the training in speed reading improved the performance of two of the three longitudinal subjects.

A similar pattern of results emerged from the cross-sectional comparison of the speed readers (filled circles) and the skimmers (unfilled circles) for the high-level questions probing the *Colter* passage (bottom-left, Figure 14.9). The line is fit through the data for the skimmers; it shows the skimmers' speed-accuracy trade-off function. If there were no effect of speed-reading training, we would expect about half of the speed readers to lie above that function and half, below the function. As Figure 14.9 shows, nine of the eleven speed readers had better comprehension performance than the skimmers' speed-accuracy function would predict, indicating that the training produced an ability to read rapidly while decreasing the loss of comprehension. In this experimental design, the untrained skimmers represent the speed-accuracy function without any training, while the speed readers' function indicates the effect of training. In general, the speed readers' function shifted from curves like A in Figure 14.1 to curves like B. In both longitudinal and cross-sectional comparisons, the shift in speed-accuracy functions occurred only for the high-level questions probing the *Reader's Digest* passages.

Passage summaries The three groups of readers summarized each passage after reading it, and there were no large differences in the performance of the three groups, in spite of the far greater reading time of the normal readers. The absence of major differences among the summaries produced by the three groups of readers should be contrasted with the question-answering performance described previously, which indicated that the normal readers consistently acquired more information from the passages than either group of rapid readers. The summaries are imprecise indicators of comprehension.

Conclusions about This Study

In summary, this study suggests that speed readers attain a new reading skill but one with limited applications. Relative to untrained rapid readers, speed readers had a comprehension advantage only on high-level information from texts on familiar topics. That is, the skill is not helpful in all texts or for all types of information. This evidence strongly implies that speed-reading skill is not at all perceptual but conceptual, instead. Acquiring speed-reading skill consists of learning to infer connections between those segments of the text that happen to have been sampled. It is only for the familiar material that readers have sufficiently detailed schemata to support the inference making. The speed readers, in effect, do more top-down processing (using previous knowledge to infer what is in the text) and less bottom-up processing (perceiving words and word sequences) than normal readers.

The eye-fixation behavior of normal readers, speed readers, and skimmers provides several insights about the processes that underlie rapid reading. While normal readers sample a text fairly densely (fixating about 80 percent of the content words), rapid readers fixate only about half as many words (30-40 percent) and for only two-thirds the duration (200-240 milliseconds) per fixated word. Content words are twice as likely to be fixated as function words, both by normal readers and rapid readers. However, in the case of rapid readers, this result is almost entirely due to the generally greater length of content words. Neither speed readers nor skimmers are very selective about fixating the most important words of a text. The span over which rapid readers extract word meaning is relatively narrow. Rapid readers cannot answer questions about a detail if they did not fixate directly on it or within three character spaces of it. Both rapid-reading groups modulate their reading rate over various portions (screens or paragraphs) of the text. Finally, the gaze durations of normal and rapid readers on a fixated word are proportional to the word's length and the logarithm of its normative frequency, although the parameters associated with these two effects for the rapid readers are considerably smaller than for normal readers.

The eye fixations indicate where the speed readers' advantage does *not* lie. The speed readers do not use an exotic scanning strategy, except that their scanning is more uniform, which may free some attentional resources. Nor does the speed readers' advantage reside in sampling more important words or in a wider perceptual span.

The speed readers' advantage is *primarily conceptual*, in putting together the information that is fortuitously sampled. It probably is best to look at speed reading as a means of realizing an already existing potential for inference making, rather than a radical transformation of the reading comprehension process. Admittedly, this study examined only a limited range of speed-reading skill (newly trained readers who took a seven-week course), and the conclusions might not generalize to expert speed readers who have had much more practice and might attain rates considerably faster than 600-700 wpm. It is also true, however, that many speed readers are probably of the same skill level as the subjects we have discussed.

The general notion of a speed-accuracy trade-off in reading is a good one for understanding some of the conflicts in the literature about the benefits of speed reading. In particular, this concept helps explain why some researchers have re- ported speed gains without losses in comprehension. Whether a reader can learn to read faster without loss of comprehension will depend upon the reader's initial location on the hypothetical speed-accuracy curve. If the text is easy, the reader should be able to read much faster without sacrificing comprehension. On the other hand, if the text is difficult, then increases in speed are likely to result in sacrifices in comprehension. Although the speed-accuracy function is a useful concept, it is also a simplification, because the accuracy of comprehension is not a single dimension. Comprehension consists of obtaining several different kinds of information which may vary in its susceptibility to variations in reading speed.

There is another salient aspect of speed reading that we have not formally assessed: how stressful and effortful it can be. Several of the speed readers volunteered that they found speed reading to be a very demanding technique. Presumably, some of this stress may be due to the acquisition of a new technique. However, even expert speed readers have informally commented that prolonged speed reading is effortful and difficult to maintain. There may be some costs to extended running of the mental engine at high speeds.

RSVP *R*eading-*R*apid Serial *V*isual *P*resentation

An unconventional form of rapid reading, called RSVP, was developed by Forster (1970). In this technique, the text is presented one word at a time, each word appearing for the same duration at the same location on the screen. This presentation mode differs from normal reading in several ways. First, the duration of gaze on each word is not under the control of the reader. Second, there are no eye movements. Third, no words can be skipped. And fourth, the words that have already been seen cannot be looked at again.

In some ways, the RSVP paradigm resembles speeded listening comprehension. For instance, the pacing of an RSVP reader is not under the reader's control, just as the rate of listening is not under the listener's control. Also, subjects do not have to make selective fixations in listening or in RSVP. Moreover, since the text is not continuously available, there is no possibility of previewing, regressing, or rereading.

Clearly, RSVP does not mimic the way readers naturally speed up their reading processes. Our speed-reading experiment shows that the major part of the speed gain in rapid reading is attributable to a sparser sampling of the text, while only a minor part is attributable to shorter processing times on individual words. By contrast, in RSVP, all of the speed gain is provided by shorter processing times on each word; rather than make the sampling sparser than in normal reading, RSVP makes it maximal, presenting every single word of the text.

RSVP was previously used only as a laboratory tool to examine how perception and comprehension were affected if the time allotted to look at each word of a sentence were greatly reduced from the normal duration. Forster (1970) found that at the rate of 62 milliseconds per word, only about four words of a six-word sentence were detected, let alone integrated, into the representation of the sentence. Moreover, the probability of correctly reporting a given word was partially dependent on the complexity of the syntax of the sentence and on the lengths of the words that preceded and followed the word. Thus, there are clear limits to the amount of information that can be perceived, let alone integrated, in high-rate RSVP presentation.

A New Reading Technology?

RSVP presentation is currently being evaluated by some investigators as a form of rapid reading on, video terminals (Juola, Ward, & McNamara, 1982). Normal eye movements during reading may involve some planning and execution time that is made unnecessary by the computerized text presentation of RSVP. Juola and associates proposed that by eliminating the need for eye movements, the exposure du- ration necessary to process a word under RSVP conditions might be less than the corresponding gaze duration. The evaluations generally indicate little difference in comprehension and memory performance produced by RSVP reading and comparably rapid normal reading (Juola, Ward, & McNamara, 1982; Potter, Kroll, & Harris, 1980). However, it is important to remember that the performance measures that have been used in these studies to evaluate comprehension have generally been fairly insensitive, testing only for overall comprehension or recall, rather than attempting to localize specific comprehension deficits that may be produced by RSVP reading.

In the study done by Potter, Kroll, and Harris (1980), readers recalled and understood a short RSVP text slightly less well than a conventional text. In the RSVP conditions, the text was presented at 250, 125, or 83 milliseconds per word. In the conventional reading, the text was presented for the same total duration as the corresponding RSVP condition, which turns out to be 33, 17, or 11 seconds per passage. The people who read the passages under conventional reading conditions (in normal format, but with a deadline) could recall slightly more (12 percent) of the content. Moreover, the conventional format produced somewhat fewer misinterpretations (better comprehension) of the content of the passage. In both types of reading, performance was generally better when the total processing time was longer, reflecting the familiar speed-accuracy trade-off that was described previously.

The evaluations of RSVP comprehension have searched for possible benefits of this reading technique and found few. However, they have not diligently searched for costs. It is likely that many of the words presented in RSVP may not be adequately comprehended if they are presented for considerably less than the mean gaze durations (about 230 milliseconds observed for the rapid readers; a detailed comprehension test would likely detect the deficit .(Just, Carpenter, & Woolley, 1982).

In evaluating a new reading technology such as RSVP, it would be wise to ask under what conditions it is effective, rather than attempt to establish a universal superiority or inferiority to normal reading. The effectiveness of RSVP reading very likely depends on the nature of the text, the reader, and the task. For example, if the text contained many infrequent words and concepts, extra processing time would be required for these selected words, which would be unavailable in RSVP reading. By contrast, a relatively easy text, like a narrative about commonplace events, might be tractable in RSVP, because high-level processes could use the reader's prior knowledge to fill in comprehension gaps.

The effectiveness of RSVP reading could also depend on an individual reader's memory capacity, such that readers with large capacities could store the RSVP words that are very demanding until the processing resources became available. It may be that the large individual differences in readers' memory capacity for the material they have just read are predictors of their RSVP comprehension ability (Daneman & Carpenter, 1980).

Finally, the effectiveness of RSVP reading surely depends on what kind of information the reader is trying to obtain from a text: the topic, the major theme, supporting arguments, or specific evidence and facts. For example, the results of the speed-reading experiment discussed earlier suggest that rapid reading is more detrimental to the comprehension of low-level details than to the comprehension of the gist. RSVP probably produces similar effects.

RSVP of the Future

Can speed reading be made more efficient by using a modified form of RSVP to enhance those processes basic to rapid reading, as revealed in the earlier experiment? First, only a sample of the words of the text would be presented (say, one out of every three words) in their original order of occurrence. Second, the sampling would be intelligent rather than random, using plentiful computer-processing capacity rather than scarce speed-readers' capacity. An example of an intelligent sampling algorithm might be one that selects the most informative words of a sentence, such as the least frequent content words and semantically critically function words, like negations and quantifiers. Third, the presentation duration of each of the presented words would be determined by the theoretical estimate of the processing time for the word, as specified by a model like READER.

This new paradigm might have all the advantages of standard RSVP (the computer obviating the need for motor control of eye movements) and most of the advantages of natural reading (exposure durations designed to match processing times). One disadvantage of this proposed paradigm relative to speed reading is that it does not allow for individual differences between readers with respect to the locations of extra long pauses. This speculative proposal illustrates the important role that the underlying cognitive processes play in designing and evaluating new reading technologies.

Summary

The contrast between the eye-fixation patterns of normal readers and those of speed readers and skimmers illuminates many of the processes that underlie rapid reading and indicates how it differs from normal reading. While normal readers sample a text fairly densely, rapid readers can read two and one-half to three times faster by fixating half as many words and spending only about two-thirds the time (200-240 milliseconds) on each fixated word. The gaze durations of normal and rapid readers on fixated words are proportional to the word's length and the logarithm of its normative frequency, although the parameters associated with these two effects are considerably smaller for the rapid readers than the normal readers.

The comprehension level of rapid readers was inferior to that of normal readers. However, training in speed reading did produce an advantage over untrained skimming, but the advantage was limited to easy texts on familiar topics and, even then, only to high-level information. The advantage may depend on rapidly inferring the relations among those fragments of the text that happened to be visually sampled; such inferences may only be available for the kinds of material for which a reader has a well-developed schema.

A new form of rapid reading, involving Rapid Serial Visual Presentation of the words of a text, enables people to read rapidly, but the comprehension consequences of the new paradigm have not yet been adequately evaluated. The RSVP paradigms that have been examined to date have not made full use of what is known about speed reading. The potential of RSVP as a reading technology of the future remains to be evaluated.

One theme of this book is that *reading* is a generic term because reading processes vary widely, depending on the text and situation. In some situations and for some texts, speed reading can be an extremely adaptive form of reading. The results in this chapter suggest that it will be useful for texts that conform to relatively familiar schemata and for situations that only require the gist, or situations in which the reader neither has the time nor desire to understand the text deeply. It would be ludicrous, for example, to use speed reading while studying a religious text or evaluating poetry. But speed reading can be seen as a useful, if limited tool that can permit a skilled reader to respond flexibly to different texts and reading tasks.

Suggested Readings

Several of the articles that were referred to in this chapter can be consulted for specific points, but we have no general readings to recommend. In fact, the sparse knowledge about the nature of speed reading was one of the motivations for doing the research that is reported in this chapter.