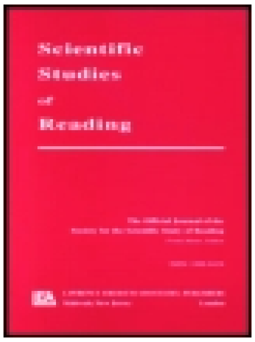

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Reading for One Second, One Minute, or One Year From the Perspective of Rauding Theory

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Rauding theory purports to add to our knowledge of (a) the processes involved in 1 sec of reading, (b) the percentage of comprehension that occurs during 1 min of reading, and (c) the gain in achievement that occurs during 1 year of reading. Relevant to 1 sec of reading, this theory predicts the time required for three component processes to be successfully executed during a fixation on a word. Relevant to 1 min of reading, the three laws and two equations of rauding theory allow a precise prediction of the accuracy of text comprehension that occurs; this prediction is based on (a) the reading level and rate level of the individual, (b) the difficulty level and length of the text, and (c) the time spent reading. Relevant to 1 year of reading, a model is presented that includes the primary factors that cause high and low reading achievement. The model has four causal echelons: reading achievement, or general reading ability, at Echelon 1; reading level and rate level at Echelon 2; and listening level, decoding level, and naming speed level at Echelon 3. At Echelon 4, there are two teaching and learning factors, one age factor, and three aptitude factors (verbal knowledge, decoding, and cognitive speed). This model can also be used to diagnose reading disabilities. Empirical evidence of a correlational nature is presented in support of the model. Finally, theory and research relevant to normal reading for 1 sec, 1 min, and 1 year has been unified via the constructs of reading level and rate level. Rauding theory should be considered when investigating normal reading for lower grade readers, middle grade readers, adults, and disabled readers.

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In reading research, it makes a big difference whether 1 sec, 1 min, or 1 year is involved. Each of these three slices of time has carried its own theoretical constructs and practical implications. In the past, generalizing results from one of these slices of time to another has been done using vague generalizations that are fraught with uncertainty. Rauding theory uses the reading level and rate level of an individual to make mathematically precise predictions about (a) the milliseconds required for the components of the rauding process to operate successfully during a fixation that occurs when reading for 1 sec, (b) the percentage of comprehension that occurs during 1 min of reading, and (c) the gain in achievement that occurs during 1 year of reading.

The first major section that follows presents background information relevant to the theoretical framework underlying rauding theory and how the theory relates to 1 sec, 1 min, and 1 year of reading. The second major section contains details of how rauding theory relates to 1 min of reading, as well as a review of the three laws and the two primary equations of rauding theory. The third major section contains a detailed explanation of a causal model of reading achievement that is relevant to 1 year of reading. The fourth section explicitly unifies the theory relevant to reading for 1 sec, 1 min, and 1 year. The fifth and final section provides a summary and conclusions.

THEORETICAL FRAMEWORK

Three Slices of Time

What exactly, do the terms 1 sec, 1 min, and 1 year of reading mean? Each of these three slices of time is described in turn.

One second of reading refers to the cognitive processes that occur during one eye fixation on a word. Most researchers in reading are familiar with Gough's (1972) famous article on "one second of reading." An important part of the model he presented was called TPWSGWTAU, or The Place Where Sentences Go When They Are Understood. This part of the model is especially relevant to rauding theory, because the comprehension of the complete thoughts in sentences has been a fundamental part of this theory since its inception (Carver, 1977). A more recent and more streamlined model of the word recognition processes during 1 sec of reading was created by Seidenberg and McClelland (1989) and was referred to extensively by Adams (1990) in her book on beginning reading. Much of the research relevant to 1 sec of reading has (a) involved the cognitive mechanisms responsible for word recognition, (b) used latency measures of the millisecond of time required to recognize words, nonwords, and short phrases (e.g., see Perfetti & Roth, 1981), and (c) focused on understanding "the reading process."

One minute of reading refers to much of the research that presents prose passages to readers that are about 100 to 300 words in length and then measures comprehension or recall. For example, the research conducted by Anderson, Pichert, and Shirey (1983) on schema theory fits into this 1 min slice of time. Another example comes from the research by J. R. Miller and Kintsch (1980) on memory and recall. Although this type of research involves short passages and only about 1 min of reading, most researchers in this area will probably contend that their results will generalize to 1 hr or more of reading longer passages, such as chapters and books. In brief, rauding theory has much to contribute to our knowledge about the amount of comprehension that occurs during 1 min of reading, as is explained in much more detail later.

One year of reading refers to the research that involves gain during a school year, such as the research conducted by Juel, Griffith, and Gough (1986). Also, the research on reading instruction that involves different methods, such as the first grade studies (Stauffer, 1967), comes under the rubric of 1 year of reading. As is explained in detail in a later major section, rauding theory has recently been expanded so that it contributes to the description, explanation, prediction, and control of reading achievement during 1 year of reading.

One Second of Reading

According to rauding theory, the cognitive processes involved in 1 sec of reading are similar but different for various reading processes, or types of reading. There are purportedly five basic processes involved in reading text, or passages (Carver, 1990b). That is, when someone is reading paragraphs in a book, for example, one of five basically different reading processes is likely to be involved. These processes, or reading gears, are called scanning (Gear 5), skimming (Gear 4), rauding (Gear 3), learning (Gear 2), and memorizing (Gear 1). Table 1 contains the culminating component for each one of the five basic reading processes, as well as the rate at which each is typically operated by a college student.

The fastest basic process is a scanning process, which is Gear 5. This fastest gear involves only one component, lexical accessing, so it operates at a relatively high rate for college students—around 600 words per minute, or 100 msec per word (e.g., see Carver's 1990b review of Fisher's 1975 research). Gear 4, a skimming process, involves two components (lexical accessing and semantic encoding), so it operates slower—around 450 words per minute, or 133 msec per word, for college students (e.g., see Carver's 1990b review of the 1917 research of Whipple & Curtis). Gear 3, the rauding process, involves three components (lexical accessing, semantic encoding, and sentence integrating), so it operates even slower—around 300 words per minute, or 200 msec per word, for students who are reading at the college level (e.g., see Carver, 1983). It should be noted that these three components of the rauding process are based on the three components advanced by Perfetti (1985), namely lexical accessing, semantic encoding, and proposition integrating.

TABLE 1
Five Basic Reading Processes or Reading Gears

Gear	*Process*	*Culminating Component*	*Rate for College Students (Wpm)*
5	Scanning	Lexical accessing	600
4	Skimming	Semantic encoding	450
3	Rauding	Sentence integrating	300
2	Learning	Idea remembering	200
1	Memorizing	Fact rehearsing	138

Note. Wpm = standard-length words per minute; a standard-length word is six character spaces, or six letters and spaces.

Gear 2, a learning process, involves four components (lexical accessing, semantic encoding, sentence integrating, and idea remembering), so it operates still slower—around 200 words per minute, or 300 msec per word, for college students (e.g., see Carver's 1990b review of the 1985 research of Lorch, Lorch, & Matthews). Gear 1, a memorizing process, involves all five components noted in Table 1 (lexical accessing, semantic encoding, sentence integrating, idea remembering, and fact rehearsing), so it operates at the slowest rate of *all*—around 138 words per minute, or 433 msec per word, for college students (e.g., see Carver's 1990b review of Meyer's 1975 research). Most psychological research in reading has been conducted with college students, and it has involved learning processes or memorizing processes that operate at rates around 200 words per minute (or 300 msec per word, Gear 2), or rates around 138 words per minute (or 433 msec/word, Gear 1).

The rauding process, Gear 3, is the process most readers use regularly. It is the type of reading that is most typical; it is normal reading, ordinary reading, natural reading, or simple reading. It is the process that is used most often when adults are reading something that is relatively easy for them to comprehend—that is, a magazine, a newspaper, a novel, a memo at work, or a letter from a friend. Evidence that most of the reading that goes on in the world involves the rauding process comes from Sharon (1973); he surveyed 5,067 adults in a national probability sample and found that less than 1% of their reading involved anything that was difficult to understand during their typical 2 hr of reading each day. The goal to be achieved when an individual executes the rauding process is the comprehension of the complete thoughts in the sentences. The rauding process is the focus of rauding theory.

The term *rauding* comes from the combination of two words, reading and auding (Carver, 1977). It refers to the frequently occurring situation where individuals are reading or listening, and they are understanding most of the thoughts that they are encountering as they read or aud the sentences involved. Rauding focuses on the idea that reading prose and listening to prose generally involve the same comprehension processes. It does not matter whether the thoughts in the prose are presented visually when reading or auditorily when listening, the goal of comprehending sentences is the same; this particular process is called the rauding process.

In summary, there are five basic reading processes involved when individuals are reading passages for 1 sec. Each process contains a different set of components that operate during one eye fixation on a single word in a sentence. Adding a component to a reading process adds milliseconds to the time needed to successfully execute this process. The rauding process, called Gear 3, is the most important process because it is the one involved in normal or typical reading. It involves three components, called lexical accessing, semantic encoding, and sentence integrating. The rauding process is the basic reading process that is focused on in rauding theory. If the rauding process is involved in 1 sec of reading, or one eye fixation on a single word, then rauding theory should be relevant.

Inducing the Rauding Process

If a researcher wants to study the rauding process, how can it be induced in a research study? There are three primary factors that influence whether readers are likely to be engaged in the rauding process (see Carver, 1990b). The first factor is the relative difficulty of the material or passages that are involved. If relatively easy passages are presented, then the rauding process is more likely to be executed by the reader. On the other hand, the rauding process is not likely to be engaged if the material presented is relatively hard—that is, at a higher level of difficulty than the ability level of the individual.

The second primary factor is the way in which the instructions are presented by the researcher. If individuals are asked to read the material once as they would normally or ordinarily read, then they will probably use their rauding process. On the other hand, if individuals are asked to learn the essential elements of the text, they are likely to shift out of Gear 3, the rauding process, into Gear 2, a learning process. Or, if individuals are asked to read very carefully so they can recall the details later, they are more likely to shift out of the rauding process into a memorizing process, which is Gear 1.

The third primary factor influencing a reader's choice of gears is the objective consequences. If individuals are asked to identify incomplete thoughts or anomalous sentences, they are likely to use Gear 3, their rauding process. On the other hand, if individuals know they are going to be required to answer difficult multiple-choice questions, they are likely to shift down to Gear 2, a learning process. Or, if they know they are going to have to write down everything they can remember, they are likely to shift further down into Gear 1, a memorizing process.

Finally, if the researcher wants some post hoc evidence relevant to whether the rauding process was actually engaged or not, then the reading rate of the individual can be measured during the data collection. If college students were in fact reading the passages at rates around 260 to 300 words per minute, on the average, then the rauding process was probably engaged. On the other hand, if the reading rates averaged 450 to 600 words per minute or 100 to 200 words per minute, then the rauding process probably was not being executed for most of the college students involved.

Other Theoretical Perspectives

It will be helpful now to relate rauding theory to other theories in reading to clarify its unique nature. Table 2 contains a comparison of four different theoretical perspectives in reading—rauding theory, verbal efficiency theory, schema theory, and whole language. These four theoretical perspectives are compared with respect to three different dimensions—that is, their focus on (a) each slice of time discussed earlier, (b) each basic reading process discussed earlier, and (c) each type of reader, such as lower grade readers, middle grade readers, adults, or disabled.

In rauding theory, "lower grade readers" are those individuals who have not yet reached the age of third graders in school. Middle grade readers are of an age typical for students in Grade 3 to Grade 7. Adult readers are at an age typical for eighth graders or higher. Disabled readers in rauding theory are those whose achievement levels are at least 2 grade levels below what could be reasonably expected from their age or their grade in school.

From the *Yes* and *No* entries under the Rauding theory column in Table 2, it can be seen that this theory focuses on typical reading (or the rauding process) during 1 sec, 1 min, and 1 year for lower graders, middle graders, adults, and disabled readers. Note that Table 2 first contrasts rauding theory to verbal efficiency theory—as explicated by Perfetti (1985). The focus of verbal efficiency theory seems to be on typical reading during 1 sec of reading for lower graders, middle graders, adults, and disabled readers. Although Perfetti does review some research on skimming, or speed reading, this is not a focus of the theory, as evidenced by the fact that his concern was mainly on the eye fixations that occur at fast rates. Also, verbal efficiency theory does not seem to deal seriously with 1 min of reading because the longest amount of time that reading was involved in the research presented by Perfetti (1985) can be estimated to be about 20 to 25 sec. Perfetti tried to generalize to reading instruction, or 1 year of reading, but this was not a focus of the theory because there was little research presented relevant to this particular slice of time. Furthermore, the theoretical foundation for the research presented was rooted in concepts from 1 sec of reading.

Table 2 also compares rauding theory to schema theory, using the review article by Anderson and Pearson (1984) as the primary source. Anderson and Pearson have acknowledged that the hypotheses and predictions of schema theory are (a) most appropriate "when a person is studying a text—that is reading with the deliberate intention of learning ideas and information" (p. 277) and (b) less likely to be

TABLE 2
Various Dimensions in Reading and How They Relate to Four Different Theoretical Perspectives in Reading

	Four Theoretical Perspectives in Reading			
Dimensions in Reading	*Rauding*	*Verbal Efficiency*	*Schema*	*Whole Language*
Type of reading process				
Scanning and skimming	No	No	No	No
Typical reading (rauding)	Yes	Yes	No	Yes
Learning and memorizing	No	Yes	Yes	No
Time spent reading				
1 sec	Yes	Yes	No	No
1 min	Yes	No	Yes	No
1 year	Yes	No	No	Yes
Type of reader				
Lower grade readers	Yes	Yes	No	Yes
Middle grade readers	Yes	Yes	No	Yes
Adult readers	Yes	Yes	Yes	No
Disabled readers	Yes	Yes	No	No

appropriate when a person is "simply reading." So, schema theory is not relevant to the rauding process, which is simple reading or normal reading. Table 2 thus indicates from the *Yes* entries under the Schema column that this theory is mainly relevant to learning and memorizing processes during 1 min of reading by adult readers.

Finally, Table 2 compares rauding theory to a whole language approach, using an article by Goodman (1989) as the primary source. Again, from the *Yes* entries under the Whole Language column in Table 2, it can be seen that the whole language focus has been on typical reading (or the rauding process) during 1 year of reading for lower and middle grade readers. The Whole Language perspective is similar to rauding theory in its focus on typical reading, but it is mostly silent with respect to the comprehension that occurs during 1 min, and it is generally not concerned with adult readers or disabled readers.

By contrasting rauding theory to these other three theoretical perspectives in reading, it should be clear that rauding theory is not entirely unique in its focus on typical or ordinary reading. However, it is completely unique in that it is the only one of these four theoretical perspectives to focus on typical reading during 1 sec, 1 min, and 1 year for lower graders, middle graders, adults, and disabled readers.

Basic Constructs

To complete this theoretical framework, a listing of the basic constructs in rauding theory is presented in Table 3, along with identifying symbols and related traditional concepts. For example, note that the theoretical construct called rauding accuracy level is symbolized as A_L, and it is similar to the traditional concept of reading level, or instructional level, measured in grade equivalent (GE) units. Also, note that the construct of rauding rate is symbolized as R_r, and it is similar to the traditional concept of normal reading rate, or how fast the individual typically reads. When rauding rate is measured in rate units, such as words per minute, it is symbolized as R_r, but if rauding rate is measured in GE units, it is symbolized as R_L and is called rauding rate level, or rate level.

Before leaving Table 3, it may be helpful to point out that the constructs that are symbolized with a subscript L refer to level and are achievement type measures in GE units. For example, if $E_L = 4$ for a particular student, this may be interpreted as indicating that the student has a level of reading achievement, or general reading ability, that is at the fourth-grade level. The constructs in Table 3 that have an r as a subscript are those that coincide with the operation of the rauding process, whereas those that have no subscripts refer to what happened with respect to the entire passage or body of material presented. This means that the symbols with the subscripts r refer to only the amount of the passage that was covered during the operation of the rauding process. For example, A_r refers to the accuracy of comprehension that occurred during the time that the rauding process was operating on a passage. Suppose individuals are asked to read a passage once as they normally read, and a particular individual comprehended 80% of the passage. In this example, $A_r = .80$, and A would also be .80 because the individual finished reading the entire passage once. However, suppose this hypothetical individual was asked to read this passage normally but was subsequently asked to stop (time limit) halfway through the passage. The accuracy of comprehension for the material covered again would be estimated as 80%, or $A_r = .80$, but the accuracy of comprehension for the entire passage might be 40%, or $A = .40$, because only half of it was covered during the time limit. So, A_r is the accuracy of comprehension that is associated with the rauding process being executed at the rauding rate, R_r; E_r is the associated efficiency.

This completes the theoretical framework needed to understand the following two major sections that contain the details of how rauding theory can be used to predict (a) accuracy of comprehension during 1 min of reading and (b) gain in reading achievement during 1 year of reading.

ONE MINUTE OF READING

Lawfulness

As previously noted, most research involving individuals reading prose passages has involved around 1 min of reading because the text has usually been around 100 to 300 words long, yet, most researchers who use these passages probably want to

TABLE 3
Constructs From Rauding Theory With Their Symbols and Related Traditional Concepts

Symbol	*Construct*	*Related Traditional Concept*
D_L	Difficulty level	Readability (of a passage)
A	Accuracy of passage comprehension	Percentage comprehension (of a passage)
R	Rate of passage comprehension	Average rate or reading time (of a passage)
E	Efficiency of passage comprehension	Reading efficiency (of a passage)
A_r	Rauding accuracy	Individual's accuracy of comprehension (during time spent reading a passage once)
R_r	Rauding rate	Individual's typical rate of reading (during time spent reading a passage once)
E_r	Rauding efficiency	Individual's efficiency of reading (during time spent reading a passage once)
A_L	Rauding accuracy level	Individual's reading level in GE units (measured by standardized vocabulary tests)
R_L	Rauding rate level	Individual's typical reading rate in GE units (measured by standardized rate tests)
E_L	Rauding efficiency level	Individual's reading achievement, or general reading ability, in GE units (or reading ability as measured by standardized comprehension tests)
D_L–A_L	Relative difficulty	Difficulty of the material for the individual

generalize their results to at least 1 hr of reading. The comprehension that occurs when the rauding process is executed for 1 min, or 1 hr, is quite lawful. In fact, rauding theory contains three formal laws that apply to 1 min of rauding (Carver, 1981).

Law 1 is that individuals attempt to comprehend thoughts in passages at a constant rate, called their *rauding rate,* unless they are influenced by situation-specific factors to change that rate. This means that individuals ordinarily read at a relatively constant rate (e.g., see Carver, 1983, 1990b), and this constant rate at which they normally read is their rauding rate, R_r. When individuals are reading in a typical fashion, their rate of passage comprehension, R, is ordinarily the same as their rauding rate, R_r; so ordinarily, $R = R_r$. For example, the rauding rate, R_r, of an individual can be measured with a standardized test (Carver, 1990b), such as 300 words per minute. Given this rate, Law 1 of rauding theory says that when an individual is asked to read a relatively easy passage once, then how long the individual will take in minutes can be predicted very accurately by dividing the number of words in the passage by 300. That is, the individual's rate of reading the entire passage, R, is likely to be the same as R_r as measured by a standardized test.

The constancy of rauding rate is one of the cornerstone ideas in rauding theory—hence, Law 1. Of course, it is often possible to get individuals to shift out of their rauding process, into other basic reading processes that operate at different rates, by giving them relatively hard passages to read, by telling them to read slowly and very carefully, or by asking them to write down everything they can recall—as was discussed earlier in the theoretical framework.

Law 2 is that $E = AR$; the efficiency of passage comprehension depends on the accuracy and rate of passage comprehension. As the accuracy of passage comprehension goes up, so does the efficiency of passage comprehension. As the rate of passage comprehension goes up, so does the efficiency. E is the product of A and R, indicating that there can be no efficiency when either accuracy or rate is zero. This Law 2 equation works as designed when A is expressed as a proportion, such as .70, and R is expressed in standard-length sentences per minute so that E is also in standard-length sentences per minute. A *standard-length sentence* has been defined as 16.67 standard-length words, and a *standard-length word* has been defined as six character spaces (Carver, 1990b).

Law 3 is that the most efficient rate of passage comprehension is the rauding rate—that is, when $R = R_r$, then $E_{max} = E_r$. This means that if individuals are somehow induced to read passages at a rate that is faster or slower than their rauding rate, R_r, their number of sentences comprehended per minute, E, will decrease because their rauding rate is their most efficient rate of reading. Each individual has learned to be highly efficient by reading at a constant rate, the rauding rate, because any other rate is less efficient. The rate at which individuals normally operate their rauding process is also the rate at which they most efficiently comprehend sentences.

Supporting Data

Some of the data that support these three laws is now reviewed, beginning with Law 1. Figure 1 contains data that were collected by G. R. Miller and Coleman (1971) and reanalyzed by Carver (1976). There were 36 passages that G. R. Miller and Coleman asked college students to read, and they have been grouped by difficulty level along the horizontal axis in Figure 1. In this figure, difficulty level is represented as G_d, an older symbol, instead of D_L, as it is currently symbolized in rauding theory (see Table 3). Note that there were six groupings of passage difficulty with six passages in the easiest group, Grades 1 to 3, and two passages in the hardest group, Grades 16 to 18.

Reading rate in words per minute is represented along the vertical axis. Note that the figure contains two abbreviations for words per minute; one is capitalized (Wpm) and the other is not capitalized (wpm). When words per minute is designated as wpm, it refers to actual words, but when it is designated as Wpm, it refers to standard-length words. A standard-length word was defined earlier as six character spaces, including letters and the blank space between words.

Notice in Figure 1 that when reading rate is measured in actual words per minute, wpm, the dashed line shows that reading rate decreases rapidly from a high of about 320 wpm for passages at Grades 1 to 3 difficulty to a low of about 200 wpm for passages at Grades 16 to 18 difficulty. So, these data are completely counter to Law 1 of rauding theory, which holds that reading rate is typically constant. However, these data represent actual words per minute, wpm, not standard words per minute, Wpm. Law 1 requires that rate be measured in a standard manner, such as standard-length words per minute, Wpm, or standard-length sentences per minute (Spm).

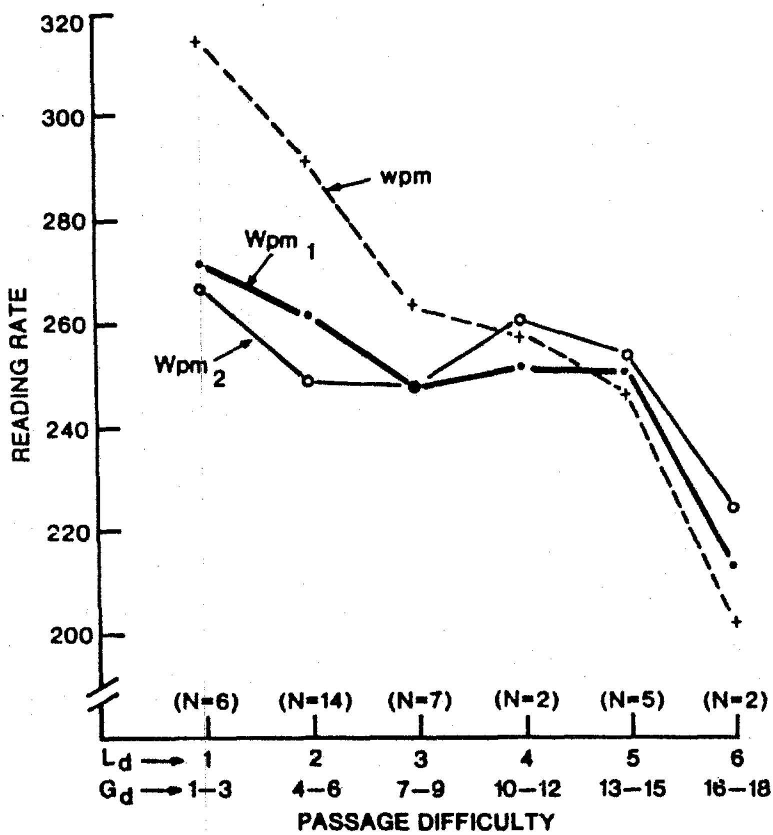

FIGURE 1 Reading rate as a function of passage difficulty (G_d and L_d) using actual words per minute, wpm, and standard-length words per minute, Wpm. There were two methods for estimating standard-length words per minute, designated as Wpm_1 and Wpm_2. Passage difficulty, in GE units, was designated by an older symbol, G_d, which means the same as difficulty level, D_L. From "Word length, prose difficulty, and reading rate," by Ronald P. Carver, 1976, *Journal of Reading Behavior, 8,* p. 200. Copyright 1976 by the National Reading Conference. Reprinted with permission.

In Figure 1, rate in standard-length words per minute was estimated from the original data in two slightly different ways, symbolized as Wpm_1 and Wpm_2, but both provide almost exactly the same results. Reading rate was approximately constant all the way from passages at Grades 1 to 3 in difficulty up to passages at Grades 13 to 15 in difficulty, varying only from about 250 to 270 Wpm. However, when the passages became relatively hard for these college students at Grades 16 to 18 in difficulty, rate dropped off to around 200 Wpm. The rate dropped off when the material became relatively hard probably because many students shifted into a learning process, Gear 2, as was discussed earlier in connection with inducing the rauding process in research. As long as the material was relatively easy for these college students, their rate stayed relatively constant in accordance with Law 1 of rauding theory.

Figure 2 contains more data supporting Law 1 of rauding theory, taken from Carver (1983). In this figure, note that the difficulty level of the material varies along the horizontal axis from Grade 1 to Grade 16. Reading rate in standard-length words per minute, Wpm, is represented along the vertical axis. For these data, the individuals were grouped into five levels of reading ability. The highest level of ability (labeled *5*) is the college level readers. Their reading rate was relatively constant from the Grade 1 difficulty passages up through the Grade 13 difficulty passages. When the material became relatively hard for these college level readers at Grade 16, their rate dropped off. Again, this drop off in rate is probably due to many of these readers shifting out of the rauding process into a learning process when the material became relatively hard. It may also be noted that the reading rate of individuals at the other four levels of ability were also relatively constant—that is, high school (labeled *4*), junior high (labeled *3*), Grades 4 to 6 (labeled 2), and Grades 1 to 3 (labeled *1*).

There is a great deal of data supporting Law 1 of rauding theory that holds that individuals tend to read at a relatively constant rate across a range of difficulty levels as long as the material is relatively easy ($D_L < A_L$). Besides the data collected by G. R. Miller and Coleman (1971) in Figure 1 and Carver (1983) in Figure 2, Carver (1990b) reviewed other supporting data collected from college students (Coke, 1976; Letson, 1959; Zuber & Wetzel, 1981) and from elementary and secondary students (Ballentine, 1951; DiStefano, Noe, & Valencia, 1981; Morse, 1951; Seibert, 1943). With respect to Law 1, Carver (1990b) also pointed out that "research data that superficially seem to provide counter evidence (e.g., Kintsch & Keenan, 1973; Rothkopf & Coatney, 1974), in fact do not do so because these data involve reading processes that operate in first and second gear" (p. 215). Whereas reading rate for good readers has traditionally been considered to be fluid and flexible within individuals across difficulty levels and purpose conditions (e.g., see Hoffman, 1978), the empirical evidence strongly supports a rate that is relatively constant under ordinary reading conditions wherein individuals are asked to read relatively easy materials as they would normally read. Again, this relatively constant rate referred to in Law 1 is called their rauding rate, R_r; it is the rate at which they typically operate their rauding process.

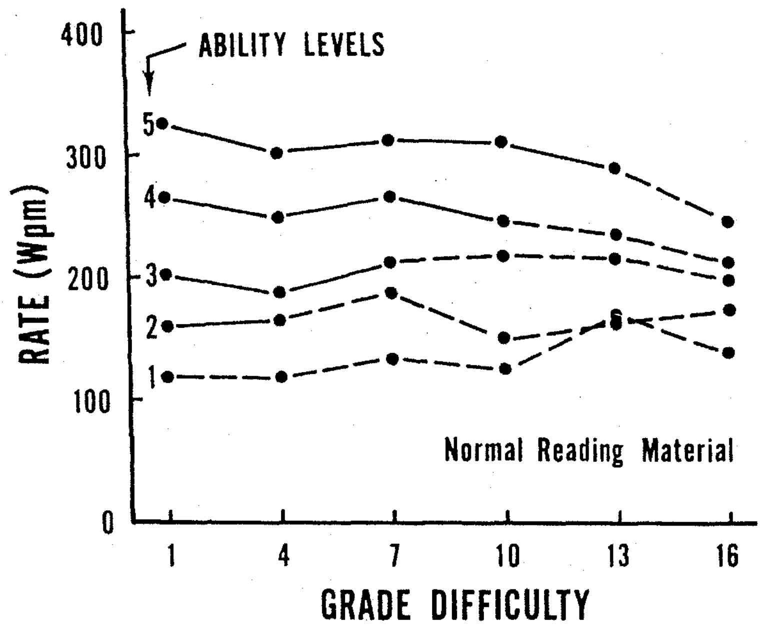

FIGURE 2 Reading rate in standard-length words per minute, Wpm, as a function of difficulty level, D_L, of the material for individuals (called Grade Difficulty) at five levels of reading ability. The five levels of ability were as follows: Level 5, college; Level 4, high school; Level 3, junior high; Level 2, elementary; Level 1, primary. The long dashed lines indicate that the material was relatively difficult ($D_L > A_L$) because the disability level of the material was higher than the ability level of the individual. From "Is reading rate constant or flexible?" by Ronald P. Carver, 1983, *Reading Research Quarterly, 18,* p. 201.

There is also a considerable amount of evidence supporting Law 2 and Law 3. Figure 3 contains data collected from college students who both read and listened to passages presented at rates varying from 83 Wpm to 500 Wpm (taken from Carver, 1982). Reading rate was manipulated using motion picture film and auding rate was manipulated using time-compressed speech. The passages involved were taken from four different levels of difficulty, ranging from elementary school material to college level material. After each passage was presented, the accuracy of comprehension was measured by (a) administering objective comprehension tests and (b) having these college students report what percentage of the passage they thought they had comprehended, called Understanding Judgments.

In Figure 3, there are eight different graphs relating manipulated rate, *R,* to efficiency, *E.* Each graph has rate, *R,* varying along the horizontal axis from 83 to 500 Wpm, and efficiency, *E,* varying along the vertical axis. Efficiency, *E,* was

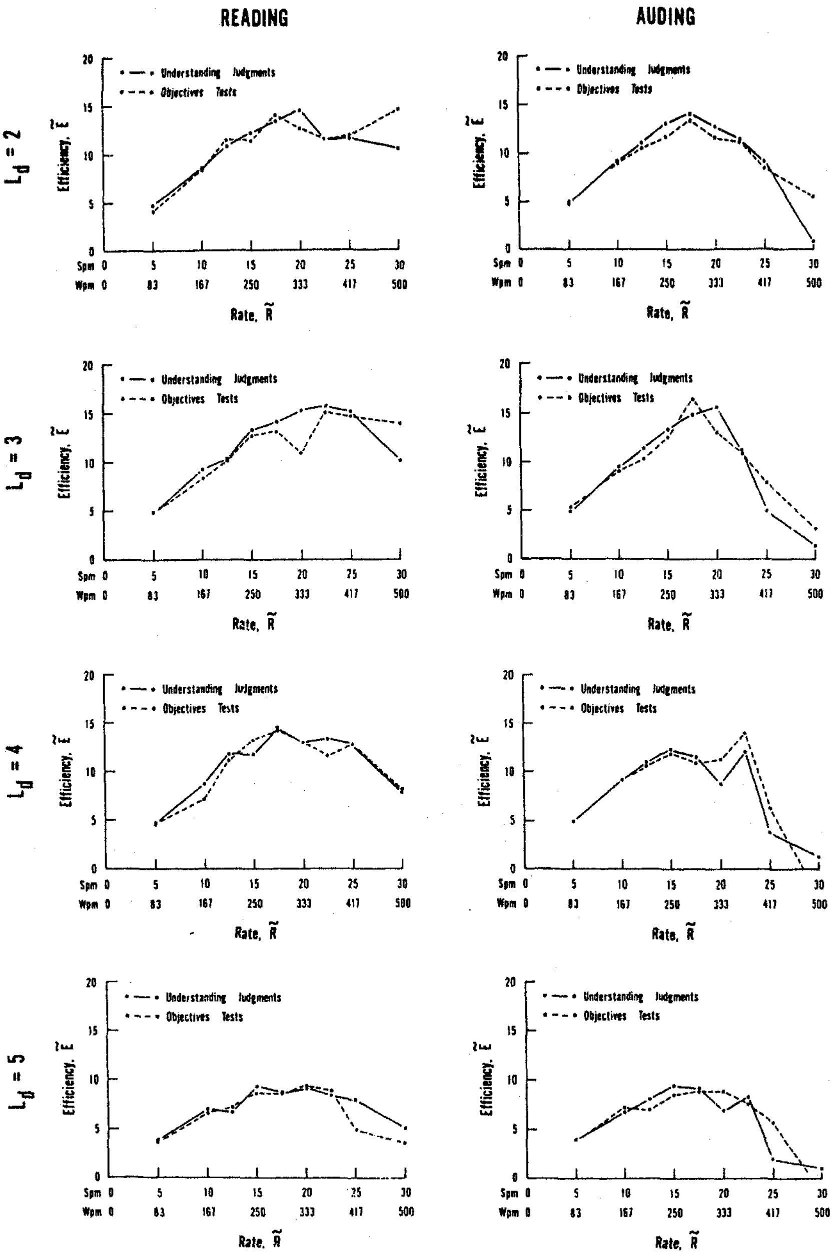

FIGURE 3 Estimated efficiency of passage comprehension, *E*, as a function of the estimated rate of passage comprehension, *R*, when accuracy of comprehension is estimated two ways, understanding judgments and an average of two objective tests. There are eight graphs, one for reading and one for auding at each of four levels of difficulty. The difficulty levels are as follows: $L_d = 2$ is $D_L = 4, 5, 6$; $L_d = 3$ is $D_L = 7, 8, 9$; $L_d = 4$ is $D_L = 10, 11, 12$; $L_d = 5$ is $D_L = 13, 14, 15$. From "Optimal rate of reading prose," by Ronald P. Carver, 1982, *Reading Research Quarterly, 18*, p. 71. Copyright by the International Reading Association. All rights reserved.

measured using Law 2 of rauding theory—that is $E = AR$. This means that the accuracy of comprehension, A, as determined from the Understanding Judgments (solid line in the eight figures) or from the Objective Test data (dashed line in the eight figures) was multiplied by the rate, R, that the passage was presented. Rate, R, was the number of thoughts in the passage (T_p) divided by the time (t) the passage was presented in minutes; T_p was measured in standard-length sentences, defined earlier as 16.67 standard-length words.

Four of the graphs in Figure 3 represent the results from passages presented visually for reading (left column) and the other four graphs represent the results from passages presented auditorily for listening (right column). There are four rows of graphs with a reading and auding graph in each row, and each row represents passages at different levels of difficulty. The two graphs in the top row contain the results for elementary school passages ($D_L = 4, 5, 6$), the second row contains the results for junior high school level passages ($D_L = 7, 8, 9$), the third row contains the results for high school level passages ($D_L = 10, 11, 12$), and the bottom row contains college level passages ($D_L = 13, 14, 15$).

The result immediately apparent from inspecting these eight graphs in Figure 3 is that each of the 16 curves represented by the solid and dashed lines (two curves in each of the eight graphs) is shaped as an inverted U. In general, the curves for the Objective Test data are in an inverted U shape and replicate almost exactly the curves for the Understanding Judgments data in each of the eight graphs. For both the Understanding Judgments and the Objective Test data, efficiency generally has an optimum, a maximum, or a peak, around 300 Wpm, and this is the most important aspect of these data. This means that as rate, R, increases (starting at 83 Wpm), efficiency, E, also initially increases. However, when R reaches about 300 Wpm (or 18 Spm), then efficiency, E, reaches its maximum. As R continues to increase to 500 Wpm (or 30 Spm), efficiency, E, declines. These data are not perfectly consistent in that the highest E value for the curve for the Objective Test data on the graph for reading passages at the elementary school level difficulty was not close to 300 Wpm. However, this result appears to be an anomaly because in 15 of the 16 curves, the highest point on the curve was close to 300 Wpm.

According to Law 3 of rauding theory, it was no accident that the highest point on 15 of the 16 curves in Figure 3 was around 300 Wpm for these college students. Individuals tend to read all material at their rauding rate, a constant rate, because they can comprehend the most sentences per minute at this rate, no matter whether the sentences are at elementary school difficulty, junior high difficulty, high school level difficulty, or college level difficulty. Furthermore, it does not matter whether the sentences are presented visually for reading or auditorily for listening, their most efficient rate is their rauding rate, R_r.

Rauding theory acknowledges that humans are very efficient information processors, in that they have learned to operate their rauding process at a constant rate because that rate is most efficient (around 300 Wpm for college students). Slower rates than R_r and faster rates than R_r result in less efficiency—that is, fewer sentences comprehended per minute. Individuals do not speed up to a rate higher than their rauding rate when they are given very easy material to read at Grade Levels 4, 5, and 6, because if they were to speed up to a rate higher than their rauding rate they would comprehend less sentences per minute. Individuals do not slow down the rate at which they operate their rauding process on college level material—that is, slower than 300 Wpm—because if they did they would also comprehend fewer sentences per minute. They would comprehend fewer sentences per minute at rates higher than R_r, because they would not have the time required to successfully operate the three components of the rauding process—lexical accessing, semantic encoding, and sentence integrating—as discussed earlier in the One Second of Reading section.

Equations

Besides the three laws of rauding theory that apply to 1 min of reading, as presented in the previous section, theoretical equations based on these laws have also been presented (Carver, 1990b). Subsequently, Carver (1990a) collected data that allowed these theoretical equations to be precisely instantiated by empirically collected data. Given next is one of these mathematical formulas that allows the comprehension that occurs during 1 min of reading to be predicted:

$$A = \frac{tR_r}{T_p}[.04(A_L - D_L)+.64] \tag{1}$$

The A in Equation 1 symbolizes the accuracy of comprehension of text, or a passage, in the form of a proportion. As the amount of time, t, an individual is allowed to read a passage increases, the accuracy of comprehension, A, increases. As the rauding rate of the individual increases, R_r, then A also increases. If the length of the passage in standard-length sentences increases, symbolized as T_p, then the accuracy of passage comprehension decreases. If the rauding accuracy level, A_L, of the reader increases, then A increases. As the difficulty level of the passage, D_L, increases, then A decreases.

Equation 1 will be illustrated using a hypothetical example. Let us suppose we have a college student who (a) is reading at the 14th grade level ($A_L = 14$) and (b) has a rauding rate at 300 Wpm ($R_r = 18$ Spm). Furthermore, let us say that this student was given a 334-word passage ($T_p = 20$ standard-length sentences) to read for 1 min ($t = 1.0$), and that the passage was at the eighth grade level of difficulty ($D_L = 8$). When these hypothetical values are substituted into Equation 1, the result is $A = .79$—that is, it would be predicted that this student would comprehend 79% of the sentences, or complete thoughts, in the passage.

Equation 1 is appropriate as long as the reader is not allowed to spend more time reading than it takes to finish reading the passage once. In the previous example, this college student would require 1.11 min to finish reading the passage once because her rauding rate, or typical rate, was 18 Spm and the passage contained 20 standard-length sentences (20/18 = 1.11). If she had been given 1.11 min to read, then her accuracy of comprehension would have been 88% ($A = .88$). If she had been given more than 1.11 min to read this passage, then the following equation is needed:

$$A = \frac{\frac{t}{T_p}}{\frac{t}{T_p} + \frac{1}{R_r}\left[\frac{1}{.04(A_L - D_L) + .64} - 1\right]} \tag{2}$$

By using Equation 2, the percentage of the passage comprehension can be predicted when the time allowed for reading is more than enough to finish reading the passage once, thereby allowing the student to begin reading the passage again.

A considerable amount of data supporting the validity of Equations 1 and 2 have been collected (see review by Carver, 1990b). For example, Figure 4 (from Carver, 1984) contains data collected from 102 college students. The time allowed for reading, in minutes, is along the horizontal axis. Passages were presented for reading at five different lengths of time that varied from about 0.1 min to about 1.6 min. Notice that the accuracy of comprehension is along the vertical axis, which is represented by *A* in Equations 1 and 2. The accuracy of comprehension of the passages, *A*, was measured four different ways—Understanding Judgments, Best Titles Test, Missing Verbs Test, and Sentence Halves Test. Note that *A* was estimated to be approximately the same at each value of *t*—that is, the four data points were extremely close to each other at every value of *t*, except at about $t = 0.2$ where the four data points varied from about $A = .35$ to $A = .55$.

The most important aspect of Figure 4, however, is the extremely close association between the theoretical prediction curves (from Equations 1 and 2) and the data points. This means that the theoretically predicted values of accuracy of comprehension were extremely close to the empirically determined values no matter which of the four measures of comprehension were used.[1]

Rauding theory appears to have no competitors when it comes to predicting the accuracy of comprehension of passages around 100 to 300 words in length when they are read for around a minute. Stated differently, rauding theory seems to have

[1]Equations 1 and 2 presented earlier are actually empirically modified versions (based on research by Carver, 1990a) of the original Equations 1 and 2 involved in this 1984 research.

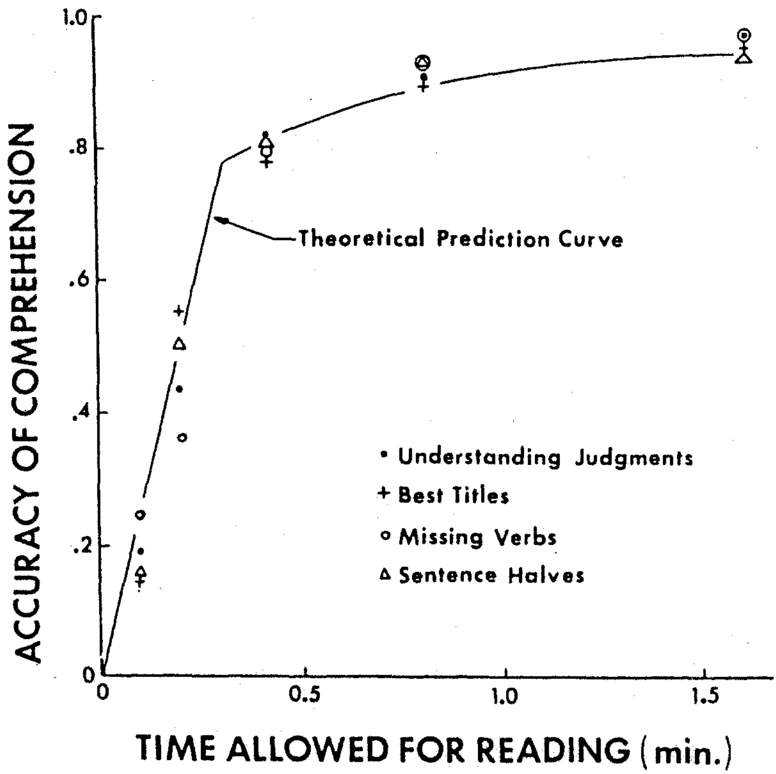

FIGURE 4 Accuracy of comprehension as a function of the time allowed for reading in minutes, for four different measures of comprehension. Also presented is the independently derived and theoretically predicted relation between accuracy of comprehension, *A*, and time, *t*. From "Rauding theory predictions of amount comprehended under different purposes and speed reading conditions," by Ronald P. Carver, 1984, *Reading Research Quarterly, 19,* p. 215.

no competitors when it comes to predicting the percentage of a book that has been comprehended after it has been read twice, for example.

Equations 1 and 2 also have implications for how educators (or researchers), can intervene to increase the accuracy of comprehension of students. First, consider the passage, chapter, or entire book. If students in a class are having trouble comprehending a textbook, for example, the textbook can be replaced with one at a lower level of difficulty. The gain in the accuracy of comprehension from the first textbook to the second textbook can be predicted quite accurately from the different values of D_L. Of course, if the purpose is to challenge students to learn more difficult material, then replacing the textbook with an easier one could be counter productive.

Second, consider the students who are reading the textbook. Their rauding rate, R_r, is relatively constant and cannot be improved or changed in a short period of time. Their rauding accuracy level, A_L, is relatively constant and also cannot be improved or changed during a short period of time. Parenthetically, it should be noted that R_r and A_L are factors that can be influenced or improved during 1 year of reading, which will be discussed in the next major section.

From the information just given, it can be deduced that only time, t, can be manipulated to increase the accuracy of comprehension on a daily basis. If a teacher wants a higher level of accuracy of comprehension for a textbook, then the teacher can induce students to spend more time reading the book.

In summary, there are a great deal of data supporting the constructs, laws, and equations of rauding theory that attempt to describe, explain, predict, and control the comprehension that occurs when individuals read text or passages normally for around 1 min or 1 hr. There are no known data that indicate rauding theory is invalid for situations involving 1 min of typical reading. The lawfulness of operating the rauding process for 1 min is quite remarkable, and that lawfulness has been summarized in rauding theory by (a) three laws and (b) Equations 1 and 2.

ONE YEAR OF READING

Causal Model

Although the predictions emanating from rauding theory that are relevant to 1 min of reading have been studied for several years, only recently has rauding theory been expanded to 1 year of reading. A causal model of the primary factors that purportedly cause high and low reading achievement is presented in Figure 5. From this model, gain in reading achievement over a year of time can be predicted.

Before considering the substantive details of this causal model in Figure 5, it will be helpful to point out that the theoretical constructs of rauding theory are presented inside the circles, and similar related concepts are presented above the circles. Below the circles are the abbreviated names of tests that have been used to measure the constructs; in the box toward the bottom of the figure are the full names of these tests. Descriptions of the tests are given later. In the box toward the top of the figure are theoretical equations and their qualifying conditions that are explained later.

In this causal model, the focus is on trying to improve rauding efficiency level, E_L, a construct very similar to reading achievement. This construct is also similar to an ability that Perfetti (1985) said he wanted to study when he used the term *reading skill,* which he described as follows: "Our intuitive concept of reading skill includes reading fast and reading with good comprehension" (p. 10). Furthermore, E_L also represents an ability that Perfetti (1985) referred to as *general reading ability,* because it includes both accuracy and rate. E_L also represents what is often

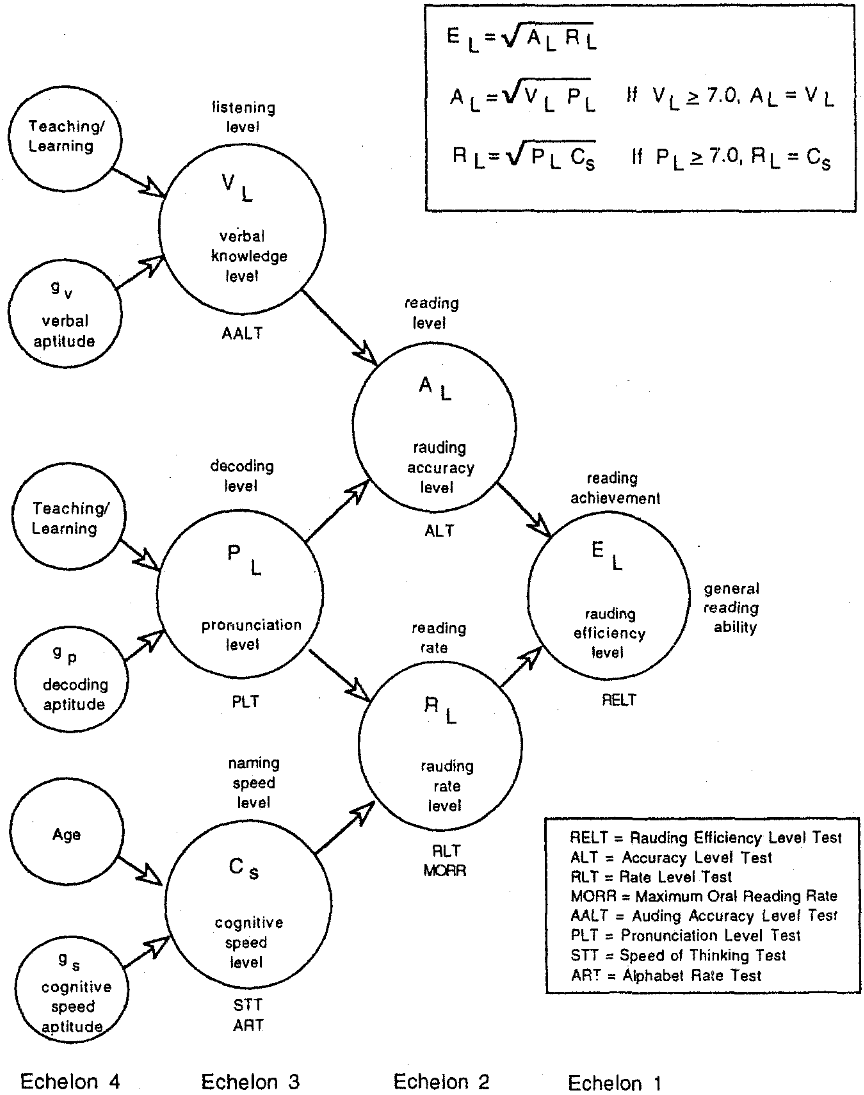

FIGURE 5 A causal model for reading achievement, which contains the primary factors that cause high and low reading achievement.

measured by standardized reading comprehension tests that involve answering multiple-choice questions on passages under a time limit wherein many of the students do not have time to finish. Finally, E_L is the focal point of this causal model because E_L is purported to represent what educators want students to improve each year—that is, an overall ability measured in GE units and called reading achievement.

From the arrows running between circles in the model, it can be seen that A_L and R_L are hypothesized as being the key determiners of E_L, or its proximal determiners. Notice also that there are four vertical columns of circles in Figure 5 that are labeled at the bottom as echelons. A_L and R_L are in Echelon 2, so the proximal causes of high and low reading achievement, high and low general reading ability, or high and low rauding efficiency level, E_L, are the two factors at Echelon 2 called rauding accuracy level, A_L, and rauding rate level, R_L. As discussed earlier, A_L is a construct that is similar to the traditional concept of reading level, or instructional level, and A_L will often be called "reading level" to facilitate communication. Also, as discussed earlier, R_L is rauding rate, R_r, expressed in GE units, and R_L will often be called "rate level" to facilitate communication. According to this causal model, the only way to get increases in reading achievement, E_L, is to increase reading level, A_L, or rate level, R_L (or rauding rate, R_r). In fact, this causal model holds that:

$$E_L = \sqrt{A_L R_L} \tag{3}$$

Equation 3 states the causal relation in precise mathematical form—that is, reading achievement, E_L, is equal to the square root of the product of reading level, A_L, and rate level, R_L.

It should additionally be noted that the general idea inherent in Equation 3 has roots at least as far back as Holmes and Singer (see Singer, 1965), who assumed that reading ability was composed of two equally important factors, called *speed* and *power*.

If reading achievement is determined by A_L and R_L, and we want to improve E_L then we need to know the factors that cause improvement in A_L and R_L; these factors are represented by the circles in Echelon 3, namely, V_L, P_L, and C_r. The proximal causes of reading level, A_L, are hypothesized to be verbal knowledge level, V_L, and pronunciation level, P_L. The construct V_L, verbal knowledge level, is similar to the more traditional concept of listening level, whereas the construct P_L, pronunciation level, is similar to the more traditional concept of decoding level. Improvement in reading level, A_L, purportedly is caused by improvement in listening level, V_L, or improvement in decoding level, P_L, according to the following equation:

$$A_L = \sqrt{V_L P_L} \tag{4}$$

Equation 4 expresses this causal relation in precise mathematical terms—that is, reading level, A_L, is equal to the square root of the product of listening level, V_L, and decoding level, P_L.

It should be acknowledged that Equation 4 was stimulated by the simple view of reading, espoused by Gough and Tunmer (1986) and Hoover and Gough (1990), that reading is made up of the product of listening and decoding. However, the theory associated with this simple view of reading generally has been closely connected to what happens during 1 sec of reading, whereas Equation 4 is not purported to have direct connections to 1 sec of reading.

With respect to rauding rate level, R_L, at Echelon 2, its proximal causes are hypothesized to be pronunciation level, P_L, and cognitive speed level, C_s, both at Echelon 3. Notice that P_L at Echelon 3 is purported to be a proximal cause of both A_L and R_L at Echelon 2. Cognitive speed level, C_s, is a construct that is similar to (a) the older concept of thinking rate (e.g., see Buswell, 1951) and (b) the newer concept of naming speed (e.g., see Spring & Capps, 1974). Cognitive speed level, C_s, will often be referred to as "naming speed level" to facilitate communication. According to the causal model, improvement in rauding rate level, R_L, comes from improvement in decoding level, P_L, or naming speed level, C_s, as summarized by the following equation:

$$R_L = \sqrt{P_L C_s} \tag{5}$$

Equation 5 states the causal relation in mathematical form—that is, rate level, R_L, is equal to the square root of the product of decoding level, P_L, and naming speed level, C_s.

Before continuing, it should be pointed out that all of the constructs in Echelons 1 to 3 must be measured in GE units, otherwise Equations 3 to 5 will not be appropriate. Furthermore, it may also be helpful to note that all of the constructs in Echelons 1 to 3 have a subscript L except one, C_s. These constructs in Figure 5 with a subscript L (E_L, A_L, R_L, V_L, and P_L) all represent achievement measures that educators, or education, should be able to improve by instruction. C_s does not have a subscript L, because in the causal model, education is purported to have little or no influence on it, as will become apparent later when its proximal causes in Echelon 4 are discussed.

All of the causal connections represented by Echelons 1, 2, and 3 have supporting data, some of which will be presented later. However, at present there are no measures and no data relevant to the hypothesized causal factors depicted at Echelon 4. Each of the three constructs at Echelon 3 has two causal factors at Echelon 4. Parenthetically, it may be noted that this causal model could be accurately described as a simple causal model of reading achievement in that each of the six factors in Echelons 1 to 3 is itself causally influenced by two, and only two, factors.

The two proximal causes of V_L, listening level, at Echelon 3, are two factors at Echelon 4, namely teaching and learning and verbal knowledge aptitude (g_v). This particular teaching and learning factor at Echelon 4 represents all of the teaching and learning experiences that somehow increase the listening level, or verbal knowledge level, of individuals. This factor can probably be described best by saying that it represents what Carroll (1967) meant when he said that most of the learning that occurs in school comes from telling things to students, whether orally or in print. He pointed out that even most visual learning is accompanied by words, as in the audio that accompanies videos and movies and the caption that gives meaning to a picture. So, if we want to improve V_L, so that A_L can be improved, which in turn improves E_L, then we can tell the things to students that we want them to know, because they learn the most from being told. This "telling" can take the form of lectures, videos, movies, and conversations, or it can take the form of reading challenging expository materials that expand knowledge. Listening level, V_L, should also be improved by instruction that focuses on learning words, ideas, and concepts, such as in the content areas of such traditional subjects as history, science, English, social studies, and language arts. Much of the research that has been conducted on text learning and schema theory is applicable to this causal connection between the teaching and learning factor and V_L in Figure 5.

Even though we often tell students in school what we want them to know, some students are likely to remember what they were told whereas other students are not. That is, there are individual differences with respect to what students can comprehend and remember from what they are told. This aptitude for being able to remember what we were told earlier is called verbal knowledge aptitude, g_v; it is the basic ability to store factual verbal information well enough to be able to recall it later on cue.

Students with high g_v will be able to store and remember more information from passages than students with low g_v. Perfetti (1985) was undoubtedly referring to a concept similar to g_v when he stated that "high ability readers remember more of what they have just heard or read than do low ability readers" (p. 96). This aptitude exists after we have controlled for differences in background knowledge and vocabulary. It is a basic aptitude that probably is little influenced by education or experience.

As an example of how verbal knowledge aptitude, g_v, and teaching and learning experiences are the two proximal causes of verbal knowledge level, V_L, consider two students in Grade 4 who have the same verbal knowledge level, say $V_L = 4$. However, one may have low verbal knowledge aptitude, g_v, but have had excellent teaching and learning experiences so that the fourth grade level of V_L has been achieved by Grade 4. The other student may have high verbal knowledge aptitude,

g_v, but have had extremely poor teaching and learning experiences so that the fourth grade level of V_L has also been achieved by Grade 4.

With respect to the causes of decoding level, P_L, at Echelon 3, there are two causal factors at Echelon 4; they are hypothesized to be teaching and learning and decoding aptitude (g_p). The teaching and learning experiences that cause improvement in decoding level are probably those that foster learning the alphabetic principle in beginning readers (phonological coding) and foster orthographic skills in intermediate readers, such as spelling instruction and high volume of reading. However, the same instruction is likely to result in different decoding levels because of individual differences in decoding aptitude, g_p. (Note: The subscript p in g_p came from the P in P_L.)

Some students are more likely to learn and remember sound–symbol correspondences than others. Individuals with high g_p will be able to learn faster and remember better the sounds that go with letters and spelling patterns in words. Therefore, two students in Grade 4 may have the same decoding level, say $P_L = 4$, but different decoding aptitudes. One may have low g_p, but may have had excellent teaching and learning experiences relevant to decoding and thereby achieved $P_L = 4$. The other student may have high g_p, but may have had extremely poor teaching and learning experiences relevant to decoding and thereby also achieved $P_L = 4$ by the fourth grade.

With respect to cognitive speed level, C_s, at Echelon 3, the two causal factors at Echelon 4 are hypothesized to be age and cognitive speed aptitude (g_s). This means that between at least Grade 1 and Grade 8, it is theorized that an individual's GE for C_s will go up 1 year due to maturation alone. The other factor influencing C_s is g_s, but this is misleading because cognitive speed level, C_s, normed for age is g_s. Therefore, C_s and g_s reflect the same ability, except C_s is expressed in GE units and allows absolute comparisons between individuals of different ages, whereas g_s is age normed so that it reflects aptitude with respect to individuals at the same age.

The three aptitude factors at Echelon 4—g_v, g_p, and g_s—would be readily expressed in standard score units, such as z-scores and T-scores, and would therefore be similar to IQ scores from the standpoint of units of measurement. However, IQ tests generally represent an average over many mental abilities of which g_v or V_L is likely to be heavily represented, with g_p and g_s minimally represented or not represented at all.

Previous Theory and Data

Now that the causal model has been described in some detail, it is related more closely to previous theory and data. Five ideas need to be considered.

First, the idea that rauding efficiency level, E_L, represents approximately the same ability as what is measured by traditional reading comprehension tests, and that it is composed of an accuracy factor and a rate factor, has received a great deal of empirical support, especially from such traditional reading comprehension tests as the Nelson–Denny and the Iowa Test of Basic Skills, (ITBS) as well as other comprehension tests (Carver, 1992a, 1992b).

Second, the idea that listening level and decoding level are the primary factors influencing reading level has received direct support from Carver (1993) and indirect support from research on the original simple view of reading (e.g., see Hoover & Gough, 1990), as noted earlier.

Third, the idea that decoding level and naming speed level combine to form the two causal factors in influencing typical reading rate, or rauding rate level, R_L, seems to have no direct historical roots in theory.

Fourth, the idea that verbal knowledge aptitude, decoding aptitude, and naming speed aptitude are very important factors in reading is very similar to the conclusions drawn by Stanovich, Cunningham, and Feeman (1984), who advanced verbal comprehension, decoding accuracy, and decoding rate as three relatively independent abilities that are important in predicting early reading progress.

Fifth, the idea that reading achievement (at Echelon 1) is primarily influenced by the quality of education, age, and three aptitude factors (at Echelon 4) is hardly new in a general sense. It is an old idea in that we have always known that education in general, and teachers and textbooks in particular, can have major effects when they are successful in pushing hard on the two teaching and learning buttons at Echelon 4. It is also an old idea in the sense that it endorses the arguments presented by Siegel (1989), Stanovich (1991), and Aaron (1991) that *g*, or IQ, or general intelligence, should not be used to estimate potential in reading because *g* or IQ are not highly related to reading achievement; however, in the causal model, g_v, g_p, and g_s are very specific aptitudes that affect reading achievement.

The ideas represented at Echelon 4 are new in the sense that they are counter to the proposal by Stanovich (1991) that listening replaces intelligence as a measure of potential. The discrepancy between listening level, V_L, and reading level, A_L, cannot indicate potential in the traditional sense that the wider the discrepancy the more potential individuals have for improving their reading level. For example, if an individual has a listening level at Grade 8 ($V_L = 8$) and a reading level at Grade 4 ($A_L = 4$), then this person has a large discrepancy and would purportedly have a great deal of potential for improvement. According to Equation 4, however, the decoding level of this individual would have to be at the second grade level ($P_L = 2$), and the cause for this low decoding level would likely be a very low decoding aptitude, g_p. This student would not have large potential unless g_p was high and the student had had very poor teaching and learning experiences. In any event, potential would be indicated by g_v, g_p, and g_s, not by the discrepancy between listening level, V_L, and reading level, A_L.

The previous point about potential can be summarized as follows: (a) those students with high g_v, g_p, and g_s have the most potential and are likely to be the best readers, and (b) those students with low g_v, g_p, and g_s have the least potential and are likely to be the worst readers. The low aptitude students are the ones who are most likely to frustrate educators, whereas the students who have mixtures of highs and lows with respect to g_v, g_p, and g_s are the ones likely to present great challenges from a theoretical, diagnostic, and an instructional standpoint.

Reading Disabilities

The causal model presented in Figure 5 has implications for diagnosing reading disabilities. Those individuals who have a low E_L for their age are poor readers or problem readers. They can be diagnosed as having accuracy or rate disabilities, or both (at Echelon 2). Parenthetically, it may be noted that Lovett (1984) seems to be the first to advocate accuracy and rate disabilities, but her diagnoses were based more on measures similar to P_L plus a mixture of R_L and C_s. The causes of disabilities in accuracy and rate (at Echelon 2) can be diagnosed as due to disabilities in listening level, decoding level, or naming speed level (at Echelon 3). This system of diagnosis is currently being researched, and it should be possible in the future to predict potential for improvement due to intervention, from measures of g_v, g_p, and g_s.

In the past, those individuals labeled as dyslexics probably have been students with high g_v and a low g_p. The high g_v probably explains why dyslexics have an average or higher IQ score, because these tests often reflect crystallized intelligence in the form of verbal knowledge. However, the probable low g_p of dyslexics is likely to prohibit them from making good progress in improving their decoding level, P_L. Many dyslexics probably also suffer from low g_s, as the naming speed research reviewed by Wolf (1991) would indicate. Low speed of naming overlearned symbols, such as digits and letters in continuous lists, has been shown to be a frequent characteristic of dyslexics (e.g., see Bowers, Steffy, & Tate, 1988; Wimmer, 1993).

Given that IQ tests have traditionally been used to diagnose reading disabilities (e.g., see Siegel, 1989), it is important to analyze the IQ test in terms of the causal model. If an IQ measure contains subtests that are loaded heavily on g_v, g_p, and g_s, then the IQ test probably will correlate relatively high with E_L because these three factors are distal causes of E_L. Most IQ tests, however, contain a sampling of the eight cognitive abilities that Carroll (1993) proposed as being the components of g, or general intelligence, namely, fluid intelligence, crystallized intelligence, general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness, and processing speed. If an IQ measure contains subtests that do not load heavily on the g_v, g_p, and g_s factors, then the IQ score is not likely to correlate highly with E_L.

Knowing g_v, g_p, and g_s should be very helpful with respect to diagnosing why an individual is relatively low in reading achievement. If an individual is low on V_L and high on g_v, this will suggest that this individual has had poor instruction with respect to verbal knowledge improvement; therefore, instructional intervention in this area is likely to result in relatively quick and large improvements in V_L. If an individual with low V_L also has a low g_v, then this will suggest that the reason V_L is low is not because of poor instruction in this area; instead, the implication would be that remedial instruction in this area would result in relatively slow and small improvements in V_L. Similarly, if an individual is low on P_L and high on g_p, this would suggest relatively poor prior instruction in decoding, so that good future instruction should result in relatively quick and large improvements in P_L. If g_p is low, then this would suggest that instruction is likely to result in relatively slow and small improvements in P_L. Finally, if g_s is low, then this would suggest that this student will probably always require more time to read, compared to peers, so that this student should always be given extra time to read whenever possible.

As noted earlier, students with high aptitudes in g_v, g_p, and g_s are highly likely to be good readers, whereas students with low g_v, g_p, and g_s are highly likely to be poor readers. However, as the causal model indicates, achievement is also highly influenced by teaching and learning experiences relevant to V_L and P_L. It should also be noted that diagnosing the reading disabilities, such as has been outlined in this section, has been modified slightly so as to be appropriate for adult readers, and that will be explained in the next section.

In summary, the basic causes of poor reading achievement are rooted in the factors at Echelon 3—listening level, decoding level, and naming speed level. Disabilities in these factors are most likely due to low aptitudes at Echelon 4—that is, low g_v, g_p, or g_s. Therefore, remediation is likely to come from education or treatment focused on verbal knowledge, when it is low, and focused on decoding ability when it is low. The relative success of an intervention probably is predictable from whether g_v, g_p, and g_s are high, average, or low.

Adult Readers

The causal model depicted in Figure 5 is most relevant to lower grade readers and middle grader readers. In the future, it may need to be modified for lower grade readers. The model has already been modified to be more appropriate for adult readers through a modification that involves distinctions among beginning readers, intermediate readers, and advanced readers. A *beginning reader* has not reached a reading level of Grade 2 ($A_L < 2.0$). An *intermediate reader* has reached a reading level of Grade 2 ($A_L > 1.9$), but has not yet become an advanced reader. An *advanced reader* is defined as one who has $V_L > 6.9$, $P_L > 6.9$, and $C_s > 6.9$. Modifications in the causal model are needed for advanced readers.

When individuals become advanced readers—about Grade 8 or higher in reading achievement—then it is hypothesized that P_L drops out as a causal factor in the model. So, V_L and A_L become synergistic or redundant; improving listening level,

V_L automatically results in the same improvement in reading level, A_L, and vice versa. In the causal model, the following equation applies:

$$A_L = V_L \text{ when } V_L > 6.9 \tag{6}$$

This equation was stimulated by theory and research, such as the work reviewed by Sticht and James (1984), who presented data indicating that reading ability and auding ability become equal at Grade 7.

P_L also drops out as a causal factor for R_L when reading achievement reaches about Grade 8. Then, it is hypothesized that R_L is primarily determined by C_s, and they become mostly redundant. In the causal model, the following equation has been hypothesized:

$$R_L = C_s \text{ when } P_L > 6.9 \tag{7}$$

Equations 6 and 7 also indicate that for typical students in Grade 8 and higher, including many adults and most college students, improvement in E_L can only come from improvements in V_L and/or A_L. Improving rate level, R_L, is unlikely because it is probably limited solely by cognitive speed. Thus, improving E_L probably can only come from increases in verbal knowledge, unless these older students happen to have some type of reading disability that can be remediated.

Example

Now that the causal model has been presented and discussed, an example is given to illustrate how it works from a mathematical modeling standpoint. In Table 4, the scores obtained by a hypothetical student, Paul, have been presented for the beginning of three school years—Grade 4.0, Grade 5.0, and Grade 6.0. At the beginning of Grade 4.0, Paul was above grade level in listening ($V_L = 5.0$) but below grade level in decoding ($P_L = 3.0$) and naming speed ($C_s = 3.0$). When the aforementioned values of V_L and P_L are substituted into Equation 4, reading level was found to be 3.9. When the values of P_L and C_s were substituted into Equation 5, rate level was found to be 3.0. When $A_L = 3.9$ and $R_L = 3.0$ were substituted into Equation 3, then reading achievement or general reading ability was found to be 3.4—that is, $E_L = 3.4$.

In this hypothetical example, Paul had normal experiences in the fourth grade and gained 1.0 GE in each of V_L, P_L, and C_s so that A_L, R_L, and E_L all showed a 1.0 GE gain also. However, in Grade 5 Paul did not read anything, and he also did not do any writing or spelling either. Paul therefore did not gain in decoding level during Grade 5 ($P_L = 4.0$). Paul did listen and learn from what he was told, and he did participate in conversations during the year so he was able to gain 1.0 in listening level ($V_L = 7.0$). Paul also matured 1 year so his naming speed level increased 1.0

TABLE 4
Predictions of Gain in Reading Achievement for a Hypothetical Student Named Paul

Grade	*Date*	V_L	P_L	C_s	A_L	R_L	E_L	*Gain*
4.0	Aug 92	5.0	3.0	3.0	3.9	3.0	3.4	—
		(Paul had a normal fourth grade.)						
5.0	Aug 93	6.0	4.0	4.0	4.9	4.0	4.4	1.0
		(Paul did not read during fifth grade, and he did not do any spelling either.)						
6.0	Aug 94	7.0	4.0	5.0	5.3	4.5	4.9	0.5

GE units (C_s = 5.0). When these values for V_L, P_L, and C_s were substituted into Equations 4 and 5, and then these results were substituted into Equation 3, we find that Paul gained 0.5 GE units in reading achievement or general reading ability—that is, his E_L increased ½ of a GE from 4.4 to 4.9.

The example in Table 4 indicates that the model predicts that a student will gain ½ of a GE unit in reading achievement even if the student does no reading during the year—that is, the student does not improve his or her decoding level during the year. One implication of this mathematical modeling is that teachers who deemphasize learning experiences that might have a direct and significant impact on decoding level will still have students who show nontrivial gains in reading achievement, when achievement is measured by a traditional reading comprehension test that reflects rate as well as accuracy. Another implication of this mathematical modeling is that educators who emphasize decoding for one entire year may only get a 0.5 GE improvement when they measure reading achievement using a traditional standardized reading comprehension test that reflects reading efficiency.

Empirical Evidence

In this section, evidence will be presented relevant to the validity of Equations 3, 4, and 5 that express the causal relations among Echelons 1, 2, and 3.

Figure 6 contains a summary of data relevant to the validity of Equation 3, that E_L is equal to the square root of the product of A_L and R_L. Notice in this figure that the symbol E_L' was used. A prime was added to the symbol for the value of E_L predicted from A_L and R_L to discriminate between E_L that is measured directly by a test and E_L predicted from A_L and R_L using Equation 3—that is:

$$E_L' = \sqrt{A_L R_L} \tag{8}$$

The data in Figure 6 came from 97 students in Grades 3 to 12 who were administered three tests—the Rauding Efficiency Level Test (RELT; Carver,

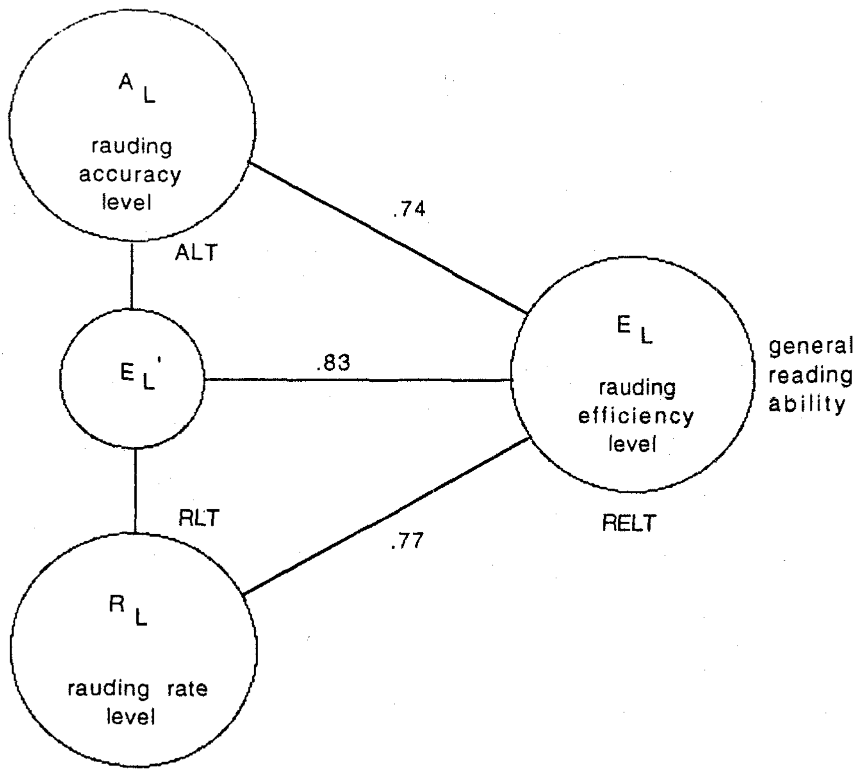

FIGURE 6 Empirical evidence relevant to reading achievement, E_L, being the square root of the product of reading level, A_L, and rate level, R_L; the three partial correlation coefficients involving 97 students in Grades 3 to 12 have been controlled for grade in school.

1987), the Accuracy Level Test (ALT; Carver, 1990b), and the Rate Level Test (RLT; see Carver, 1990b). The RELT consists of 100-word paragraphs that increase in difficulty level from Grade 1 ($D_L = 1$) to Grade 18 ($D_L = 18$). As the passages presented on the RELT become more difficult, they also are presented for a lesser amount of time that is commensurate with the higher rate expected at that level. For example, the first grade level passage ($D_L = 1$) is presented at the rauding rate of students at $A_L = 1$, so that the time allowed to read the passage is what is required of an individual at $R_L = 1$ to finish reading the passage once. Then, the second grade level passage ($D_L = 2$) is presented for a lesser amount of time so that a person at $R_L = 2$ will have time to finish reading it once but a person at $R_L = 1$ will not. After each passage is presented, the individual is presented with paraphrases of the information that is in the passages, as well as nonparaphrases. The task for the individual is to be able to correctly identify the paraphrases and the nonparaphrases. If a student gets 80% of these test items correct on Passage 4 ($D_L = 4$) but 60% or less of these paraphrase items correct on Passage 5 ($D_L = 5$), then E_L would equal 4 because Passage 4 would be the highest level of difficulty that the individual could accurately comprehend when the passage was presented at a rate comparable to the difficulty level. Note that each passage is presented at a higher rate but still requires accurate comprehension to pass (greater than 60%) so that the RELT measures rauding efficiency level, E_L, which is the highest level passage that the individual can read efficiently.

The indicator of reading level, A_L, in Figure 6 came from the ALT. At the time this test was administered, it contained 100 vocabulary items that had been shown to reflect the reading level, A_L, of the student. The indicator of rauding rate level, R_L, in Figure 6 came from the RLT. This test involves passages at the second grade level of difficulty that have been modified so that a word is added every fourth word to create a test item; the task for the examinee is to choose the word that belongs in the passage from the two choices presented every fourth word and to do this as fast as possible. Note that the partial correlation between A_L and E_L was .74, controlled for grade, and the partial correlation between R_L and E_L, controlled for grade, was .77. However, the most important result in Figure 6 was the correlation between (a) E_L, as measured by the RELT and (b) E_L', as calculated by substituting the scores for A_L and R_L into Equation 8. Notice that this partial correlation between E_L and E_L' was .83, which was quite high considering that the reliability of the RELT was probably not any higher than this. The data in Figure 6 provide strong support for Equation 8 as well as the empirical techniques used to estimate A_L, R_L, and E_L.

Some researchers may object to reading level being estimated by a vocabulary test. There is evidence directly relevant to the validity of this indicator (Carver, 1992a, 1992b). However, it is also important to point out that this value of E_L' that was derived from GE scores on a vocabulary test and GE scores from a rate test substituted into Equation 8 correlated considerably higher with scores on the ITBS–Comprehension ($r = .85$) than did the more authentic measure of E_L from the RELT ($r = .67$), for 56 students in Grades 3 to 8 (see Carver, 1992b). The reason that the more authentic measure correlated lower with another purported efficiency measure, as compared to a surrogate derived from a vocabulary test and a rate test, probably is due to the RELT having lower reliability than E_L'. The E_L' scores were derived from the ALT and RLT, and their reliability coefficient as an indicant of E_L is reported to be .88 for students in Grades 5 and 6 (Carver, 1994a).

Before continuing, it should be noted that research published before 1995 did not use Equation 8 for predicting E_L from A_L and R_L (e.g., Carver, 1992b); the formula used in earlier research was $E_L' = (A_L + R_L)/2$—that is, the arithmetic mean of A_L and R_L. However, it should also be pointed out that the advantages of using Equation 8 are more theoretical than practical because the partial correlation between the two previously mentioned measures (from Equation 8 and from the arithmetic mean) was .998 for the 97 students in the research just discussed. The main advantage of Equation 8 is that it makes E_L' equal 0 when either A_L or R_L is zero, and this is theoretically appealing because it is not logical to have an efficiency level higher than zero if either A_L or R_L is zero.

The correlational data presented earlier in Figure 6 are relevant to the validity of the causal relation between Echelons 1 and 2 of the model, along with the posited mathematical relation represented by Equations 3 and 8. Next, correlational data is presented relevant to the causal relations between Echelons 2 and 3, and their posited mathematical relations as contained in Equations 4, 5, 6, and 7.

Figure 7 contains data relevant to the validity of listening level, V_L, and decoding level, P_L, at Echelon 3, being the proximal causes of reading level, A_L, at Echelon 2, as posited by Equation 4. To facilitate communication, a distinction is made between A_L measured directly using the ALT, as described earlier, and A_L predicted from a measure of listening level (from the Auditory Accuracy Level Test [AALT]) and a measure of decoding level (from the Pronunciation Level Test [PLT]). The AALT is a vocabulary test that is presented auditorily, and the PLT is a word identification test.[2] This predicted reading level will thus be symbolized by an attached prime as follows:

$$A_L' = \sqrt{V_L P_L} \tag{9}$$

The correlational data in Figure 7 came from four different data collection efforts—Studies 1, 2, 3, and 4. Study 1 involved 52 students in Grades 3 to 5 who had no missing data (see Carver & Leibert, 1995, for more methodological details). Out of each set of four coefficients in Figure 7, the first was the partial correlation controlling for grade in school from Study 1. For example, the partial correlation between listening level, V_L, and decoding level, P_L, was .52 for Study 1.

Study 2 involved 104 students in Grades 2 to 11 who had no missing data (see Carver, in press, for a more detailed description of methodology). Out of each set of four coefficients in Figure 7, the second was the partial correlation controlling for grade in school for Study 2. For example, the partial correlation between listening level, V_L, and reading level, A_L, was .83 in Study 2.

Study 3 involved 64 college students who had no missing data (see Carver, in press, for a more detailed description of methodology).[3] Out of each set of four

[2]For these data in Figure 7, the ALT, AALT, and the PLT all used the same words. Carver (1996) studied the effect of using the same or different words (from different test forms) on these three tests, and no important effect was found.

[3]The Carver (in press) research involved tests of fluid intelligence and memory capacity such that the n for no missing data was 62, whereas the n for no missing data here in Study 2 was 64.

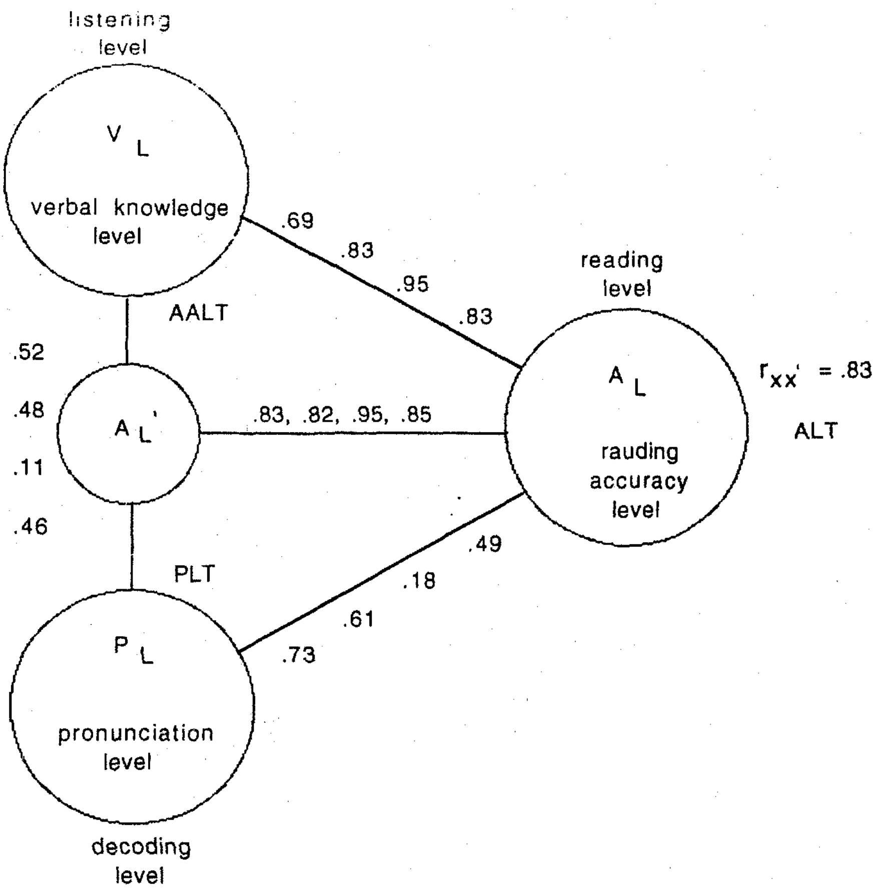

FIGURE 7 **Empirical evidence relevant to reading level, A_L, being the square root of the product of listening level, V_L, and decoding level, P_L; each set of four correlations represent results from four different research studies.**

coefficients, the third represents the simple correlation from Study 3. For example, the correlation between decoding level, P_L, and reading level, A_L, was .18 in Study 3.

Study 4 involved 128 community college students with poor reading ability (see Carver & Clark, 1996, for a more detailed description of methodology). Out of each set of four coefficients, the fourth represents the simple correlation from Study 4. For example, the correlation between A_L' (from Equation 9) and A_L (from the ALT) was .85 in Study 4.

It may be noted in Figure 7 that each set of four coefficients was approximately the same size except for the coefficients involving P_L in Study 3; however, this was as expected from Equations 6 and 7 presented earlier, because P_L is theoretically expected to drop out of the causal model when students reach about Grade 7 or 8 in reading ability, as was the case for all of these 64 college students. The coefficients involving P_L in Study 3 were therefore lower than the corresponding coefficients for Studies 1, 2, and 4 (.11 for P_L and V_L; .18 for P_L and A_L); the coefficient for V_L and A_L in Study 3, .95, was higher than in the other three studies, as was expected because V_L and A_L theoretically were supposed to become synergistic above $V_L = 6.9$.

The most important findings presented in Figure 7 are the four correlations representing the relation between A_L' and A_L. These were all extremely high correlations, ranging from .82 to .95. For each of the four studies, the correlation between A_L' and A_L was the highest of the four correlations involved in Figure 7. Also, it should be noted that the reliability coefficient for ALT reported in the manual was .83 (Carver, 1994b). Because the four correlations between A_L' and A_L were all approximately equal to .83, or higher, this means that all of the reliable variance in reading level, A_L, is probably accounted for by listening level, V_L, and decoding level, P_L, via the theoretical relation expressed in Equation 4 (and modified by Equation 6). It appears that there is strong correlational support for listening level and decoding level being the proximal causes of reading level according to the causal model and Equations 4 and 6.

Figure 8 contains data relevant to decoding level, P_L, and naming speed level, C_s, at Echelon 3, being the proximal causes of reading rate, R_L, at Echelon 2, according to the theoretical relation posited by Equations 5 and 7. Again, it will be helpful to create a special symbol to represent R_L as predicted from decoding level, P_L, and cognitive speed level, C_s. A prime has thus been added as follows:

$$R_L' = \sqrt{P_L C_s} \tag{10}$$

As indicated in Figure 8, naming speed level, C_s, was measured by two tests—the Speed of Thinking Test (STT) and the Alphabet Rate Test (ART). The STT involves the speed of deciding whether a capital letter and a lowercase letter, such as Ab, have the same name. The ART involves naming continuous lists of randomized letters of the alphabet as fast as possible. Evidence for the validity of these two measures as indicators of C_s has been presented elsewhere (Carver, 1991).

Figure 8 also shows that R_L is measured by two tests—the RLT and the Maximum Oral Rate Test (MORR). The RLT was described earlier. The MORR involves reading a passage at the second grade level of difficulty as fast as possible. Evidence to support the RLT and the MORR as indicators of R_L has been presented elsewhere (Carver, 1991).

Figure 8 is similar to Figure 7 described earlier in that the data involves correlations from the same four studies that were described earlier in connection with Figure 7. Furthermore, the pattern of results is very similar. The correlations

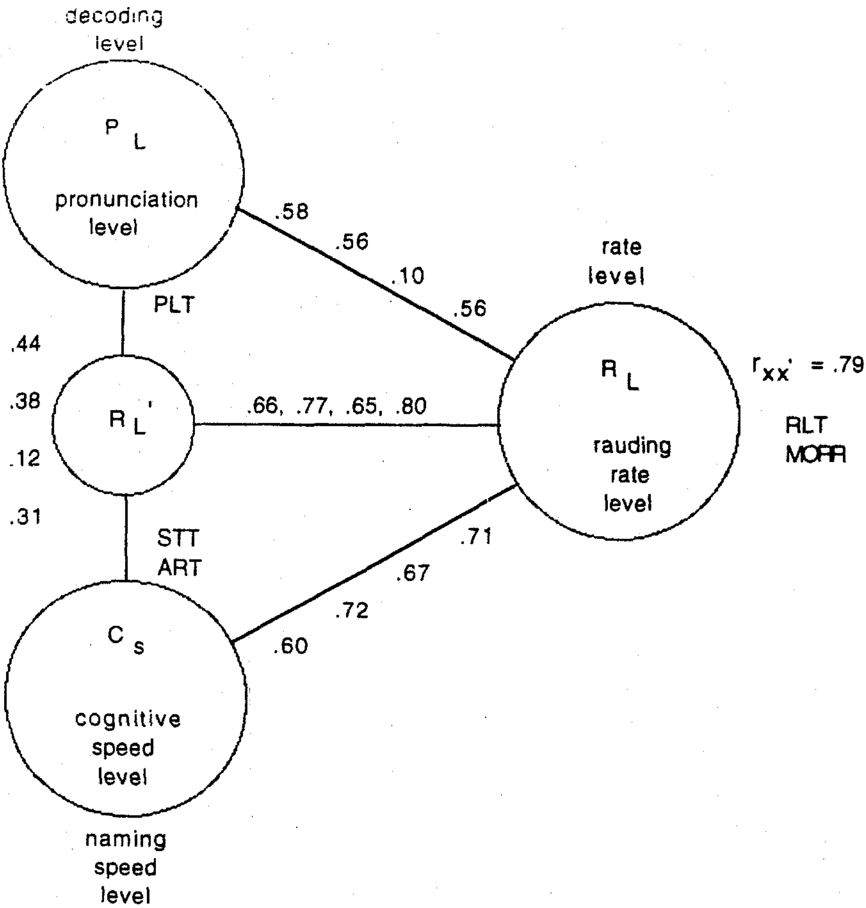

FIGURE 8 Empirical evidence relevant to rate level, R_L, being the square root of the product of decoding level, P_L, and naming speed level, C_s; each set of four correlations represents results from four different research studies.

involving P_L in Study 3 are smaller than the corresponding ones from the other three studies because P_L has dropped out as a causal factor for R_L for these college students, as explained earlier. Again, the correlation between R_L' *and* R_L is the highest of the four correlations for each of the four studies, except for Study 3 where the correlation between C_s and R_L was the highest, as would be expected. For these data, the reliability coefficient reported for the criterion variable, R_L, was .79 (see Carver, 1994b), and the four correlations between R_L' and R_L were all approximately equal to .79, or somewhat smaller, ranging from .66 to .80.

The data in Figure 8 suggest that almost all of the reliable variance in rate level, R_L, can be accounted for by decoding level, P_L, and naming speed level, C_s, according to the theoretical relation posited by Equation 5 as modified by Equation 7.

In summary, it appears from the data presented in Figures 6, 7, and 8 that there is strong correlational support for the proximal causes depicted in the causal model for Echelons 1, 2, and 3 and represented mathematically by Equations 3 to 7. Again, no correlational data exist at present to support the proximal causes hypothesized at Echelon 4, and there is no direct experimental support for any aspect of this causal model. However, structural equation modeling was applied to the partial correlations (controlled for age) for all the individuals in both Studies 1 and 2 ($N = 156$), and the causal model in Figure 5 fit the data with a goodness of fit of .99, using Bentler and Bonett's (1980) normed fix index. It should be pointed out that the exceptionally good fit involved six variables (V_L, P_L, C_s, A_L, R_L, and E_L) but the E_L variable was not independent of A_L and R_L because it was derived by substituting A_L and R_L into Equation 8.

UNIFYING THE THREE SLICES OF TIME

Now that the details underlying how rauding theory is relevant to 1 sec, 1 min, and 1 year of reading have been presented, it is appropriate to point out how rauding theory has unified these three slices of time. This unification revolves around the fact that rauding accuracy level, A_L, and rauding rate level, R_L (or rauding rate, R_r) are both directly involved in reading for 1 sec, 1 min, and 1 year. Again, note that when rauding rate is symbolized as R_r this means that it is measured in rate units, whereas when rauding rate is symbolized as R_L this means that it is measured in GE units.

During 1 sec of rauding, or one eye fixation on a standard-length word when individuals are reading relatively easy material, the time required in milliseconds for this process to operate successfully can be determined. It is $60{,}000/R_r$ when R_r is measured in standard-length words per minute. For example, 200 msec would be required for a college student with a rauding rate, R_r, of 300 standard-length words per minute. So, the minimum time required for the components of the rauding process—lexical accessing, semantic encoding, and sentence integrating—to successfully operate can be determined from an attribute of the individual, R_r. Also, the materials that individuals can be expected to successfully raud during 1 sec of reading can be determined from their difficulty level in relation to another attribute of the individual, A_L; the rauding process is more likely to operate successfully when the material being read is relatively easy ($A_L > D_L$). Researchers who are interested in studying what happens during 1 sec, or one eye fixation during the execution of the rauding process, can try to induce the rauding process by using passages wherein $A_L > D_L$ and allowing at least $60{,}000/R_r$ msec per standard-length word.

Next, let us consider 1 year of reading. When educators are successful in pushing the two teaching and learning buttons in Echelon 4 of the causal model, they get improvement in reading level, A_L, and rate level, R_L, at Echelon 2, via improvement in listening level, V_L, and decoding level, P_L, at Echelon 3. Furthermore, as previously mentioned, improvement in rate level, R_L, automatically means improvement in rauding rate, R_r, because R_L in GE units is the same ability as R_r in Wpm. This improvement that educators get in A_L and R_L (or R_r) means that there will also be improvement in the accuracy of comprehension, A, during 1 min of reading, via Equations 1 and 2, as presented earlier.

The educators who are the most successful in helping students improve their listening level and decoding level during 1 year of reading in school will automatically be the most successful in helping students improve their accuracy of comprehending textbooks, novels, magazines, newspapers, and so forth, during 1 min (or 1 hr) of typical reading. Also, when A_L and/or R_L improves, then students can successfully operate the rauding process on more books and other materials and can complete the reading of these materials in less time because more can be accomplished in 1 sec of reading. Furthermore, the amount of improvement in the accuracy of comprehension of passages during 1 min of reading, A, can be predicted with the precision of mathematical formulas (via Equations 1 and 2) from the amount of improvement in listening level, V_L, and decoding level, P_L, during 1 year of reading in school (via Equations 3, 4, and 5).

SUMMARY AND CONCLUSIONS

Rauding theory purports to contribute to our knowledge of typical or ordinary reading (called the rauding process) during 1 sec, 1 min, or 1 year of reading by lower grade readers, middle grade readers, adult readers, and disabled readers. Rauding theory has little to contribute to our knowledge about such basic reading processes as skimming and scanning or learning and memorizing, except perhaps it may stimulate a better organization of that knowledge (see Carver, 1990b).

With respect to 1 sec of reading, rauding theory purports to contribute to our knowledge of the cognitive process involved in typical reading by adding a time dimension. That is, when an individual fixates on a standard word during the rauding process, the amount of time in milliseconds that is required to lexically access the word, semantically encode it, and then integrate it into the complete thought formed by the sentence can be determined from the rauding rate of the individual. Also, the level of difficulty of materials that individuals can successfully operate the rauding process may be predicted from the reading level of the individual.

With respect to 1 min of reading, equations have been developed to predict the comprehension of passages (see Equations 1 and 2); these equations are based on the three laws of rauding theory. The percentage of passage comprehension can be predicted from the length of the passage, the time allowed to read the passage, the typical reading rate of the student, the reading level of the student, and the difficulty level of the material. At present, no other theory besides rauding theory predicts precisely how much of a particular passage will be comprehended by a particular reader who reads for a particular amount of time.

With respect to 1 year of reading, a causal model has been developed for lower graders, middle graders, adults, and disabled readers. This causal model includes the primary factors that cause high and low reading achievement (see Figure 5). Most of the model has empirical support of a correlational nature (see Figures 6, 7, and 8); there has been no experimental research on the model.

The causal model has implications for reading instruction. For example, the model predicts that students who go through the entire school year without improving their decoding level will still gain 0.5 GE units in reading achievement due to typical or average gains in listening level and naming speed level.

The model also has implications for reading diagnosis. For example, general intelligence or IQ should not be used to diagnose reading problems because *g* or IQ are not important causal factors; the important causal factors from a cognitive ability standpoint that should be used to diagnose reading problems are verbal knowledge aptitude, g_v, decoding aptitude, g_p, and cognitive speed aptitude, g_s (see Figure 5).

In conclusion, rauding theory purports to contribute to our understanding of 1 sec, 1 min, and 1 year of ordinary reading by lower graders, middle graders, adults, and disabled readers. Rauding theory offers the prospect of organizing what we think we know and providing a theoretical framework for investigating what we do not know.

ACKNOWLEDGMENTS

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