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VIEWPOINTS

Looking Backward: Reflections on a Career in Reading

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When I agreed to do an article that would capture the essence of my research, I did not realize how hard it would be. What made the task difficult was that I was not sure how to write the article in an interesting way. I thought a descriptive narrative of my work might be about as interesting as reading the phone directory. As I considered this problem, I realized that a presentation of my work against the backdrop of the history of reading and writing might be appealing. This history could take the long view as well as the short view.

The long view is driven by the fact that I have studied the history of writing, and this history can be traced back thousands of years. The short view is driven by the fact that although my research on reading goes back only 40 years, during this short span of time academic psychology has gone through three paradigm shifts. Additionally, the field of reading has experienced some important wars (captured in the title of Chall's, 1967, classic book *Learning to Read: The Great Debate*). What follows, then, is a brief overview of the history of writing as well as a description of my work on fluency. A history of writing is included because it reflects my personal view on this important aspect of reading.

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A BRIEF HISTORY OF WRITING

Justification for a History of Writing

There is good reason for including a section on the history of writing. Too often, those who are highly informed about issues relating to the psychology and pedagogy of reading have neglected to inform themselves about the history of writing. How we read a text is tied up with the writing system used to represent the thoughts we wish to communicate. For example, which way of writing the following number is easiest to read: MCMXXXX or 1940 or one thousand nine hundred forty? Aside from differences in familiarity with one of the systems shown, there are differences in the complexity of the process required to figure out the number.

At times we forget and myopically think that the whole world reads the printed page the way we do, overlooking the fact that a huge segment of literate humanity read from texts that are not alphabetically based. The reading process for this group fails to mirror in important ways what we do when we read from an alphabetically based written code. Knowing about the developmental history of writing and the stages through which the alphabet passed on its journey from infancy to maturity is fascinating and deserves to be known. Moreover, there are important unanswered questions about the relation between the particular kind of writing system we are reading and the process used to decode and understand that script.

For example, the Chinese script maps directly onto concepts, whereas the alphabetic script maps onto sounds. For reading in Chinese, the process can be represented in the following way: printed symbol → meaning. In essence, as soon as the Chinese symbol is decoded, it maps directly onto meaning. However, in reading an alphabetic script, the reader routinely subvocalizes the words. For reading in an alphabetic system, the process can be represented as: printed symbol → subvocalization → meaning. Supposedly, the Chinese reader can go directly from the script to its meaning, but researchers such as Perfetti (Wang, Koda, & Perfetti, in press) are now questioning that assumption. Can it be that subvocalization is the mediating link between a written code and its meaning for all forms of writing? In addition, as we shall see as we trace the history of the alphabetic code, the final development of the alphabet made possible the modern dictionary as well as the computer keyboard that has only a limited number of keys to represent the letters of the alphabet.

Discovery of the Phoneme

Having taken a moment to explain why a history of writing is important and should be included in this narrative, let me explain the origin of my interest in the history of writing. About 20 years ago, I was in the Cairo Museum in Egypt looking at a hieroglyphics exhibit. Some of the information startled me: It stated that at some point in the development of hieroglyphic writing, hieroglyphic symbols were used to represent the sounds of the Egyptian spoken language. This surprised me, because what the museum label was describing was a phoneme—the essential element in the development of the alphabet. I had always thought that hieroglyphics were a nonalphabetic form of writing and alphabets did not exist until much later, around the time of the Phoenicians (hence, the origin of the word *phonics*). Pondering the question as to who was right, I began a study of writing. It was a study that was shaped by my training as a psychologist and, thus, what I focused on was not the same as what a cultural anthropologist or a linguist might consider to be important. However, before I go too far afield, to set the record straight immediately, let me say that my original concept about hieroglyphics was naive and that alphabets actually originated with the Egyptians. Thus, the museum exhibit was correct.

How Old Is Writing?

The answer depends on which type of writing is under scrutiny. If we include cave painting as a primitive type of writing, we have evidence from a cave in Lascaux, France that it dates back to 20,000 BCE. Moving ahead thousands of years to 5000 BCE, people in Iraq who frequented the region between the Tigris and the Euphrates Rivers used a form of writing on clay with sticks that is known as cuneiform. During the same time period, Egyptians used hieroglyphics (picture writing), and in Ban Po, near Xian Province in China, anthropologists have found writings that are direct precursors of modern writing used by the Chinese today.

Writing systems such as the ones used by the Chinese and the Egyptians shared a common weakness. Although they could easily represent concrete nouns such as *table* or *boat* with pictures, they found it nearly impossible to represent abstract nouns such as *freedom* or *love.* To be able to write about abstract ideas, a clever Egyptian discovered the phoneme around 1500 BCE. By assigning written symbols to represent phonemes, a writer could express abstract ideas in a written form. The discovery of this abstract entity, the phoneme, is crucially important because it was the first step in the long road that led to development of the modern alphabet. Examples of early writing that used the alphabetic principle include hieroglyphics and the Semitic scripts as used by the Hebrews and their neighbors, the Phoenicians, in the land now known as Lebanon. The Semitic scripts are aptly described as consonant alphabets because they omitted symbols for the vowel sounds.

Information Storage Systems

A characteristic of all writing systems is that they store information for later use, which is precisely what human memory does. When, however, psychologists describe human memories, they do so in terms of the following:

- *Speed of input:* How fast can one get information into storage?
- *Speed of output:* When you need the information, how fast can you get the information out of storage?
- *Longevity:* How long will the information last in storage before it is lost?
- *Capacity:* How much information can be placed in storage?

These characteristics of human memory can also be used to evaluate and study the various writing systems that have been used in the history of writing. For example, think of Moses writing the Ten Commandments on stone tablets with perhaps a hammer and chisel, or cuneiform writing on soft clay with a wood stick. Compare these forms to writing with a pen and paper in terms of speed of input, speed of output, capacity, and longevity.

Different materials have been used over thousands of years to input and store information, such as stone, clay, leather, wood, papyrus, paper, and computer hard drives. For each of these media, specialized instruments are used to enter the information: hammers, chisels, reeds, paint brushes, inks, paint, pencils, pens, printing presses, and keyboard and mouse. In evaluating each of the media and instruments for information storage, it is useful to do so in terms of the characteristics of memory systems.

Papyrus and the Alphabet

Of all the materials used for information storage, papyrus holds a unique but underappreciated role in the development of the alphabet. Papyrus is a plant that grows along the banks of the Nile River. The Egyptians learned how to peel off thin layers of papyrus and place them on top of one another to make a thin, flat, dry material that could be written on. The Egyptians traded papyrus with the Phoenicians and the Hebrews, but they also shared something far more valuable: the discovery of the phoneme, the basic unit of speech and the key element in alphabetic writing. We know that around 1500 BCE some brilliant Egyptian figured out that a spoken word was actually a composite of smaller speech sounds. For example, the English word *pan* is a composite of three phonemes, /p/, /a/, and /n/.

With the breakthrough finding of the phoneme came the need to represent these phonemes in written form. The Egyptians took hieroglyphic symbols and had them serve double duty—a single hieroglyphic form was used to represent the picture-concept function as well as its new function of representing a basic speech unit called the phoneme. Of course, linguists who tried to decipher hieroglyphics did not understand that a hieroglyphic symbol was serving a dual purpose until 1819, when Thomas Young realized that hieroglyphics were also phonetic. Later, child prodigy Jean Champollion identified almost all the hieroglyphs that represented the phonemes of the Egyptian language. His contributions opened the door to the study of ancient Egyptology.

Development of the Modern Alphabet

The modern alphabet has gone through several developmental stages. As we know, it was the Egyptians who first discovered that words in a spoken language can be broken into their basic constituents.

The next stage in the development of the alphabet happened around 1000 BCE, about 500 years after the discovery of the phoneme, when the Phoenicians and the Hebrews developed the consonant alphabet (also called the Semitic alphabet). The Semitic alphabet assigned letters to represent sounds, and the letters served that function exclusively. However, only the consonant sounds were represented by letters. For skilled readers, omission of the vowel sounds was not a problem; for example, "th hmbrgr sndwch csts $1.50 cnts."

The Greeks made additional refinements to the alphabet between 800 BCE and 400 BCE. Because the earlier Semitic writing contained letters that were not useful to the Greeks, the Greeks found a use for these extra visual symbols by assigning vowel sounds to them. Unlike the Semitic alphabet, which did not have letters for vowels, the Greek alphabet used a full range of letters to represent consonants and vowels, and these were sequenced in a fixed order. Having a fixed alphabetic order was an important improvement and was essential for the later development of the dictionary so that words and their definitions could be located quickly. The word *alphabet* comes from the first two letters of the Greek alphabet, alpha and beta.

Before leaving the history of writing, there is one last topic I would like to address: advantages and disadvantages of different scripts, such as the thought writing used by the Chinese and the alphabetic writing used in our country.

China is huge in both size and population, and several different languages are spoken within its borders. The written script used by the Chinese maps onto thoughts, not speech sounds, so speakers of different languages can understand the same written texts. However, the disadvantage to the Chinese form of writing is that learning to read requires learning to decode a basic vocabulary of several thousand words, which presents a formidable memorization hurdle.

The advantage of reading with an English alphabetic script is that the 26 letters of the alphabet can be used to represent the many thousands of words found in the English language. Consequently, once the student knows the letter–sound combinations and has gained some knowledge of the spelling patterns, the student should be able to decode a large number of words. Theoretically, then, learning to read should be easier for the student learning English than the student learning Chinese.

There are some downsides to our alphabetic writing system, however. People who speak different languages that use the same alphabet, such as English and Spanish, cannot understand each other's written texts even though the letters used to create the texts are the same. A second problem is the importance of being able to hear the composite sounds that make up the spoken words. Failure to hear the sounds in words spells trouble for the child, and that is one reason so much emphasis is placed on phonemic awareness training. Functional magnetic resonance imaging (fMRI) studies of dyslexic students show that the part of their brain that does phonological processing works differently than it does in normal readers.

There are disabled readers both here and in China, but the neurological causes of these problems may be different, depending on the script that is being learned. Comparing the brain processing of disabled readers who are learning to read using alphabetic writing to thought writing is an area of study that lies in the future. I am certain that researchers such as Perfetti, who want to find out if some form of subvocalization takes place in reading Chinese script, or Shaywitz, who does fMRI studies of dyslexic children, have given some thought to this problem. With regard to the question of which script is better, the thought writing system of the Chinese or the alphabetic system used in the Western world, the best answer I can give is, "It depends."

As I think back on my interest in reading research, it is clear to me that my interests have been somewhat diverse. As the first section of this article indicates, I have been deeply interested in the history of writing, but, in addition, going back to my doctoral dissertation, I have also been profoundly involved in the decoding aspects of reading. If I were to identify what contributions I have made to the field of reading, I would imagine that they were in showing that there is more to word identification than mere accuracy. In fact, it could be expressed in the phrase, "Beyond accuracy to automaticity." In the following sections I address some of these issues.

AUTOMATICITY, FLUENCY, AND THE NATIONAL READING PANEL

Many scholars believe that the model of automatic information processing that LaBerge and I developed set the stage for the current interest in reading fluency (LaBerge & Samuels, 1974). However, before I discuss this model, I should state that in 1965 I received my doctorate from UCLA, where Ken Goodman, the father of whole language, was my classmate. Although Ken and I have held very different views of reading throughout the four decades since our days as fellow graduate students, we recently found an area of common concern in which we are joining forces. Ken and Yetta Goodman and I convinced the Reading Hall of Fame to sponsor a symposium to discuss the No Child Left Behind legislation at the 2006 International Reading Association meeting in Chicago, where we will share the platform with several other Hall of Fame members to express our thoughts on how we believe the law should be changed.

This legislation has a noble goal—the desire to help all students become literate—and for this reason it won bipartisan support. Unfortunately, there are considerable problems with how the legislation is being enforced (penalties are imposed on high-performance schools if even a few students in a special category fail to meet the mark) and with the inadequate funding for all the mandated testing. There is also concern about how the federal government is moving into areas that traditionally and constitutionally have been the domain of the states. Consequently, there is considerable unrest among educators about No Child Left Behind.

As I have watched my colleagues progress through their careers, I have noticed that for many there is a common road: They start with a focus on the science or discipline they are in, but then they develop broader policy concerns along the way. Certainly, my own career exemplifies this progression; some of my earlier work constituted what can be thought of as basic research, and now No Child Left Behind falls into a much different domain. At this point, let me go back to my work in basic science.

My work on automaticity and fluency began in the early 1970s, during the overlapping span of years when psychology was leaving behaviorism behind and embracing the new "paradigmatic theology" known as cognitive psychology. Cognitive psychology was opening new doors that had been closed under behaviorism. Under behaviorism, the emphasis was on studying phenomena that could be measured directly, such as how rewards affect behavior or how word frequency and sentence length influence readability. Because of behaviorism's emphasis on studying things that can be observed directly, important components of reading, such as comprehension, were not studied; comprehension is a covert process that takes place in the hidden recesses of the brain.

However, with the advent of cognitive psychology, the stage was set for studying covert processes, such as comprehension and the mechanisms that make reading fluency possible. As an addendum, I should add that the newest psychological paradigm is cognitive neuropsychology. It has not replaced cognitive psychology but is running parallel with it. Okay; I can get rid of the acronyms. This new kid on the block uses procedures that actually allow psychologists to see the workings of the brain while the individual is involved in reading activities.

Several findings from neuropsychology should be of interest to reading educators. First, the question of whether dyslexia has a biological origin has been answered affirmatively. Second, the question of whether the brain actually changes with interventions has also been answered affirmatively. However, what has not been established with this new mode of peering into the working brain is what parts of the brain are used in fluent reading as opposed to nonfluent reading. Although we know from Fink's (2006) research that dyslexic readers can learn to read well enough to become prominent in their fields, we do not know if they ever become fluent readers.

The paradigm shift to cognitive psychology that started with Miller's (1959) "Magical Number Seven, Plus or Minus Two" opened the door to a whole new era in reading. Chall's (1967) book, *Learning to Read: The Great Debate,* ushered in renewed efforts to teach phonics and other decoding skills. However, whereas Chall's book encouraged teachers to provide instruction in phonics, at the same time, Goodman (1967) and Smith (1971) were espousing their views of how reading should be taught, and they argued against teaching phonics and the artificial texts used in basal readers. They thought that children could learn to read naturally, the way they learned to speak. Chall's book title was an apt description of the reading wars taking place in this country at that time, with teachers taking positions either on the side of the Goodman and Smith whole-language position, or the skills-based approach, or somewhere in the middle. Now, 38 years after Chall's book was first published, the pendulum has swung to a moderate position of balanced instruction.

The impression I want to convey is that powerful forces have been at work in our country with regard to shifts in psychology as well as in reading. From our earliest days when White settlers came to these shores from Europe, reading was viewed as more than a functional cognitive skill. It was a skill that had religious as well as political connections. Why should not people be concerned about reading? Those who had an interest in religion recognized the importance of being able to read the Bible, which was viewed historically in our country as the route to salvation. The very first U.S. educational law, passed in the early 1600s, was "The Old Deluder Satan Act," which decreed that reading had to be taught in the Massachusetts Bay Colony so that children could read the Bible and defy that old trickster, Satan the Devil. Those who had an interest in preserving the institution of slavery knew that teaching slaves to read could put dangerous ideas in their heads. Consequently, providing reading instruction to slaves was forbidden. The fields of reading and psychology, and religion and politics, have never been far apart.

In 1965, when the reading wars were just starting to heat up, and the paradigmatic shifts were taking place in psychology, the University of Minnesota was given a grant to start a Human Learning Center. From the start, the Center recognized the importance of having professors from different departments collaborate.

David LaBerge, from psychology, had just developed a machine that could present a word on a screen and a student would press a Yes or No button to indicate a response. The machine could detect correct or incorrect responses, as well as the response latency. He knew the machine had potential in reading instruction, but not having had experience in the classroom, he was not sure how the machine could be used. Because LaBerge was aware that I had 10 years of experience as a classroom teacher, he came to me, and we began to discuss the reading process. Our many discussions over the course of a year led to the development of a theoretical model of reading. This model was submitted to *Cognitive Psychology,* where it was accepted (LaBerge & Samuels, 1974), and we received numerous requests for reprints, week after week. This model is now considered a classic and is widely cited.

Our model of automatic information processing in reading pulled together a large amount of information on how print on a page was processed visually and then went on to explain how print mapped onto the sound system of English. Although our model shows how the information from the page is processed and moved along to comprehension, the model has almost nothing to say about the comprehension process. Why? For the same reason that when Gough's (1972) model of reading got to comprehension he had nothing to say about the process and resorted to Merlin the magician; that is, comprehension could not be explained empirically and thus was described as occurring as though through magic. In the 1970s, Professor Wayne Otto from the University of Wisconsin invited me to spend a day with him to try to figure out some of the underlying mechanisms of comprehension. We did not get far—mainly because we did not have a clue as to how to approach the problem. With the exception of a few researchers, such as Bartlett (1932), during the period of behaviorism there was virtually no research on comprehension on which we could draw.

How does the LaBerge and Samuels reading model explain how print is processed? The original model is what is called a bottom-up information processing model. This means that the sequence of events in reading starts from the bottom, with the letters and words, and then the flow of information moves up to meaning. In the original presentation of the model, we did not consider how prior knowledge might influence the decoding process, so all the information flowed in one direction, from print to understanding. Top-down models, such as the Goodman model, do not actually start with comprehension but rather place a heavy emphasis on the role of the reader's prior knowledge when decoding text. At a later point in time I altered the model slightly so that it became more interactive. For example, if the text states, "The jeweler cut the green _______," prior knowledge should facilitate identifying the next word as *emerald.*

The LaBerge and Samuels model recognized that the unit of word recognition varies with the skill of the reader. Thus, for students who were so new to reading that they did not even know their letters, the unit of recognition could start with the distinctive features that comprise letters. For example, if the features that a beginner sees are a circle to the bottom right of a vertical line, he or she is looking at the letter b, and if the features are a circle to the top right of the vertical line, it is the letter p. Once the student has learned the distinctive features of all the letters, the unit of recognition moves up a notch to the letter level. At this phase in learning, the student can recognize each of the letters as a holistic unit.

With additional experience in reading, the student begins to learn the spelling patterns of English words. As part of the learning that takes place in learning the spelling patterns, the student learns to recognize patterns—such as *ch, gh, sch, ed,* and *ing*—as units. What seems remarkable about how the student learns these patterns is that so much of the learning comes implicitly through reading easy-to-read books and not through direct instruction. Moving to even a larger unit, the entire word could be the unit of word recognition. Finally, common phrases and word combinations such as "ice cream" or "salt and pepper" could serve as the unit of word recognition.

This bottom-up model implied that for the beginning reader, the developmental sequence was from smaller to larger units of word recognition. Beginning readers might process words going from left to right, letter by letter, a slow process that places heavy demands on short-term memory. However, skilled readers could process a text using a variety of processing units. For example, as you are reading this article, I assume that you are a skilled reader, and most of the words that I am using are high-frequency, relatively common words. In that case, I assume the unit of word recognition for you is the entire word. However, if I stick in an uncommon word, such as *meritricious* or *episcopacy,* you may have to process it the way less skilled readers do: part by part. Thus, one function of the LaBerge and Samuels model was to show the different processing routes that can be taken depending on the skill of the reader and the reader's familiarity with the words in the text.

The most important part of our model dealt with automatic processing of written texts. Huey (1908/1968) noted similar things almost a century before. Our unique contribution was that we provided the theoretical underpinnings of how automaticity developed, something that Huey was not equipped to do at the turn of the 20th century. In addition, LaBerge and I did tests on our model. Nevertheless, Huey had some insightful remarks to make about reading and automaticity. He stated that

> the more unfamiliar the sequence of letters may be, the more the perception of it proceeds by letters. With increase of familiarity, fewer and fewer clues suffice to touch off the recognition of the word or phrase, the tendency being toward reading in word wholes. So, reading is now by letters, now by groups of letters or by syllables, now by word-wholes, all in the same sentence some times, or even in the same word, as the reader may most quickly attain his purpose. (Huey, 1908/1968, p. 81)

As the same word is encountered repeatedly, he observed that "repetition progressively frees the mind from attention to details, makes facile the total act, shortens the time, and *reduces the extent to which consciousness must concern itself with the process*" (Huey, 1908/1968, p. 104, italics added). Huey strikes at the heart of fluency: less need to use attention to decode the words.

The LaBerge–Samuels explanation of automatic information processing is based on two assumptions: First, the human brain can process only a limited amount of information at one time. If the processing demands of a task, such as decoding words, require more processing capacity than the brain has available, the reader must put all the available processing capacity on the decoding task. If all of the reader's attention is focused on decoding, comprehension cannot occur at the same time. The second assumption is that to read with understanding, the person must decode and comprehend the decoded words. In beginning reading, the decoding task may be so difficult that the reader can only do one task at a time, and that is decode. Then the student can switch attention to the task of comprehension. By switching attention back and forth from decoding to comprehension, the reader can get through a text, but the process is slow and difficult. One notes that beginning readers may start reading a sentence, slowly move ahead, and then regress to the start of the sentence again. That is because the decoding and comprehension tasks have taken so long that the information put into short-term memory gets lost. The longevity of information placed in short-term memory is less than 18 seconds, so if processing a sentence takes longer, the information stored in short-term memory is lost, and the reader must start over again.

Students become automatic readers through practice that may take place over an extended period of several years. The indicators of automatic decoding are accuracy, speed, and good oral reading expression. However, the critical characteristic of fluent reading is the ability to decode and comprehend a text at the same time. Current debates over how to measure fluency in a valid way center on whether fluency is being measured with indicators, such as reading speed, or with a measurement task that demands the twin critical characteristics of fluency: simultaneous decoding and comprehension. The problem with using reading speed as a measure of fluency is what I call the "barking at print" problem. Although speed of reading may accurately identify students who can decode and understand at the same time, there are students who have developed adequate decoding skills but fail to understand what they have decoded. For example, for students with poor vocabulary knowledge, such as the large English language learner population, using a speed reading test as a measure of fluency is a misuse of a rule. Ways to measure fluency that seemed adequate years ago may no longer meet the litmus tests of good measurement today.

I was concerned about the LaBerge and Samuels (1974) article on the theory of automatic information processing because it had nothing practical to say about reading. I had always thought a good theory should have some practical application. One day, during a run around a lake near my home, I asked myself two important questions: Who are the most highly trained people, and how do they get their training? I concluded that musicians and athletes are the most highly trained people, and their training shares similar characteristics. For example, when learning a move in wrestling or playing a piano sonata, the task is broken into parts. The student is instructed how to do just one part at a time, and then the student practices the part, first to accuracy and then to automaticity. After the parts are learned, the student practices the entire movement until the full automaticity phase is achieved.

Unfortunately, because of the pressures put on teachers to cover a year's work in a year's time, reading was not taught that way. For students who were average or above average in intelligence (IQ predicts speed of learning; Gottfredson, 1997), the pace of instruction in the classroom was satisfactory, but for the kids who were struggling readers, the pace was too fast, and every day was another day of frustration and failure. I received permission from the Minneapolis schools to work with their mentally retarded students to see if a new idea of mine called repeated reading might help them. This idea was based on how athletes and musicians are trained.

The repeated reading procedure worked like this. I broke a longer story into lengths of about 150 words. I assembled the slow learners and asked them how one gets good at a sport. They all knew you had to practice it. I explained that that was what we were going to do. Reading was like a sport. You had to practice it to get good. As the students looked at their short passage, I modeled reading it to them. Then the students practiced reading by themselves. Each student worked by himself or herself to reach our goal of 85 words a minute. When a student thought he or she was ready, the student read the passage to the teacher, who recorded word recognition errors and speed. We did not emphasize error-free reading; we did not want fear of making a mistake to hamper the students' speed. When a student reached the goal of 85 correct words a minute, he or she was given the next passage, and the process was repeated.

We observed several interesting results. First, as the students worked their way through the story, there was a lot of word overlap from one passage to the next. Consequently, with each passage, it took fewer repeated readings to reach the goal. Second, as students practiced reading a passage several times, their oral reading expression improved. Third, the students noted that as they read and reread a passage, they began to sound like good readers.

The downside to the method was that computing the word-per-minute rate was bothersome, but the method worked in that the students improved in attitude and in reading ability. I published the description of the method in *The Reading Teacher* (Samuels, 1979/1997), and it was subsequently reprinted as a classic in reading. From that one short description of the study, there have been several hundred research articles published by other scholars who used the method. Have there been criticisms of the method? Of course! Is repeated reading a reading curriculum? No, and it was never intended to be. The method is an adjunct, an add-on to an instructional program. When the National Reading Panel (NRP, 2000) did a meta-analysis of the method, they reported an impressive effect size, indicating the method helped word recognition, reading speed, and comprehension, even though the method was not designed to affect comprehension.

We have developed an improved version of repeated reading using students who read to each other in pairs. One takes on the role of teacher and the other the student, and then they reverse roles. The students reread the passage four times, two times by each student. Research by O'Shea, Sindelar, and O'Shea (1985) has shown that after a student has read the passage four times, most of the gain has been achieved. There is no necessity to go through the laborious task of computing word-per-minute rate to see if the student has reached the speed goal. This technique (paired students and four rereadings of a passage) has been tested experimentally and found to be effective (Semonick, Lewis, & Samuels, 2001).

I was working on repeated reading at the same time LaBerge and I were testing our automaticity model. One of my favorite studies was a test of what size visual units students use to recognize words (Samuels, LaBerge, & Bremer, 1978). Gough (1972) argued that the unit of recognition was the letter, claiming that word recognition is a letter-by-letter process. On the other hand, Cattell (1886) claimed that word recognition was a holistic process. To test these conflicting theories, we gave a task to students in Grades 2, 4, 6, and college in which they looked at a computer screen. If the word on the screen was an animal word, the students pressed a Yes button. The computer measured response latency. The animal words on the screen varied among three-letter words (like *dog*), four-letter words (*frog*), five-letter words (*horse*), and six-letter words (*donkey*). The reasoning was simple: If the student was processing the animal words letter by letter, the longer words should take longer to recognize; if the student was doing holistic processing, long and short words should take the same time.

Our findings were most interesting, and this study had a significant impact on my later thinking about how to measure fluency. We found beginning readers were doing letter processing, supporting Gough's (1972) position, but college students and sixth graders were doing holistic processing, supporting Cattell's (1886) position. Fourth graders were using units larger than the letter but not quite the entire word. Using a somewhat different approach, McCormick and I (McCormick & Samuels, 1981) had students simply say aloud the animal word they saw, and the computer measured voice onset latency. Saying the word replicated the earlier work, which used a button push if it was an animal word, with regard to the unit of recognition. What we had was evidence that as the student gained in reading skill, the size of the unit used in word recognition became the entire word. The better the reader, the larger the size of the unit used. Remember, however, these were all high-frequency, common words. What happens if the student is recognizing uncommon words? What size unit is he or she using then? Both the Huey model and the LaBerge–Samuels model state that the size of the unit used in word recognition can vary, even within a sentence.

Not wanting to go on endlessly describing our studies testing units used in word recognition, let me summarize what we learned about the mechanism that allows the student to increase the size of the recognition unit. Our studies indicated that when a student first encounters a common word the word is processed letter by letter. However, when the student processes the same word repeatedly, the size of the processing unit increases until it is processed as an entire unit. So, the mechanism for developing holistic, unitized processing of a word was seeing the actual word or a similar spelling pattern repeatedly in independent reading.

There are several ways to determine if a person is automatic at decoding. For example, the Stroop test can be used, but it works only for a limited number of words. Speed of reading is another indicator, but it has its own problems. In general, oral reading speed can be used as an indicator of fluency, but there are students who can read orally with speed but have comprehension difficulties due to lack of vocabulary. Students who can read orally with speed but who have poor comprehension should not be considered fluent readers. To be considered a fluent reader, the person should be able to decode and comprehend at the same time. One way to test for fluency that requires the reader to decode and comprehend simultaneously is to test in the following way. Give the student a suitable text for the his or her level of reading ability. Say to the student, "I want you to read this out loud and when you are finished reading I want you to answer questions about the passage you have read." As soon as the student is finished, take the passage away and give the student the test questions. The test items can be a mix of literal and inferential comprehension questions. This testing procedure requires that the student do two things at the same time: decode the words in the text and process the text for its meaning. Langenberg, a physicist and the coordinator of the NRP (2000), was moved to say more than once in public talks after he became aware of the complexity of reading, that reading was "rocket science."

THE NATIONAL READING PANEL

In 2000, I was selected as a member of the NRP, which was assembled to help Congress determine appropriate funding guidelines for reading research and instructional programs. When I was initially informed that I had been nominated as a possible member of the NRP, I was told that several hundred others had been nominated as well, but that only eight would be chosen. With odds like that, I decided my chances were slim. I was also not sure I even wanted to be on the panel. I took a cavalier approach and sent in some material that was handy from my files. A short while later, I received word that I had been selected. I suspect the selection committee was looking for scholars who knew a lot about the psychology of reading, had a variety of different kinds of expertise, were not identified with any particular type of reading method, and were not affiliated with commercial reading enterprises, such as publishers.

I discovered that I knew all the members of the scientific branch of the NRP. My friend Joanna Williams, an expert on comprehension from Teacher's College, was there. We had spent many hours during the worst of the reading wars debating Goodman and Smith. What was interesting about the NRP was that several of the members had probably never taken a course in reading, including me, and several had probably taught only at the college level. That did not bother me at all. I knew that William James, who is considered to be the father of American psychology, never took a psychology course. While teaching at Harvard University, he originated the discipline that became the formidable field it is today. The one attribute that the members of the scientific arm of the NRP shared was that each was a nationally recognized expert in at least one component of the reading process.

From the beginning, the NRP had problems to solve. For example, the original grant was for a 1-year investigation, but we quickly realized that the scope of the research literature that had to be reviewed was so large that it would take at least a year just to study that literature. So, the grant period was extended for 1 more year; even with this extension, we had to find a way to winnow down the articles to be read and coded. Consequently, a decision was made to review only experimental or quasiexperimental studies that had been published in peer-reviewed journals. This turned out to be a decision that was criticized by many in the research community, but given the limitations we were working under, it seemed reasonable.

There were several panel battles, and I won one that was important. One member of the panel wanted to make reading fluency a subcategory, but I argued that it was important enough to be placed in its own category and be given a status equal to decoding and comprehension. The status of fluency today among teachers and researchers is higher than it has ever been, and I think this is partly due to the fact that fluency has equal status with comprehension and decoding in the report of the NRP.

Unfortunately, there were also battles I lost, and they turned out to be important ones. One battle I lost was on a disclaimer in the report about the efficacy of independent reading as part of the reading curriculum. I did not want that statement included because I knew it would upset teachers. Students can read books independently in school and they can read them outside of school, and all the correlational studies showed that the amount of reading a student did was related to achievement. However, the members of the NRP (2000) stated that because they could not find experimental studies in the literature showing that independent reading led to gains in achievement, they could neither support nor condemn this practice.

The failure of the NRP (2000) to support independent reading was one of the most controversial aspects in the report. It led me to conduct an experimental study to determine how differences in time spent in independent reading might affect reading outcomes (Samuels & Wu, 2003). Our study was conducted in two third-grade and two fifth-grade classrooms at a St. Paul inner-city school, where the teachers assigned students to classrooms in such a way that their reading ability was balanced in the classrooms. Of the four classrooms, we randomly assigned two as the experimental and two as the controls. The experimental variable was the amount of time spent in independent reading. In the experimental treatment, the students read independently for 40 minutes each day, and in the control treatment, the students read independently for only 15 minutes each day. To ensure that the students' time in the control condition equaled the time spent by the experimental students, in addition to the 15 minutes of independent reading, the teachers read children's literature to control students and discussed the stories with them for 25 minutes each day. All the teachers in the study were highly experienced.

Independent reading for the control and the experimental classes was done in class so that we could maintain control over how much time was actually spent in reading. The independent reading was done in addition to a regular balanced reading instructional plan that all the students got. All students selected books for independent reading from the school library, where a system of color-coding allowed the students to choose books at an appropriate level of difficulty. As soon as students in the control and experimental treatments finished reading a book, they took a computer-administered comprehension quiz on the book. Students were encouraged to read their books carefully so they could achieve an overall average of 85% to 92% across all quizzes attempted.

This study lasted for 6 months, and the unit used to compare experimental and control groups was the gain between pre- and posttest. Students were given a variety of tests, such as the CBM speed of reading test, the Star Test (which measured comprehension), the Woodcock–Johnson Word Recognition Test, and the Vocabulary section of the Metropolitan Achievement Test.

The study outcomes were not exactly as anticipated. For example, contrary to a general impression that more time spent in independent reading should lead to greater gains for all students regardless of ability, we found instead that it was best to match the time spent in independent reading to the student's level of reading ability. In general, the extra time spent in independent reading was beneficial to all students. For the lower ability students, more time did not necessarily lead to greater gains. However, for the higher ability students, those who received 40 minutes of independent reading had significantly greater gains in comprehension, vocabulary, and word recognition than the higher ability students who received only 15 minutes of independent reading. For the lower ability students, those who received only 15 minutes of independent reading had significantly greater gains in reading speed and vocabulary than the higher ability students who only got 15 minutes of independent reading.

Therefore, although extra independent reading had positive effects for all students, the amount of time spent in independent reading should match the student's reading ability. For higher ability readers, 40 minutes of independent reading proved to be effective. However, for the lower ability readers, 15 minutes of independent reading proved effective. This finding makes sense if one views it in terms of the student's ability to maintain motivation to stay on task and to attend to the task. When the results from this experimental study on the effects of independent reading on reading outcomes are added to the findings from correlational studies, one can state with confidence that when the amount of time spent in independent reading is matched to the student's ability to maintain attention, there are positive reading outcomes. Yes, Matthew effects do operate in reading: Those who read more get better.

CONCLUSION

As I come now toward the end of this journey into my research, there are just a few final comments. My search for ways to measure fluency continues. I have long advocated that to determine if a student is fluent, the student should be given a task requiring him or her to decode and comprehend at the same time. A simple way to do this is to give the student a text to read aloud that matches the student's ability level, with instructions to "Read this to me. When you are done, I want you to tell me everything you can remember about the story." To do this, the student has to decode and comprehend the text at the same time. There are actually several commercial tests on the market that do just this. I am also studying ways to use the computer to determine fluency.

There are big battles ahead with some researchers claiming that current and popular ways to measure fluency are unreliable or invalid. The future of fluency is tied up with our ability to measure this construct. Teachers are wise and open to better ideas. They are willing to try new ideas in the hope that they will find new improved methods to teach and evaluate. If our work on fluency can meet these twin goals, fluency will survive, but if it fails to accomplish these twin tasks, it will fall by the wayside the way so many other methods have. I like to leave my students with the following message, borrowed from Marva Collins: "Enter to learn, leave to serve." I certainly hope that these words are a fitting description of what I have been trying to do these many years.

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