Philip B. Gough, *who received the PhD from the University of Minnesota in 1961, is professor in the Department of Curriculum and Instruction at the University of Texas at Austin. His research interest is in reading and spelling acquisition.* **William E. Tunmer** *received the PhD from the University of Texas. He was a staff member of the Southwest Educational Development Laboratories before joining the faculty of the Department of Education at the University of Western Australia. His research concerns the psycholinguistics of early reading.*

References

Bakker, D. J. (1972). *Temporal order in disturbed reading*. Rotterdam, The Netherlands: University Press.

Benton, A. L., & Pearl, D. (Eds.). (1978). *Dyslexia: An appraisal of current knowledge*. New York: Oxford.

Birch, H. G., & Belmont, L. (1964). Auditory-visual integration in normal and retarded readers. *American Journal of Orthopsychiatry, 34*, 852–861.

Chall, J. (1967). *Learning to read: The great debate*. New York: McGraw-Hill.

Curtis, M. E. (1980). Development of components of reading skill. *Journal of Educational Psychology, 72*, 656–669.

Doehring, D. G., Trites, R. L., Patel, P. G., & Fiedorowicz, C. A. M. (1981). *Reading disabilities*. New York: Academic Press.

Downing, J., & Brown, A. L. (Eds.). (1967). *The Second International Reading Symposium*. London: Cassell.

Firth, I. (1972). *Components of reading disability*. Unpublished doctoral dissertation, University of New South Wales, Australia.

Franklin, A. W. (Ed.). (1962). *Word blindness or specific developmental dyslexia*. London: Pitman.

Fries, C. C. (1962). *Linguistics and reading*. New York: Holt, Rinehart & Winston.

Galaburda, A. M., & Kemper, T. L. (1979). Auditory cytoarchitectonic abnormalities in a case of familial developmental dyslexia. *Annals of Neurology, 6*, 94–100.

Goodman, K. S. (1967). Reading: A psycholinguistic guessing game. *Journal of the Reading Specialist, 6*, 126–135.

Goodman, K. S. (1973). The 13th easy way to make learning to read difficult: A reaction to Gleitman and Rozin. *Reading Research Quarterly, 8*, 484–493.

Gough, P. B. (1972). One second of reading. In J. F. Kavanagh & I. G. Mattingly (Eds.), *Language by ear and by eye* (pp. 331–358). Cambridge, MA: MIT Press.

Gough, P. B. (1984). Word recognition. In P. D. Pearson (Ed.), *Handbook of reading research*. New York: Longman.

Gough, P. B., & Hillinger, M. L. (1980). Learning to read: An unnatural act. *Bulletin of the Orton Society, 30*, 179–196.

Gough, P. B., Juel, C., & Roper-Schneider, D. (1983). Code and cipher: A two-stage conception of initial reading acquisition. In J. A. Niles & L. A. Harris (Eds.), *Searches for meaning in reading/language processing and instruction. Thirty-second yearbook of the National Reading Conference*, Rochester, NY.

Healy, J. (1982). The enigma of hyperlexia. *Reading Research Quarterly, 17*, 319–338.

Hinshelwood, J. (1900). Congenital word-blindness. *Lancet, 1*, 1506–1508.

Huttenlocher, R. R., & Huttenlocher, J. (1973). A study of children with hyperlexia. *Neurology, 23*, 1107–1116.

Kaufman, A. S. (1975). Factor analysis of the WISC-R at eleven age levels between 6½ and 16½ years. *Journal of Consulting and Clinical Psychology, 43*, 135–147.

Morgan, W. P. (1896). A case of congenital word-blindness. *British Medical Journal, 11*, 378.

Olson, R., Kliegl, R., Davidson, B., & Foltz, G. (1985). Individual and developmental differences in reading disability. In G. E. MacKinnon & T. G. Waller (Eds.), *Reading research: Advances in theory and practice* (pp. 1–64). New York: Academic Press.

Orton, S. T. (1928). Specific reading disability-strephosymbolia. *Journal of the American Medical Association, 90*, 1095–1099.

Perfetti, C., & Hogaboam, T. (1975). The relationship between single word decoding and reading comprehension skill. *Journal of Educational Psychology, 67*, 461–469.

Rozin, P., & Gleitman, L. R. (1977). The structure and acquisition of reading II: The reading process and the acquisition of the alphabetic principle. In A. S. Reber & D. L. Scarborough (Eds.), *Toward a psychology of reading* (pp. 55–142). Hillsdale, NJ: Erlbaum.

Rubin, A. (1980). A theoretical taxonomy of the differences between oral and written language. In R. Spiro, B. Bruce, & W. Brewer (Eds.), *Theoretical issues in reading comprehension*. Hillsdale, NJ: Erlbaum.

Russell, W. & Goldsbury, S. (1845). *Introduction to the American common-school reader and speaker*. Boston: Charles Pappan.

Seymour, P. H. K., & Porpodas, C. D. (1980). Lexical and nonlexical processing of spelling in developmental dyslexia. In U. Frith (Ed.), *Cognitive processes in spelling* (pp. 443–474). London: Academic Press.

Silberberg, N., & Silberberg, M. (1967). Hyperlexia: Specific word recognition skills in young children. *Exceptional Children, 34*, 41–42.

Silberberg, N., & Silberberg, M. (1968). Case histories in hyperlexia. *Journal of School Psychology, 7*, 3–7.

Silberberg, N., & Silberberg, M. (1971). Hyperlexia: The other end of the continuum. *Journal of Special Education, 5*(3), 233–242.

Smith, F. (1982). *Understanding reading*. New York: Holt, Rinehart & Winston.

Smith, S. D., Kimberling, W. J., Pennington, B. F., & Lubs, M. A. (1983). Specific reading disability: Identification of an inherited form through linkage analysis. *Science, 219*, 1345–1347.

Snowling, M. J. (1980). The development of grapheme-phoneme correspondence in normal and dyslexic readers. *Journal of Experimental Child Psychology, 29*, 294–305.

Stanovich, K. E., Cunningham, A. E., & Feeman, D. J. (1984). Intelligence, cognitive skills, and early reading progress. *Reading Research Quarterly, 19*, 278–303.

Vellutino, F. R. (1979). *Dyslexia: Theory and research*. Cambridge, MA: MIT Press.

RASE

Feature Article

Continuities in Reading Acquisition, Reading Skill, and Reading Disability

Charles A. Perfetti

Reading instruction and remediation are best grounded when based on observation of the continuities among various problems in reading. The problems of reading acquisition, reading skill, and reading disability are linked by their shared connection to word decoding. Learning to read depends on eventual (but not initial) mastery of coding procedures, and even skilled reading depends on coding processes that are low in cost to processing resources. Reading disability may also be understood as representing a point on an ability continuum that contains a wide range of coding ability. Instructional goals of word reading skill, including rapid and fluent word recognition, follow from these considerations.

QUESTIONS OF HOW to teach reading and how to remediate reading failures often have been addressed in an air of controversy that is unsettling to a researcher. Presentations of research findings and cautious suggestions concerning their applications to practical problems of instruction and disability are, in my experience, met with both too much enthusiasm and too much condemnation by practitioners. The fact of the matter is that both the workings of skilled reading and the acquisition of basic reading skill are complex enough to warrant very cautious and circumspect claims concerning how to remediate cases of reading disability.

Nevertheless, there is a good deal to say about how reading works, and much of it does have implications for instruction and for disability. My aim in the following pages is to highlight some of the essential characteristics of reading and reading acquisition and to suggest the implications for instruction and remediation that follow—as well as to point out some things that do not follow. To do this I will draw selectively on the research that has provided basic shape to our understanding of reading, that is, work that provides conclusions that are relatively noncontroversial. The value of this approach is that it focuses attention on essential observations that constrain any theory of reading; thus any theory of reading that does not account for these basic observations will fail. A second value of this approach, related to the first, is that attention to basic facts about reading allows *basic* implications concerning reading instruction and reading disability in a way that attention to the latest interesting research result often does not. Finally, a third value of this approach is that it illuminates continuities that exist among beginning reading, skilled reading, and reading disability.

In what follows, the first section summarizes basic observations in the acquisition of basic reading skill, and the second section deals with variation in reading skill among older children and adults. The final sections deal with some of the implications of these basic observations for applications to instruction and disability.

Learning to Read

Because there appear to be many ways to learn to read, there has been a good deal of controversy about how a child "should" learn to read. This obviously is a controversy without any scientific status. In addition, there have been genuine scientific differences concerning the process of reading acquisition. Many of these can also be

0741-9325/86/0071-0011$2.00

dismissed, however, once it is realized that the appearance of many ways to learn may not match the underlying reality of what is learned.

A distinction between *what* is learned and *how* it is learned is fundamental. (There is even a further distinction of some importance between how something is learned and ways to arrange for its learning, that is, teach it.) What is learned in reading depends on the writing system a child learns. If the writing system is ideographic, the learner acquires associations between ideographs and spoken language equivalents and between ideographs and meanings. If the writing system is syllabaric, the learner acquires associations between graphic forms and syllables. If the writing system is alphabetic, the learner acquires associations between . . . At this point, we expect to have this schema completed by "graphemes and phonemes" or "letters and sounds" or some such. However, things are a bit more complex than that. In an alphabetic system, the learner acquires these two associations: (1) an association between an individual grapheme and a range of phonemes and (2) an association between a string of graphemes and a word *representation*.

This means that in an alphabetic system, such as English, the beginning reader will learn, in principle, that the grapheme *b* is associated with the phoneme /b/ and that the grapheme string *bat* is associated with the word-concept BAT. This word-concept is a mental representation that includes information about its spoken form as well as its semantic values and conditions of use. By this account it is only partly correct to say that a string of letters is associated with a spoken language equivalent. The grapheme string is associated with a representation that includes a speech code plus other information.

The emphasis on mental representation should be noncontroversial. However, the significance of the idea of representation may not always be clear. When someone speaks of a child as having an "auditory problem" when the child's only difficulty is in dealing with language, there seems to be confusion between representation and perception. Similarly, when someone speaks of reading as being "holistic," there may be a confusion between representation and the procedures of word recognition. In the case of the child with an "auditory problem" it is likely that an impoverished lexical representation system, not audition, is the problem. The child lacks sufficient knowledge (representation) of the facts of English orthography, the phonetic structure of English, or some other component of the complex representation needed to read in an alphabetic language. In the case of "holistic" word reading, it is likely that the representation is holistic in that it represents a "whole word" rather than strings of constituents. The procedure for gaining access to this representation, however, may involve the identification of at least some individual letters, making it not at all holistic.

Thus what is learned in an alphabetic writing system is a complex word representation system that allows visual access from letter strings. The representation is rich in that it includes information about constituent letters and additional information, partly redundant, specifying speech values. The speech information is of two kinds: information about the pronunciation of words and information about the abstract phonemic values of letters. It is the acquisition of this second kind of knowledge, the mapping between graphemes and phonemes, that is the most difficult for the learner. It is also the most useful, because it is the productive part of the system. It allows the reader not merely to read a specific word, but also to read new words never before encountered.

The Alphabetic Principle: Is It Part of What's Learned?

If a child learns to read an alphabetic orthography, it follows that the key to the orthography, the alphabetic principle, is part of what is learned. That is, the learner comes to know that a letter, the minimal print unit, is associated with a phoneme, the minimal speech unit. It is the implicit realization of the alphabetic principle, the tacit understanding that letters stand for meaningless sounds, that allows the productivity of reading, that is, the ability to read an unlimited number of words with a limited symbol vocabulary, 26 letters in the case of English.

Here again the distinction between what is learned and how it is learned is important. The knowledge reflected in the alphabetic principle may be part of what is learned. It does not follow that teaching grapheme-phoneme correspondences in some particular direct procedure is the only way to have the child learn them.

There are, of course, obstacles to learning the alphabetic principle. Many children seem to have trouble catching on to the fact of meaningless sound and meaningless print being associated in such a way as to yield meaningful representations. There have been some intriguing proposals to help children discover the alphabetic principle, including the use of a syllabary. The syllabary has the potential for demonstrating that print maps sound rather than meaning without having to deal exclusively with phonemes (Gleitman & Rozin, 1973).

The obstacles to learning the alphabetic principle are of two types. One is that phonemes, especially stop consonants, are abstractions. They do not correspond to acoustic invariants, at least not in any direct way (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967). A given consonant will not be quite the same in one environment as in another. The *t* in "time" is not acoustically identical to the *t* in "cat." Vowels, which pose a different problem for the learner, at least do not have this abstractness problem.

Whereas the first problem is intrinsic to speech and applies mainly to consonants, the second problem is extrinsic to speech and applies mainly to vowels. It is the failure of alphabets to provide unique letter symbols for vowels. This is a matter of alphabet design, and hence is fixable, as demonstrated by experiments with special writing systems (e.g., Pitman & St. John, 1969). There is a cost to economy, however, that alphabets pay for being fully explicit. The choice is a tradeoff between an economical alphabet of few letters and one of more letters and more fully explicit grapheme mappings.

Given the difficulty that some children have in learning the code, it may be understandable that some people have devalued learning of grapheme-phoneme mappings. However, there seems to be no getting around the importance of acquiring the principle. It is the key to productive reading, which is the alternative to accumulating a vast store of specific associations between letter strings and word representations. Gough and Hillinger (1980) point out the possibility that an initial stage of reading may involve these specific associations. But the task of learning large numbers of specific associations must eventually give way to exploiting grapheme-phoneme correspondences.

Linguistic Knowledge in Early Reading

The discovery of the alphabetic principle depends in part on the appreciation of linguistic forms, as opposed to meanings. In order to appreciate that *b* is associated with /b/ and *t* with /t/, a learner must be able to notice that speech yields meaningless segments such as /b/ and /t/. This is difficult because the stop consonants are very context dependent, as noted above. An additional difficulty, perhaps more fundamental, is that meaning and communicative function dominate language use—especially among children, but also among adults.

Prior to formal instruction in reading, children have had little occasion to attend to the formal properties of language—to notice, for example that there is a speech segment shared by *apple* and *and* in the initial portion of the word. Some researchers have suggested that the prereading child does not even have a concept of a word as a separate speech entity (Downing & Oliver, 1973–74; Ehri, 1979) and that it is only through learning to read that the concept of a word emerges (Ehri, 1979). This claim is almost certainly too strong given the child's clear abilities in object naming, comprehension, and production, but it does highlight the difficulty a child has in acquiring knowledge of form strictly on the basis of spoken language. Thus, phonemic awareness, the ability to consciously attend to and manipulate speech segments, is not something that language users come by naturally; yet it seems to be fundamental to discovering and using the alphabetic principle.

This much is a logical argument. The form of the argument is (1) learning to read in an alphabetic orthography requires exploitation of the alphabetic principle on which alphabets are based; (2) use of the alphabetic principle requires some awareness of speech segments as forms separable from meanings; (3) this awareness is difficult to achieve prior to learning about reading. At this point one might claim that the entire argument is irrelevant to learning to read, that the alphabetic principle is a feature of orthographies but not of reading, or some such argument in the spirit of whole word, meaning-based reading. If one should make such an argument, one would have to demonstrate a generally productive system for reading new words that doesn't somehow use grapheme-phoneme mappings.

It is possible to make such an argument for the case of skilled adult reading. Models of skilled reading such as that proposed by Rumelhart and McClelland (1981) seem to work, at least for reading short words, without having any intermediate level at which letters are associated with phonemes. Letters are associated directly and exclusively with word representations in memory. Whether such a model will prove to be sufficient for adult skilled reading remains to be seen. But there is no reason to assume it can be applied to *learning* to read. In order to achieve a large corpus of grapheme-addressable words, the child has to have a procedure for reading the words and getting their representations into memory. For this, the relationships between graphemes and phonemes provide an essential foundation for learning.

Meanwhile, logic aside, there is ample evidence linking awareness of speech segments to success at learning to read. Liberman and Shankweiler (1979) summarize a number of studies that establish this linkage and also make a clear case for the importance of the ability to mentally manipulate speech segments (see also Ehri, 1979). One conclusion from this research is that children who, prior to reading instruction, perform successfully on tasks of phoneme awareness are more likely to be successful at learning to read than children unable to perform these tasks. Furthermore, adults who have not learned to read fail on the phoneme segmentation task used by Liberman, Shankweiler, Fischer, and Carter (1974), while adults who have just been in a literacy program succeed at the tasks (Morais, Carey, Alegria, & Bertelson, 1979).

It thus seems reasonable to believe that learning to read and the development of phonemic knowledge are mutually supportive, as Liberman, Liberman, Mattingly, and Shankweiler (1978) have argued. It appears, in fact, that some primitive phonemic knowledge is necessary to get started at learning to read alphabetically, but that the ability to truly manipulate speech segments is brought about by the experience of reading itself (Perfetti, 1985). It has, however, become clear from studies by Bradley and Bryant (1983) that children who are trained in speech-segment knowledge improve in reading.

Procedures for Learning to Read

The lack of linguistic knowledge does not prevent reading from getting underway. Indeed, the transparency of linguistic knowledge, and hence the difficulty we have in acquiring phonemic awareness, means that reading must begin without much phonemic knowledge for most readers. To understand the course of beginning reading in the absence of linguistic knowledge, we need to know the *procedures* of beginning reading, as opposed to the reader's abstract competence in language.

The procedures of beginning reading include the features of the printed page and the knowledge the reader

uses to produce reading responses. Certainly it is part of learning how to read to begin to have the constituent letters control the reading process. However, at the beginning, the child can use any of several features of the printed page to control reading, on the assumption that what is on the page is meaningful. For example, the features of overall word shape in combination with specific letters contribute to the process of word identification. Research clearly points to the initial letter of a word as controlling the beginning reader's attempts to obtain meaning (Marchbanks & Levin, 1965; Williams, Blumberg, & Williams, 1970). The child learning to read English acquires left to right scanning procedures within a word, eventually attending to several, perhaps all, of the letters of a word; at the start, though, the child attends especially to the first letter. In addition to attention to the first letter, the child also can attend to shape cues. Such cues do seem to be used, not as global cues about the shape of the word, but as cues dependent on shapes of constituent letters (Rayner & Hagelberg, 1975).

The details of these print controlling processes are complex and not completely clear. They probably vary by individual and by manner of instructions, and they change rapidly over the course of early reading. There have been several analyses of the development of these print control processes that point to qualitatively differentiated stages in their development (e.g., Marsh, Friedman, Welch, & Desberg, 1981). Whether there are distinct stages or not, the important general point is that reading can progress without clear appreciation of specific letter constituents and without letter-phoneme mappings.

Perhaps the most important of the procedures for beginning reading is the use of context. This provides the extrinsic factor in reading as opposed to the intrinsic factors associated with print. What's important here is the fact that extrinsic factors, especially the use of context to guide meaningful reading, dominate the early reading of many readers. Children in the first grade are very sensitive to the meaning features of reading from the very beginning. Over the course of the first year of instruction, there is some change in the control of reading, with the early reliance on context giving way to more control by stimulus features, that is, the letter constituents of the word. This early reliance on meaning and growing attention to print is reflected in the oral reading errors of children (Biemiller, 1970; Weber, 1970).

Summary

This brief account of learning to read should be noncontroversial in most respects. It asserts the importance of mastering the alphabetic principle for reading an alphabetic orthography, acknowledges the difficulty that children face in using this principle, and points out that in the beginning reading can proceed without any linguistic knowledge, or at least without very much. Implicit is the idea that children can and do learn to read by attention to "whole words" and to meaning. Indeed meaning dominates the early reading process for many readers. True progress in reading comes when the alphabetic principle and the grapheme-phoneme correspondences the principle allows are acquired.

Skilled Reading

In beginning reading, the ability to read words is of prime importance. The general argument of the preceding section was essentially one of what it takes to read words. What seems left out in such an account is attention to meaning and comprehension. However, one of the important points even about beginning reading is that meaning factors dominate the overall process. This is exemplified by the extent to which beginners rely on context. In skilled reading, the importance of context continues as a prominent part of comprehension, and, in general, comprehension guides the reading procedures of children and adults both. On the other hand, it is important to make clear that even for skilled reading with comprehension, word identification or lexical access is an important component of reading.

Lexical access, the identification of a word represented in permanent memory, is of central importance in all reading, even the reading of skilled adults. The reason for this is simple enough: Lexical access is the recurring part of reading. The idea that readers skip over vast amounts of text in reading has been shown, quite clearly, to be false. Studies of eye movements find that the eye fixates on more than half the words of a text. One estimate is that about 70%–80% of all content words are fixated (Carpenter & Just, 1981). Although the percentage of fixations is lower for function words, the clear conclusion is that most words are fixated. The reader's purpose can play a significant role in the rate of fixations. Readers expecting a test make more fixations than readers who are only skimming, and speed readers and skimmers make fewer fixations than untrained readers (Just, Carpenter, & Masson, 1982). With fewer fixations, speed readers are not, however, able to answer as many questions about the text (Just et al., 1982).

The reason for this rather dense word sampling rate derives from the narrow perceptual span of word identification. Readers do not obtain much information beyond the center of a fixation, the narrow region of foveal reception. In fact, information sufficient to identify a word is available only within three or four spaces (letters) to the right of a fixation (Rayner, 1975). This means that the reader, in a typical situation, is unable to perceive the letters of the word to the right of the one currently fixated. Information about the shape of words and letters is available from a larger region, about 12 spaces to the right of fixation, but such information is not sufficient to identify a specific word.

Thus the span of perception is narrow and this fact dictates frequent eye fixations. One might suppose that context exerts a significant role on fixation frequency, but the effects of context are complex and perhaps not as profound as common sense suggests. Readers seem not to skip words that are predictable, for example (Zola, 1979; reported in McConkie & Zola, 1981). Context does affect the duration of a fixation, however, and under some conditions a highly predictable word is somewhat less likely to be fixated (Erlich & Rayner, 1981). Even when context does have the effect of reducing fixation frequency, the effect is rather slight. In the Erlich and Rayner study the fixation rate for predictable words remained well above 50%.

The general picture shows a skilled reading process that is driven by rapid but frequent access to printed words. The duration of a fixation and the frequency of fixations are somewhat modifiable. But basic constraints on visual analysis assure a narrow perceptual span which, in turn, assures frequent fixations. The most important observation from this is that lexical access has to occur at a high rate during reading.

Of course, there is much more to reading than word identification. The processes that underlie eye fixations include all of the comprehension processes that obtain meaning from texts and construct mental models of what the text describes. Models of reading based on eye fixation data apportion the duration of fixations to a number of different comprehension factors (Just & Carpenter, 1980). However, none of these comprehension processes are independent of lexical access. The encoding of propositions and subsequent comprehension depend on lexical access as an initiating event.

Verbal Efficiency

An important constraint on comprehension processes is that there are limitations in processing resources. This means that higher level comprehension processes share, to some extent, processing resources with lower level processes, including word identification. Verbal efficiency theory is the generalization of this basic assumption to reading comprehension skill. This theory, spelled out in detail elsewhere (Perfetti, 1985), claims that individual differences in comprehension skill arise from differences in lower level linguistic skills that manifest themselves in word identification and memory. The basic assumptions concerning shared limited resources and their allocation to components of the reading process seem relatively noncontroversial by now: Comprehension processes are at risk to the extent that lower level processes use resources that are needed by higher level processes. The processes that bring about word identification have the potential for being relatively nondemanding of resources. To the extent that word identification processes become attention free or "automatic," comprehension processes can operate smoothly. In the absence of highly automated word identification skills, a reader's comprehension is at risk. A parallel implication of verbal efficiency is that individual differences in working memory capacity will produce individual differences in comprehension.

There is substantial correlational evidence in support of the two main implications of verbal efficiency theory. Children who are below average in reading comprehension skill consistently show below-average abilities in word identification and in *functional* working memory capacity (not necessarily in memory storage capacity). The evidence for these skill relationships is quite strong. The question can no longer be whether they exist but what to make of them (see Perfetti, 1985, for a summary of the evidence.)

> "It is a clear implication for instruction that children should learn something about decoding. This entails learning something about the alphabetic principle, the specific orthographic patterns of the writing system, and the specific mappings of print and speech."

One bit of informal evidence may put the case for verbal efficiency in perspective. Although we have many studies that show a strong relationship between reading comprehension and speed of word identification, I have always been sensitive to the widely made claim that there are many children with comprehension problems who have no difficulties in word identification. The most interesting version of this claim is that many children are "word callers," presenting smooth oral readings without comprehending a word of what they are reading. In order to try to find some children who have comprehension problems without word identification problems, we asked teachers to identify such cases for us. The teachers, at least those who taught children beyond the second grade, seemed to know the sort of child we were looking for. They identified several for us—children who had trouble comprehending what they read but who had good word recognition skills—and we gave them some experimental tasks. The most important ones were a word identification task and a listening comprehension task. We gave these same tasks to a large sample of average readers to provide a comparison with each child identified. There was a different comparison group for each grade, making this rather expensive research, roughly 16 comparison subjects for each identified comprehension problem.

The results of this little exercise were that of nine children identified as having a comprehension problem, all except one turned out to have a subtle (or obvious) word identification problem. They were more than one standard deviation below the appropriate comparison group in speed of word identification, measured by the time taken to begin vocalization of a single printed word, shown in isolation. (This measure has proved to be the most consistently discriminating measure of reading skill.) These students also tended to have below average listening comprehension skills. The one child who did not score low in the word identification task turned out not to have a comprehension problem, as measured by our standardized comprehension test.

This does not mean that there are no reading comprehension problems independent of word identification problems. I am sure there are a few. But it is interesting that they are not so easy to find as one might expect on the basis of informal observation. It is easy, apparently, to believe that a child has good word identification skills based on a casual assessment of reading. However, a measure of the time it takes to identify a word will often reveal the extra effort that a student has to put into word identification. Often, accuracy problems can be revealed as well, provided some less common words are used. Finally, it is a good bet that if a child is found to have a comprehension problem in the absence of a word identification problem, a careful examination of spoken language comprehension will show a problem. Cases of pure reading comprehension problems will be very rare.

Schema Factors

An important general factor in comprehension is the use by the reader of knowledge related to the content of a text. This knowledge is essential in the construction of a mental text model, what Van Dijk and Kintsch (1983) call a "situational" model; that is, a model of the situation described by the text. To understand a text about anything, a reader must have specific knowledge structures available to provide the "scaffolding," as Anderson, Spiro, and Anderson (1978) put it. Absence of the necessary knowledge structures, or schemata, will result in impoverished comprehension (Spilich, Vesonder, Chiesi, & Voss, 1979). There are by now many demonstrations of the critical role such knowledge plays in comprehension.

The question of exactly how schema factors exert their influence is more complex. Since the effort after meaning is the dominant characteristic of skilled reading, the use of schemata is perhaps the most important process in comprehension. There is some sense in which no comprehension has occurred without the use of a schema. In the comprehension of a real text, dozens of related schemata are activated in a continuous process of constructing a model of what the text is about. On the other hand, the idea that knowledge structures have a profound influence on lower level processes of word identification may be incorrect. There may be some degree of autonomy at the level of word identification for a skilled reader. That is, the ability to identify a word, for a skilled reader, has become independent of meaning contexts. In contrast, for a reader of low skill, the word identification process may remain more context dependent (Perfetti & Roth, 1981; Stanovich, 1980).

It is more likely that the effects of knowledge structures occur very early in the encoding of elementary meaning relationships (propositions) rather than at the early stages of word identification. This hypothesis is consistent with evidence that shows delayed effects of context on a reader's selection of the appropriate meaning of an ambiguous word (Swinney, 1979). That is, the encoding of word meanings, not the elementary identification of words, probably provides the earliest locus of specific knowledge effects in reading. Later effects, for example in the encoding and integration of propositions, are profound.

In the context of verbal efficiency theory, schema activation resembles word identification in its potential for automation. That is, a well written text will contain triggers that activate appropriate schemata. Indeed, many of the necessary schemata can be thought of as associated meaning elements connected with words. Thus the identification of words in context leads to associated schemata. Other schemata are associated less with word-concepts than with more complex concepts. Unlike well automated word identification, however, schemata may require some sustained attention over time. The use of a schema may be subject to interference from ineffective word identification, sentence parsing difficulty, or other lower level processes.

Finally, the importance of schemata for comprehension should not obscure the fact that individual differences in comprehension skill cannot rest wholly on differences in the availability of schemata. This is at least the reasonable hypothesis until such time that we are forced by the evidence to conclude that generalized reading skill does not exist. The essence of schema theory is that what is understood depends on what the reader knows, and since different readers know different things, schema theory predicts idiosyncratic differences in comprehension. It also predicts cultural and age-related differences, but it does not capture the idea of a generalized reading skill that serves the reader in all situations. Schema theory can be extended to account for general reading skill, in principle, but it requires the postulation of consistent individual differences in schema activation, that is, consistencies within an individual across different texts. Such individual differences may be found, but it would be necessary to demonstrate that they do not derive from word identification problems or working memory limitations, or some other factor known to limit comprehension.

Summary

This brief summary of skilled reading has emphasized that comprehension is the defining characteristic of skilled reading, and that lexical factors continue, nonetheless, to play a large role in comprehension just as they do in beginning reading. The constraints on visual information processing assure that reading with comprehension requires that most words be accessed by the reader. Verbal efficiency considerations point to the need to make lexical processes, since they are recurring and fundamental to comprehension processes, to be relatively low in processing costs. Individuals who are not good at reading comprehension tend to have trouble with word identification, as reflected in speed or accuracy, and they often have problems understanding spoken language. Schemata are critical in comprehension and their facile activation during reading aids in efficiency, but schema theory itself is not a good bet for explaining individual differences in comprehension ability.

Reading Ability and Disability: A Continuum?

Thus far, I have essentially summarized what I take to be a reasonable account of how children learn to read in an alphabetic orthography and how skilled reading works in general. Questions of reading disability can be addressed by taking these normal processes as points of departure.

Individual differences within the normal and below-normal ranges of ability have to be considered first: How shall we understand the difference between a child of average ability and one of below-average ability when both are in, say, the fourth or fifth grade, and neither is labeled as learning disabled? This question has guided some of my own research on reading ability, so it is appropriate to summarize some of what I have found to be the answer.

Our studies have focused on children in normal classrooms in grades 2 through 6. Children designated as less skilled readers have typically been 1 to 2 years below the grade level and always in the normal IQ range. Skilled readers have been average and above in reading comprehension, measured by comprehension tests. Much of the research comparing these populations of skilled and less skilled readers is summarized in Perfetti (1985) and reported in numerous research papers cited there. Accordingly, my reference here to this research will be very brief, directed at what I see as the most consistent and characteristic results, rather than to the more delicate and more tentative results.

There have been a couple of result patterns that seem especially characteristic. One is that skilled readers are consistently faster and more accurate at isolated word identification, even though the defining skill measure is a test of comprehension. A second one is that skilled readers show advantages in memory for both spoken and written language, although this advantage does not always extend to other memory tasks. In the case of word identification, our studies have used a number of different tasks. However, the task that has been the most discriminating for reading skill is the vocalization or naming task, in which the subject reads a single word or nonword presented on a screen and names the word as quickly as possible. This vocalization latency measure, the time to begin the vocalization of the stimulus, is longer for less skilled readers in all grades than for skilled readers. Furthermore, the differences in latency between skilled and less skilled readers are modified by certain factors:

- For words of low frequency, the differences between skilled and less skilled readers increase.
- For long words, the differences increase.
- For pseudowords, orthographically regular and pronounceable nonwords, the differences increase.
- For nonlinguistic stimuli, including pictures, color patches and digits, the differences decrease.
- When the words are presented in meaningful discourse context, the differences decrease.
- When words are presented in misleading contexts, ones which lead the reader to expect some different word, the differences increase.

The explanation for such differences is not completely understood, but one thing is clear. Whatever the underlying factor is, it is responsible for consistent differences in the time it takes to identify a linguistic object. Since the differences increase for rare words and for long words, and especially because they increase for pseudowords, a simple word familiarity factor seems to be ruled out. There is no doubt that a reader of skill becomes more familiar with more words than a reader lacking skill, but this familiarity itself is probably not the explanation. It seems more likely to depend on the use of subword orthographic units that would serve the reader in rare words as well as common words and for nonwords as well as real words. Of course, the subword unit knowledge itself may derive from lexical experience. The critical general fact, regardless of the underlying cause, is that the skilled reader shows more rapid identification of linguistic stimuli independent of context. The hallmark of the skilled reader is context-free word identification skill.

The second characteristic factor is that skilled readers show a more accurate memory for both spoken and written language. This factor can be expressed as a greater functional memory, one that would help account for the greater verbal efficiency of the skilled reader. It does not always show itself in a test of short-term memory capacity, suggesting that it is active processing, of the kind implied by the concept of working memory, rather than the passive short-term memory capacity concept that is the important memory factor. More important is the fact that this memory difference is found for spoken language as well as written language. It suggests a basic modality-free working memory factor related to language.

Many questions can be raised concerning these general facts. Is the memory factor mainly a sequencing factor? Does it really depend on language or is it more general? Is there a common language representation factor that underlies both the decoding factor and the memory factor? (I think the answer to this last question is probably "yes.") Such questions are very important for understanding the underlying nature of language skill. But the general characterization provided by the most solid facts seems to go a long way in providing the features of a reading skill continuum. The ability to handle spoken and written language, including simple identification and memory, is what skilled readers have that less skilled readers lack. At the most general level, we can say that the ability to identify and manipulate linguistically coded stimuli is the ability continuum for reading.

The next question is whether what is known about specific reading disability belongs on such a continuum. The question of definition is a critical one here, and I take one of the reasonably widely accepted definitions to be

that specific reading disability or developmental dyslexia is applied to children (a) who are normal or above in nonverbal IQ, (b) who are 2 years or more below the appropriate norm in reading achievement, and (3) whose reading disability is not explainable primarily by social or emotional factors. The label can apply to adults as well, with the caveat that normative performance becomes increasingly difficult to define (for further discussion of definition issues see Duane, 1979; Jansky, 1979; Vellutino, 1979). Acquired dyslexia is beyond the scope of the general claims to be made here, although it is possible that acquired and developmental dyslexia share a general causal mechanism.

The general hypothesis tentatively put forth is that developmental dyslexics fall on a continuum of ability that includes readers of average skill and readers of low skill. "Low ability" readers and dyslexics are more different in the level of their skill than in the qualitative nature of their reading problems. The basis for the continuum is again the degree of coding ability for linguistic stimuli along with linguistic memory, a related ability. This is not to say that every case of dyslexia has the same etiology and the same manifestations. This is probably not the case, although it is not clear. The idea is simply that the vast majority of developmental dyslexics have problems that are traceable to defective linguistic coding of one sort or another.

The basis for such a claim is the rather strong evidence that dyslexics in general show problems in linguistic processing of one sort or another. Based on such evidence, Vellutino, in his 1979 review of dyslexia research, concluded that verbal deficits were the major factors in reading disability. It is difficult to evaluate the vast research, which often produces inconsistent results, that bears on this hypothesis. But it does appear that there has been nothing to clearly contradict this conclusion since Vellutino's review. Furthermore, there has been research that has added to the picture of the dyslexic as one with a linguistic problem rather than a visual or "holistic" perception problem.

For example, Olson, Kliegl, Davidson, and Foltz (1985) have carried out a thorough analysis of 141 dyslexics between the ages of 7 and 17. Although there are a number of interesting individual differences in their results, for example in the reading *style* of subjects, there did not appear to be any fundamental differences between the most severely disabled subjects—those that satisfy stringent criteria for dyslexia—and subjects who resemble more the low-skill readers of research that compares average and below-average readers. For example, both the more severely and the less severely disabled showed a phonological coding deficit relative to normal readers. Olson et al. (1985) specifically failed to find any evidence for subgroups of disability defined according to the Boder (1973) distinction between dysphonetics and dyseidetics.

The prevailing view among disability specialists is a bit different from this continuum idea. This view holds that there are subtypes of dyslexia that are qualitatively different and that all subgroups are qualitatively different from "garden variety" poor readers. Boder's theory (1971, 1973) is especially widely appreciated in this regard, although there is a rich history of subclassification in the field, for example, Johnson and Myklebust (1967), Birch (1962), and Bakker (1979) to name only a few instances. Boder's two most important subtypes are the *dysphonetics* and the *dyseidetics*. The dysphonetics have weak decoding skills and their linguistic skills in general are poor. They read words in context better than in isolation. This description should be very reminiscent of the general characteristics of low-skill readers given in previous sections. This group is also the larger of the two, more than six times more numerous than the dyseidetics, a group that is characterized by good decoding but a disability in holistic visual word recognition. Defective recognition of visual gestalts is said to be their basic characteristic.

Although there are some confirmatory studies in the literature (e.g., Fried, Tanguay, Boder, Doubleday, & Greensite, 1981), there are enough studies that fail to find evidence for these subgroups to raise doubt about the relative frequency of the dyseidetics. The Olson et al. (1985) study, one by Godfrey, Syrdal-Lasky, Millay, and Knox (1981), and one by van den Bos (1982) all report failing to find any differences in processing by groups classified as different by the Boder test.

It is of course not possible, and it is perhaps incorrect, to say that there are no dyseidetics. It is possible to suggest that the vast majority of children diagnosed as having specific acquired reading disability will have problems in linguistic coding, linguistic memory, and linguistic processing generally. If so, differences between dyslexics and children who are simply less skilled in reading may be largely quantitative. Such differences do exist. For example, dyslexics apparently have a generalized naming problem that is independent of linguistic stimuli (Denckla & Rudel, 1976a, 1976b), in contrast with the observation that at least some less skilled readers have a naming problem only for linguistic stimuli. However, a continuum that allows linguistic processes to occur within the limits placed by general name retrieval processes seems to fit facts such as this.

Are There Implications for Teaching and Remediation?

In the preceding sections, except the last one, I have presented what should be noncontroversial characterizations of learning how to read and reading skill. That is, solid research supports the general characterization, although very important details are less certain. What to make from these characterizations for practice is not automatically provided as part of this account. However, it is certainly possible to make a few firm observations.

It is a clear implication for instruction that children should learn something about decoding. This entails learning something about the alphabetic principle, the specific orthographic patterns of the writing system, and the specific mappings of print and speech. This conclusion has been reached many times by thoughtful researchers in reading instruction (Gleitman & Rozin, 1977; Gough & Hillinger, 1980; Liberman & Shankweiler, 1979).

It is possible to go beyond the conclusion that the child should learn how to decode printed words. A second implication is that the child should learn enough about decoding and word identification so that words can be identified without effort. This is a general implication of verbal efficiency theory: Efficient word access is a useful instructional goal beyond accuracy of word identification.

There seem to be two implications to discuss: first, the ability to identify words, and second, the ability to identify words efficiently. In fact these two implications will turn out to derive from a single principle: *The most important property of a word identification system is the quality of word representation*. A high quality word representation is one that contains redundant and accessible information—about the world's spelling, its pronunciation, its syntactic environments, and its semantic values.

Learning to read is the process of attaining a larger number of these quality word representations. The way to bring about this learning is not necessarily identifiable with one particular teaching procedure. Human beings, including children, are prolific pattern learners. Exposure to printed words, at least active exposure, provides a powerful condition for acquiring quality word representations. Thus, reading itself has the potential to bring about learning to read.

This presents a paradox well recognized by any teacher or designer of instruction. Pattern induction is a powerful mechanism for learning to read, but it is available to the student only through reading. What is especially helpful for the learner is to have part of the representation system. The mapping system, the grapheme-phoneme correspondences in an alphabetic system, would be a significant advantage to a child learning to read. It is the one representation system that allows the acquisition of other representation systems.

This mapping system can be taught successfully in a very direct manner, of course. The direct teaching of decoding principles has obvious advantages and no known disadvantages. The direct teaching of decoding does *not* produce word callers in children (Lesgold & Resnick, 1982). It does provide a solid backup for word identification processes that continue to develop with actual reading experience. The conclusions of Chall (1967) and others (Williams, 1979) concerning the advantage of code-emphasis programs over meaning-emphasis programs, even though the advantage may be slight, seems beyond dispute.

This is not to say that there is only one right way to provide code instruction. The instruction method is less determined by theory and data than is the learning result. That is, there are many different ways to learn to read—superficially, at least. However, only those ways that sooner or later bring about the child's learning of orthographic patterns and print-speech mappings will be successful.

The second consideration for acquiring skill in reading is efficient word identification as an instructional objective beyond accurate word identification. The claim, however, is that these two objectives derive from the same principle of high quality word representation. The speed and efficiency of access to printed words arise from the quality of their representation, not from some factor extrinsic to the lexicon, that is, not from some separate speed factor. Speed of word identification reflects the accessibility of a word representation. In part this accessibility seems to be a question of automatic processing. As LaBerge and Samuels (1974) demonstrated, automaticity of identification processes can follow extended practice with printed symbols.

However, there is more to efficient word identification than automaticity. Indeed the existence of automatic processing even for symbols smaller than words has become increasingly hard to demonstrate, when one takes the ability to perform some second task as the standard for claiming that performance on a primary task is automatic. I think we should begin to understand the kind of efficient process involved in skilled word identification as a consequence of a word representation that is activated easily, perhaps automatically, because it has redundant and fully deterministic information associated with it.

Should training of speed be an instructional objective for students of low skill? Such training is not necessarily successful (Fleisher, Jenkins, & Pany, 1979), especially if it focuses on short-term training. Short-term training can be successful only if one assumes that speed is a skill to be "tacked on" to a skill of accuracy. If, instead, speed is seen as a reflection of the same word representation quality that gives rise to accuracy, a different perspective emerges. Training might instead focus on the quality of word knowledge, with speed of access following as a by-product of improved representation.

The implication of this principle is not that training of speed is a bad thing to do. Rather, it implies that speed training will be most helpful if one of two conditions are met: (1) The speed training simultaneously strengthens the word representation system and (2) the representation system does not need improvement. To be sure that the second condition is met, the student's word identification accuracy must be established beyond a doubt for a wide range of orthographic patterns, that is, for rare words and/or pseudowords. Otherwise the operative assumption should be that the training will have to affect both accuracy and speed, that is, quality of word representation, in order to be effective. This clearly means that short-term instruction is not likely to be effective if speed is its only objective.

There have been some successful attempts to bring about improvements in comprehension as a result of relatively long-term instruction. Low ability teenage readers have shown some specific, although limited, benefits from computer based training on speeded word and letter processing (Frederiksen et al., 1983). Although these benefits did not extend to comprehension, such benefits for very low skill children have been found by

Roth and Beck (1984), who presented word and subword processing tasks in speeded computer game environments. The key to success for such programs may lie in the amount of practice as well as in the design of materials that promote code and pattern learning. The average student spent 14 hours over 12 weeks in the study reported by Roth and Beck, for example.

No doubt there are other important components in which students need instruction. Decoding often seems to be just one manifestation of a problem in encoding linguistic stimuli appropriately. However, it is the central recurring part of reading and is the most clear candidate for generalized effects of training. There is no reason not to recommend it, provided that conditions can be established to maintain student motivation. The success of the two computer based training programs suggests that this does not have to be the obstacle that it sometimes seems.

Summary

In this paper, I have tried to avoid discussing new research findings in reading, reading disability, and reading instruction. From a practical point of view, it is not always helpful to present the latest research result because it is not yet reliably integrated with what is known about the processes in question. Thus, I have instead focused on stable observations that in the main are incontrovertible. These observations can constrain our theories of reading acquisition, reading skill, and reading disability, and highlight some continuities among them. The importance of code learning in an alphabetic orthography was stressed, the obstacles to code learning were again noted, but it was also argued that procedures for learning to read can make some headway without solving all the problems connected with code learning. Final progress in learning to read does depend on learning the principles on which decoding depends, however.

The analysis of skilled reading establishes a continuity between beginning reading and skilled reading. Although many other higher mental processes come into effect in comprehension, decoding and word identification remain as the central recurring parts of reading. If the processes of word identification do not achieve high levels of efficiency, comprehension processes are at risk. Verbal efficiency is a major consideration in understanding skilled reading comprehension. Further continuity is suggested by a consideration of specific reading disability. Although most theories of dyslexia emphasize multiple causes and diagnostic subtypes, it is at least possible to consider that dyslexics, in general, lie on a continuum of reading ability that contains readers of average and below-average skill as well. The facility at linguistic coding would be the processing basis for this continuum.

Finally, implications for instruction require additional considerations, but the coding skill continuum does imply that learning the code is a legitimate objective of reading instruction. There are many ways to establish conditions for this learning, but no evidence to challenge the general slight advantage owed to methods of direct code instruction. Verbal efficiency is a further goal of instruction, but this should not be equated with a goal of speeded processing itself. Speed is merely a reflection of a high quality word representation system, thus suggesting another continuum between accuracy and speed. Training in speed may be useful if it also provides an opportunity at strengthening the quality of the representation system.

Charles A. Perfetti *is professor of psychology and linguistics and senior scientist, Learning Research and Development Center, University of Pittsburgh. His PhD in psychology is from the University of Michigan. His research has been concerned with language processes, and especially reading. Some of this research and the theory that frames it are discussed in his recent book,* Reading Ability, *published by Oxford Press.*

Author's Note

Preparation of this manuscript and the author's research cited in it are supported in part by the Learning Research and Development Center, which is supported in part by the National Institute of Education.

References

Anderson, R. C., Spiro, R. J., & Anderson, M. C. (1978). Schemata as scaffolding for the representation of information in connected discourse. *American Educational Research Journal, 15*, 433–440.

Bakker, D. J. (1979). Hemispheric differences and reading strategies: Two dyslexias? *Bulletin of the Orton Society, 29*, 84–100.

Biemiller, A. (1970). The development of the use of graphic and contextual information as children learn to read. *Reading Research Quarterly, 6*, 75–96.

Birch, H. G. (1962). Dyslexia and maturation of visual function. In J. Money (Ed.), *Reading disability: Progress and research needs in dyslexia* (pp. 161–169). Baltimore: Johns Hopkins University Press.

Boder, E. (1971). Developmental dyslexia: A diagnostic screening procedure based on three characteristic patterns of reading and spelling. In B. Bateman (Ed.), *Learning disorders* (Vol. 4, pp. 298–335). Seattle: Special Child Publications.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. *Developmental Medicine and Child Neurology, 15*, 663–687.

Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read—A causal connection. *Nature, 301*, 419–421.

Carpenter, P. A., & Just, M. A. (1981). Cognitive processes in reading: Models based on readers' eye fixations. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 177–213). Hillsdale, NJ: Erlbaum.

Chall, J. (1967). *Learning to read: The great debate*. New York: McGraw-Hill.

Denckla, M. B., & Rudel, R. G. (1976a). Rapid "automatized" naming (R.A.N.): Dyslexia differentiated from other learning disabilities. *Neuropsychologia, 14*, 471–480.

Denckla, M. B., & Rudel, R. G. (1976b). Naming of object drawings by dyslexic and other learning disabled children. *Brain and Language, 3*, 1–15.

Downing, J. A., & Oliver, P. (1973–1974). The child's conception of "a word." *Reading Research Quarterly, 9*, 568–582.

Duane, D. D. (1979). Toward a definition of dyslexia: A summary of views. *Bulletin of the Orton Society, 29*, 56–64.

Ehri, L. C. (1979). Linguistic insight: Threshold of reading acquisition. In T. Waller & G. E. MacKinnon (Eds.), *Reading research: Advances in theory and practice* (Vol. 1, pp. 63–111). New York: Academic Press.

Erlich, S. F., & Rayner, K. (1981). Contextual effects on word perception and eye movements during reading. *Journal of Verbal Learning and Verbal Behavior, 20*, 641–655.

Fleischer, L. S., Jenkins, J. R., & Pany, D. (1979). Effects on poor readers' comprehension of training in rapid decoding. *Reading Research Quarterly, 14*, 30–48.

Frederiksen, J. R., Weaver, P. A., Warren, B. M., Gillotte, H. P., Rosebery, A. S., Freeman, B., & Goodman, L. (1983). *A componential approach to training reading skills* (Report No. 5295). Cambridge, MA: Bolt Beranek & Newman.

Fried, I., Tanguay, P. E., Boder, E., Doubleday, C., & Greensite, M. (1981). Developmental dyslexia: Electrophysiological evidence of clinical subgroups. *Brain and Language, 12*, 14–22.

Gleitman, L. R., & Rozin, P. (1973). Teaching reading by use of a syllabary. *Reading Research Quarterly, 83*, 447–483.

Gleitman, L. R., & Rozin, P. (1977). The structure and acquisition of reading. I: Relations between orthographies and the structure of language. In A. S. Reber & D. L. Scarborough (Eds.), *Toward a psychology of reading: The Proceedings of the CUNY Conference* (pp. 1–53). New York: Wiley.

Godfrey, J. J., Syrdal-Lasky, A. K., Millay, K. K., & Knox, C. M. (1981). Performance of dyslexic children on speech perception tests. *Journal of Experimental Child Psychology, 32*, 401–424.

Gough, P. B., & Hillinger, M. L. (1980). Learning to read: An unnatural act. *Bulletin of the Orton Society, 20*, 179–196.

Jansky, J. J. (1979). Specificity and parameters in defining dyslexia. *Bulletin of the Orton Society, 29*, 31–38.

Johnson, D., & Myklebust, H. (1967). *Learning disabilities: Educational principles and practices*. New York: Grune & Stratton.

Just, M. A. & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review, 87*, 329–354.

Just, M. A., Carpenter, P. A., & Masson, M. E. J. (1982). *What eye fixations tell us about speed reading and skimming*. Eye-Lab Technical Report, Carnegie-Mellon University, Pittsburgh.

LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*, 293–323.

Lesgold, A. M., & Resnick L. B. (1982). How reading disabilities develop: Perspectives from a longitudinal study. In J. P. Das, R. Mulcahy, & A. E. Wall (Eds.), *Theory and research in learning disability* (pp. 155–187). New York: Plenum.

Liberman, A. M., Cooper, F. S., Shankweiler, D., & Studdert-Kennedy, M. (1967). Perception of the speed code. *Psychological Review, 74*, 431–461.

Liberman, I. Y., Liberman, A. M., Mattingly, D., & Shankweiler, D. (1978). *Orthography and the beginning reader*. Paper presented at the Cross-Language Conference on Orthography, Reading, and Dyslexia, Bethesda, MD.

Liberman, I. Y., & Shankweiler, D. (1979). Speech, the alphabet, and teaching to read. In L. B. Resnick & P. A. Weaver (Eds.). *Theory and practice of early reading, Vol. 2* (pp. 109–132). Hillsdale, NJ: Erlbaum.

Liberman, I. Y., Shankweiler, D., Fisher, F. W., & Carter B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology, 18*, 201–212.

Marchbanks, G., & Levin, H. (1965). Cues by which children recognize words. *Journal of Educational Psychology, 56*, 57–61.

Marsh, G., Friedman, M., Welch, & Desberg, P. (1981). A cognitive-developmental theory of reading acquisition. In G. E. MacKinnon & T. G. Waller (Eds.), *Reading research: Advances in theory and practice* (Vol. 3, pp. 199–219). New York: Academic Press.

McConkie, G. W., & Zola, D. (1981). Language constraints and the functional stimulus in reading. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 155–175). Hillsdale, NJ: Erlbaum.

Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? *Cognition, 7*, 323–331.

Olson, R. K., Kliegl, R., Davidson, B. J., & Foltz, G. (1985). Individual and developmental differences in reading disability. In T. G. Waller (Ed.), *Reading research: Advances in theory and practice* (pp. 1–64). New York: Academic Press.

Perfetti, C. A. (1985). *Reading ability*. New York: Oxford Press.

Perfetti, C. A., & Roth, S. F. (1981). Some of the interactive processes in reading and their role in reading skill. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 269–297). Hillsdale, NJ: Erlbaum.

Pitman, J., & St. John, J. (1969). *Alphabets and reading*. Belmont, CA: Pitman Learning.

Rayner, K. (1975). The perceptual span and peripheral cues in reading. *Cognitive Psychology, 7*, 65–81.

Rayner, K., & Hagelberg, E. M. (1975). Word recognition cues for beginning and skilled readers. *Journal of Experimental Child Psychology, 20*, 444–455.

Roth, S. F., & Beck, I. L. (1984). *Research and instructional issues related to the enhancement of children's decoding skills through a microcomputer program*. Paper presented at annual meeting of the American Educational Research Association, New Orleans.

Rumelhart, D. E., & McClelland, J. L. (1981). Interactive processing through spreading activation. In A. M. Lesgold & C. A. Perfetti (Eds.), *Interactive processes in reading* (pp. 37–60). Hillsdale, NJ: Erlbaum.

Spilich, G. J., Vesonder, G. T., Chiesi, H. L., & Voss, J. F. (1979). Text-processing of domain-related information for individuals with high and low domain knowledge. *Journal of Verbal Learning and Verbal Behavior, 18*, 275–290.

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly, 16*, 32–71.

Swinney, D. A. (1979). Lexical access during sentence comprehension: Reconsideration of context effects. *Journal of Verbal Learning and Verbal Behavior, 18*, 645–659.

van den Bos, K. P. (1982). *Letter span, scanning, and code matching in dyslexic subgroups*. Paper presented at thirty-third annual conference of the Orton Society, Baltimore.

van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press.

Vellutino, F. R. (1979). *Dyslexia: Theory and research*. Cambridge, MA: MIT Press.

Weber, R. (1970). A linguistic analysis of first grade reading errors. *Reading Research Quarterly, 5*, 427–451.

Williams, J. P. (1979). Reading instruction today. *American Psychologist, 34*, 917–922.

Williams, J. P., Blumberg, E. L., & Williams, D. V. (1970). Cues used in visual word recognition. *Journal of Educational Psychology, 61*, 310–315.

RASE

CONTENTS

Publisher: Donald D. Hammill
Editorial Director: Steven C. Mathews
Production Editor: Sue Motzer
Circulation Manager: Sherry Adrian
Materials Editor: Virginia L. Brown
Appraisal Editors: Linda Brown and Brian R. Bryant

REMEDIAL AND SPECIAL EDUCATION (USPS #542-470) is published six times a year by PRO-ED, 5341 Industrial Oaks Boulevard, Austin, TX 78735. Second-class postage is paid at Austin, Texas.

POSTMASTER: Send address changes to RASE, 5341 Industrial Oaks Boulevard, Austin, TX 78735.

Subscription rates (one year or six issues, U.S. dollars only): N. Am. Institutions $45; N. Am. Individuals $30; N. Am. Students $20; all Foreign Subscribers $50.

Business correspondence: (subscription inquiries, subscription orders, change of address, advertising inquiries, etc.) should be addressed to RASE, 5341 Industrial Oaks Boulevard, Austin, TX 78735 (allow six weeks for address change).

ERIC: RASE is annotated and indexed in Current Index to Journals in Education (CIJE) and Exceptional Child Education Resources (ECER).

Microform: This publication is available in microform from University Microfilms International, 300 North Zeeb Road, Dept. P.R., Ann Arbor, MI 48106.

 Vol. 7, No. 1, ISSN: 0741-9325. Printed in the United States of America.

Volume 7 Number 1 January/February 1986

RASE Editorial Policy 4
Information for Authors 4
From the Editor 5

RASE Feature Articles

Decoding, Reading, and Reading Disability 6
Philip B. Gough and William E. Tunmer

Continuities in Reading Acquisition, Reading Skill, and Reading Disability 11
Charles A. Perfetti

The Efficacy of Group Versus One-to-One Instruction: A Review 22
Edward A. Polloway, Mary E. Cronin, and James R. Patton

Adapting Science Materials for Regular and Learning Disabled Seventh Graders 31
Thomas Lovitt, James Rudsit, Joseph Jenkins, Constance Pious, and Dina Benedetti

The Equal Additions Method of Subtraction Taught with a Modeling Technique 40
George Sugai and Pam Smith

The Information Flood in Learning Disabilities: A Bibliometric Analysis of the Journal Literature 49
Edward G. Summers

RASE Book Reviews

Thomas J. Zirpoli 61

RASE Calendar 62

RASE

Editorial Board

RASE

Special Issues Editorial Board