Reading, Writing, and Literacy

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Introduction

Some children learn to read and write with remarkable ease. Before school, and without any great effort or pressure on the part of their parents, they pick up books, pencils, and paper, and they are on their way, almost as though by magic (see Bissex, 1980; Chomsky, 1971; Clarke, 1976; Durkin, 1966; Read 1971; Sulzby, 1985).

For most children, however, learning to read and write is just plain difficult, even given years of formal instruction and enforced practice. Thus, we meet many youngsters who would just as soon not read or write and a number who hate to do so. In watching them read, we see some who balk on every other word. We see others who sound each word out letter by letter only to read, for example, "jirl" for girl, regardless of the force of the context. We see some who skip and gloss even to the extent that they forfeit the meaning of the passage. And we see others who, though they seem to read with reasonable fluency and accuracy, leave the text with little notion, much less useful thought, of what it was about. At one point or another, in one way or another, many if not most children labor so arduously in reading and so unproductively in writing that we cannot imagine they are getting anything but frustration from the exercise. These children are at the fulcrum of the literacy debate.

Most often, agree those on both sides of the debate, the problem lies in the students' poor management of the words. Yet their explanations and solutions for this problem are diametrically opposed. In caricature, those on one side of the debate argue that the students' preoccupation with the words reflects a fundamental misunderstanding of the real purposes and mature dynamics of reading. The cure, they suggest, is to design the instructional regimen such that issues of letters, spelling-sound correspondences, and word-recognition accuracy are clearly subordinated to meaning from the start. After all, they argue, if readers would focus their attention on the meaning and message of the text, then the letterwise detail of most words could

be glossed through context. Those on the other side of the debate, in contrast, argue that it is the students' inability to recognize the words with adequate ease and speed that prevents them from reading with fluency and comprehension. If this is so, they argue, then giving students the help they need to master the words is necessarily key to the cure.

In its barest essence, this debate will be familiar to all psychologists: Are learning and experience principally built bottom-up, through successive organizations of the physical data available through our senses? Or are learning and effective experience controlled top-down, as available information is selected and structured by our reigning goals, interests, and expectations? For almost any psychologist, this is a good problem at some level of abstraction or granularity.

When perspective is shifted to the classroom, however, this becomes a problem of real practical import. The power and effectiveness of our educational programs pivot on how we conceive its resolution at *every* level of abstraction and granularity as this, in turn, determines the schoolroom issues of what to teach, when, and how. Arguably, the principle motive for universal education is universal literacy. Reviewing a number of studies, the US Office of Technology Assessment (1993) estimated that the literacy competencies of approximately one quarter of adult Americans—35 to 50 million people—are inadequate for purposes of everyday tasks. The majority of these people have passed through our educational system, but many cannot read beyond the third-grade level. The social and personal impact of this situation cannot be overstated. Virtually every dynamic in which this country has invested itself—democracy, innovation, technology competition, productivity, philanthropy, technology, individual liberties, and self-determination—is predicated on a thoughtful, knowledgeable, self-educating populace.

Yet, even as the social and economic values of literacy are multiplying, so too is the evidence that many American children are not adequately learning to read. Results of the 1992 National Assessment of Educational Progress indicated that, nationwide, the reading performance of 41% of fourth graders fell beneath the cut-off point for Basic Level performance: They could not read grade-level narratives and high-interest text well enough to identify obvious themes, locate

explicitly given information, summarize, or reflect on character's actions (Mullis, Campbell, & Farstrup, 1993). The dropout and illiteracy statistics are especially marked among youth from language and ethnic minorities. These children will soon constitute the majority of our electorate. As a group, moreover, they are also the children who depend most of all on formal schooling for their literacy education.

The Cognitive Revolution and the Ascendance of the Whole Language Movement

The most recent bout in the so-called "Great Debate" (Chall, 1967) over literacy instruction began to take shape in the 1960's, at the outset of the cognitive revolution. At the time, both psychology and education were becoming increasingly frustrated with the bottom-up stimulus-response framework that had come to dominate theories of learning. This framework was logical, it was deeply entrenched, and it was mature to the point of nth order parameters and a burgeoning market in bottom-up teaching designs. But there was also something about it that was somehow incomplete, unsatisfying, inhuman.

At just that moment, there erupted a series of compelling arguments that language, that quintessentially *human* capacity, was special. The physical dimensions of the speech signal were argued to be such that it could not be processed through bottom-up perceptual mechanisms. The complexities and possibilities of syntax were argued to be such it could not be mastered through any piecewise bottom-up learning regimen. Humans must be endowed with some special, higher-order capacity to respond to structure and meaning in language (Chomsky, 1967; McNeill, 1970).

That the cognitive requirements of oral and written language must overlap at some level may be self-evident. At that time, however, psychologists saw parallels at every level. In Neisser's words, "Most people...can understand what they read without actually identifying many of the individual words. How is this possible?" (1967, pp. 134-135; see also, e.g., Kolers, 1968; Smith, 1971, 1973). Having accepted the question, the answer was necessarily sought in the reader's higher-order knowledge and expectations about language and meaning.

Suddenly reading was an interesting domain of study. For research psychologists, the buzz words were "top-down processing," and text processing became a major medium for its investigation. Indeed, in the years since then, research on reading is said to have filled more book and journal pages than any other topic in cognitive psychology (Besner & Humphreys, 1992).

Yet, if these speculations were energizing to research psychologists, they were of arresting significance to educators. Specifically, if the separate words and letters of text are functionally irrelevant to the mature reading process, then where is the advantage—and what might be the disadvantages—of making these units so focal in early reading instruction? Were our conventional methods of reading instruction seriously misguided? Could this be why so many young readers bog down on the words? Could it be that the major difference between good and poor readers lay in their ability to divert attention from the letters and words to the meaning of text? Would children learn to read more quickly and productively if, from the start, their attention was directed not to letters and words but to the meaning and message of the texts?

Of course, whether or not skillful readers skip and gloss the letters and words of text while reading, the questions of whether or not young readers can or should do so are separate. Because the interest was intense and the data were sparse, a single research study by Ken Goodman (1965) became highly influential. In designing this study, Goodman reasoned that if the functional cues in meaningful text extend beyond the level of individual words, then growing readers should be more able to read words in context than in isolation. To assess this hypothesis, he constructed word lists from each of a graded sequence of basal stories. His subjects were 100 students in grades one through three. Toward equating the subjective difficulty of the task, each child was tested first on the word lists. When a list was found on which the child missed neither too many nor too few words, she or he was asked to read the story from which that list had been taken. Goodman found that more than half of the words that had been misread or skipped in the lists were read accurately in context, and this was true across all of the children and regardless of grade. Given, as these data suggested, that children find it harder to recognize simple words than

to read them in stories, Goodman concluded, "We must abandon our concentration on words in teaching reading and develop a theory of reading and a methodology which puts the focus where it belongs: on language" (p. 134).

Goodman himself became highly active in promoting this very belief and, with remarkable rapidity, it burgeoned into what is now known as the whole language movement. According to the whole language philosophy, reading and writing cannot be nurtured piece by piece; they are holistic acts, learnable and worth learning only as such. Most of all, the whole language philosophy holds that learning is anchored on and motivated by meaning. Further, since meaning and meaningfulness are necessarily defined internally and never by pronouncement, learning can be effective only to the extent that it is cognitively controlled by the learner.

Meanwhile, away from the classroom, research psychologists were also captivated by theories of top-down processing. Working within this framework, they discovered that people's memory and reading times for words were responsive to subtle overlaps in the meanings of words (e.g., Collins & Quillian, 1969; Meyer, Schvaneveldt, & Ruddy, 1975; Tulving & Gold, 1963). Cognitive psychologists showed that readers' ability to comprehend a text at all depends on some larger understanding of what it is about (e.g., Bransford & Johnson, 1973; Dooling & Lachman, 1971). They showed that the particulars remembered from text are strongly influenced by the perspective from which it is read (e.g., Anderson & Pichard, 1978). They showed that readers readily generate inferences to complete and connect the information on the page (e.g., Bransford, Barclay, & Franks, 1972). More generally, research psychologists found broad evidence for the constructive nature of comprehension and memory. Over the same period of time, however, they also found firm evidence that, for skillful adults, reading generally proceeds through relatively thorough processing of the words and letters of text (for reviews, see Adams, 1990; Rayner & Pollatsek, 1989).

Although whole language, its advocates insist, is not a method or program of instruction, it has brought along certain dramatic changes in classroom practices across the grades. These include a general shift from teacher-directed to student-centered classroom dynamics; an

emphasis on learning through engagement with quality texts and intrinsically meaningful tasks in place of workbooks and drill; the abandonment of rigid ability grouping in favor of more equitable and flexible support strategies; an early and continuing emphasis on independent writing; and an effort toward integration across the curriculum. For the most part, these changes are long overdue and for the better. On the other hand, whole language advocates have steadfastly, adamantly, and sometimes vitriolically denied the value and rejected the practice of skills instruction, including phonics, and this has been a point of heated contention.

The word, illiterate, by dictionary definitions, means unable to read or to write. A person who is literate, in contrast, is someone who not only can and does read and write but, further, does so in service of expanding and exploring her or his own thoughts and knowledge and of sharing them with others. In keeping with this, we have divided this chapter into two main sections. The first examines issues involved in learning to read and write, and the second focuses on those involved in learning to use reading and writing in increasingly literate ways. Despite having thus divided the literacy challenge in two, we wish to assert at the outset that the essential cognitive challenge remains the same throughout. Specifically, literacy development at every level pivots on the ability to treat language itself as not merely an instrument, but an object of thought, analysis, and reflection.

Reading and Writing: The Basics

The Use of Words by Skillful Readers

The question with which researchers entered this era was that of how skillful readers might exploit context in order to skip the words. The prior question, of whether skillful readers might exploit context in order to skip the words was presumptively dismissed, ultimately to be appreciated only by force of the data.

In fact, it had long ago been established that, given very brief exposure durations, people could "see" the letters of familiar words more accurately than random strings of letters (Cattell, 1885; Pillsbury, 1897). Surely this was evidence of the higher-order influences in quest. Armed

with tachistoscopes, millisecond timers, computers, and the array of new methodologies thereby afforded, research psychologists were remarkably inventive at creating situations in which their subjects' prior knowledge and expectations ought to override the precise letterwise compositions of the words actually displayed. But none of them worked. At least with isolated words, the data stubbornly but ever more strongly indicated that, although somehow letters become more perceptible when parts of familiar words, the perception of words was meticulously respectful of the identities of their letters (e.g., Adams, 1979; McClelland & Johnston, 1975; Wheeler, 1970).

The pertinence of such word recognition data to real reading situations became clear only gradually, and largely through the help of computer-mediated eye movement technologies. Physically, after all, it seems that people ought to be able to see more on the page than the word in fixation. Cognitively, however, it seems that they do not. Smith's (1971) intuitively appealing hypothesis that fluent reading is propelled by semantic or syntactic preprocessing of peripherally viewed words is counterindicated by the data (see, e.g., Inhoff & Brihle, 1992; Rayner & Morris, 1992; Rayner & Pollatsek, 1989). Although readers' eyes do sometimes skip over words, they tend only to skip short function words and rarely to skip more than one at a time. Otherwise, for skillful readers and regardless of the difficulty or predictability of the text, the basic dynamic of connected reading is left to right, line by line, and word by word (Just & Carpenter, 1980). As in the case of isolated words, moreover, the recognition of each fixated word in text entails complete visual processing of its letters as well as early and compulsory translation of its spelling to speech (Rayner, Sereno, Lesch, & Pollatsek, 1995; Pollatsek, Lesch, Morris, & Rayner, 1992).

In the end, it seems that printed words are the basic data on which reading depends. Skillful readers generally *do* fixate most of the words; the information they gain from a text depends tightly on the specific words they have fixated; and their recognition of the words on which they fixate depends integrally on their processing the words' spellings and spelling-speech correspondences. Furthermore, this letter- and word-wise processing does *not* divert attention from meaning and message. Instead, it operates almost automatically, almost autonomously, in support of comprehension. This is possible only because skillful readers possess a remarkably

rich, redundant, and flexible system of knowledge about the spellings of words and their links to speech and meaning (Adams, 1990; Rayner & Pollatsek, 1989).

Developmental Data on Word Recognition and Reading

Researchers have not only amassed incontrovertible data for the critical role of spelling and spelling-sound knowledge in skillful reading and word recognition, but have also developed strong explanatory models of how the mind uses this knowledge (e.g., Berent & Perfetti, 1995; Coltheart, Curtis, Atkins, & Haller, 1993; Seidenberg & McClelland, 1989; VanOrden, Pennington, & Stone, 1993). But here is the converse of the issue raised earlier: Even if reading involves thorough processing of spellings and spelling-sound mappings for skillful adults, this may or may not be so for children.

What are the cues to which beginning readers are most sensitive? How do these cues change in nature or balance with reading growth? And how do more and less successful learners differ from one another? Goodman's report and the surrounding interest accentuated the importance of these questions, and within a few years there appeared in the literature two separate, observational studies of beginners' reading behaviors (Biemiller, 1970; Weber, 1970a,b). Both studies were designed to assess the growth, across the first grade year, of first-graders' sensitivity to the higher-order cues of context in their daily reading of meaningful, connected text.

Building directly on Goodman's results, Biemiller's (1970) expectation was that the children's reading errors or miscues would reflect three successively more mature stages in their sensitivity to textual cues: running from nonresponse errors, to orthographically driven errors, to contextually influenced substitutions. On the basis of his recordings of the children's oral reading from October to May, Biemiller did in fact identify these three stages. But their order differed jarringly from his expectations. Specifically, it was only in the first or earliest stage of reading development that context exerted a preemptive influence on word recognition . In this stage, although the children's errors tended to be contextually acceptable (74 percent), most (81 percent) seemed graphically unrelated to the print on the page. Further, the longer the children dwelled in this first, context-driven stage of reading, the poorer their progress as measured at the

year's end. In the intermediate stage, the children's most common error was no response, as they basically refused to read words they did not know. Finally, Biemiller observed, it was only in the last stage, at the end of first grade that the graphemic details of the words began to supersede contextual cues in influencing the children's misreadings.

Weber (1970) obtained a similar pattern of results in a study of two different first-grade classrooms. In keeping with context-based theories of reading, the vast majority (80 percent to 94 percent) of the errors these children made consisted of substituting a word in view with some other. Further, whether the children were in the high, middle, or low reading group, the majority (87 percent to 92 percent) of their substitution errors were grammatically compatible with the preceding context. On the other hand, reported Weber, not only did the better readers make fewer errors per line of running text, but their errors tended to capture more of the graphemic detail of the misread word than did those of the poorer readers.

Thus, both Biemiller (1970) and Weber (1970) found ample evidence of young readers' sensitivity to the meaning and flow of their texts. However, the pattern of these errors across development and reading ability was just the opposite of that suggested by Goodman's study. Among both Biemiller's and Weber's young subjects, reading growth brought with it, not less, but more deference to the print on the page.

How could these findings be reconciled? The answer, with hindsight, is methodological. First, Goodman had collapsed his data by grades regardless of the children's reading ability. Yet, subsequent replications have shown that the context advantage is due mostly to the poor readers, regardless of grade (Allington, 1978; Nicholson, 1991; Nicholson, Bailey, & McArthur, 1991; Nicholson Lillas, & Rzoska, 1988). Second, the children in Goodman's study were always asked to read the word lists before the stories. When, instead, they are asked to read the stories first, the advantage of context over the word lists is generally diminished; indeed, among better readers, this advantage is generally reversed (Nicholson et al., 1991; Nicholson et al. 1988; Nicholson, 1991).

This basic pattern has been replicated and extended across a variety of research paradigms. From the start, it seems that good readers-to-be are, if anything, more attuned to context than are poor readers-to-be. However, good readers-to-be are also far more sensitive to the spellings of the words and their phonological mappings (Tunmer & Chapman, 1995). This relation continues across years in school such that good readers remain significantly more able to predict upcoming words in context (for reviews see Perfetti, 1985; Tunmer & Hoover). Nevertheless, and whether measured by speed or accuracy, the word recognition of good readers is also significantly less dependent on (or susceptible to) context than is that of poor readers (e.g., Allington & Strange, 1978; Juel, 1980; Perfetti & Roth, 1979; West & Stanovich, 1978). Very quickly, and in contrast to poor readers, the ability of good readers to recognize familiar words becomes so fast and sure that supportive context results in little measurable improvement in speed or accuracy of word recognition (for extensive reviews, see Stanovich, 1980; 1986). Alongside, the ability to read unfamiliar words or pseudowords emerges as the singularly most powerful discriminator of overall reading ability (see Perfetti, 1985; Rack, Snowling & Olson, 1992; Stanovich & Siegel, 1994; Vellutino, 1979).

Overall, the data argue compellingly that letters and words are the basic data of reading (Adams, 1990). This conclusion, in turn, provides a powerful explanation for the findings of numerous studies that poor word identification skills are strongly coupled with poor reading comprehension in both children (Perfetti, 1985; Rack, Snowling, & Olson, 1992; Stanovich, 1982, 1991b; Vellutino, 1991) and adults (Bruck, 1990; Cunningham, Stanovich, & Wilson, 1990). Moreover, research now affirms that weaknesses in decoding abilities are the most common and debilitating source of reading difficulties (Perfetti, 1985; Shankweiler et al., 1995, Stanovich, 1986; Vellutino, 1991; Vernon, 1971).

Conventional Phonics: A Problematic Solution

The term phonics refers to systems of instruction, of which there are literally hundreds (Aukerman, 1971, 1984), that are designed to help children use the correspondences between letters and sounds to learn to read and write. In order to understand written text, the reader must

be able to derive meaning from the strings of printed symbols on the page. Phonics methods are built on the recognition that the basic symbols—the graphemes—of alphabetic languages such as English encode elementary speech sounds. By teaching the relationships between spellings and sounds, phonics methods are intended to assist the learning process by providing young readers and writers with a basis both for remembering the ordered identities of useful letter strings and for deriving the meanings of printed words that, though visually unfamiliar, are in their speaking and listening vocabularies.

Across the centuries, methods to help beginning readers attend to the sequences of letters and their correspondences to speech patterns have been a core element of most approaches to literacy instruction in alphabetic languages (Feitelson, 1988; Mathews, 1966; N. Smith, 1974). Further, whether assessed through large-scale classroom studies, such as the massive US Office of Education first-grade studies (Bond & Dykstra, 1967), or through myriad smaller experimental studies (e.g., see meta-analysis by Pflaum, Walberg, Karegianes, & Rasher, 1980), it has been found with overwhelming consistency that instructional approaches lending explicit attention to phonics result in significantly greater reading growth than those that do not (see also Chall, 1967).

Thus, even in the infancy of the whole language movement, strong data existed to the effect that knowing about spellings and spelling-sound mappings was essential to reading and learning to read. Nevertheless, as the whole language movement grew stronger, so too did its renunciations of phonics instruction. This stance was surely aggravated by the strong anti-phonics rhetoric of Frank Smith (1971, 1973, 1982, 1992). Yet, common sense argues that there had to be some underlying reason for the appeal of Smith's writings. Three can be offered. First, Smith methodically conflated issues of phonics instruction with the urgent social, political, and educational concerns of the whole language movement (see Adams, 1991, Stanovich, 1994). Second, the piecewise, bottom-up nature of conventional phonics instruction was inherently incompatible with the constructivist premises on which the whole language movement was built. Third and, we suspect, most influential, was the frequent plaint that conventional phonics

instruction tends to be tedious in progress and iffy in effectiveness; doubtless, many teachers sensed this and were eager for a better approach.

In fact, the phonics advantage documented by research is neither awesomely large nor comfortingly reliable. Even while the studies collectively affirm that phonics instruction is, on average, a positive component of early reading development, they also demonstrate that there are enormous differences in the outcomes of any program depending on the particular schools, teachers, children, and implementation vagaries involved. In particular, even where phonics has been taught, even where it has been taught under the watchful eye of researchers, there have remained many children who have nonetheless experienced great difficulty in learning to read. Across studies of middle-class schools using conventional instructional programs, it can be estimated that roughly 25% of children fail to catch on by the end of the first grade (Adams, 1990).

The Wonders of the Alphabet versus the Difficulty of Phonics

Over the centuries and around the world, writing systems that were comprised of large numbers of symbols were naturally the possession of the elite. They were generally passed on only to those few whom it was felt should and, among those, could and would invest the amount of time and study required for their memorization. In view of this, historian David Diringer describes the invention of the alphabet as "the creation of a 'revolutionary writing,' a script which we can perhaps term 'democratic' (or rather, a 'people's script'), as against the 'theocratic' scripts that preceded it" (1968, p 161).

The number of symbols in alphabetic systems tends to range between twenty and thirty-five, few enough to be memorized by very nearly anyone and, once memorized, adequate—at least in a perfectly alphabetic system—for purposes of reading and writing any word in the language. Yet, for many children, learning to read an alphabetic script is not easy. It sounds so simple. Why is it that so many have such difficulty?

One possibility is that the difficulty lies in learning the letters. In fact, preschoolers' familiarity with the letters of the alphabet is a strong predictor of their reading success (Bond & Dykstra, 1967; Chall, 1967; Jansky & DeHirsch, 1972; Richek 1977-78; Silberberg, Iverson, & Silberberg, 1968; Speer & Lamb, 1976) and letter naming facility continues to correlate with reading success well into the primary graders (Biemiller, 1977-78; Blachman, 1984; Muter, Hulme, Snowling, & Taylor, 1995; Wagner, Torgeson, Laughon, Simmons & Rashotte, 1995). Nowadays, most children from mainstream neighborhoods are found to know most of their letters by first-grade entry (Durrell & Catterson, 1980, cited in Chall, 1983; Mason, 1980; McCormick & Mason, 1986; Nurss, 1979). Importantly, however, there are both children and neighborhoods for which this generality is untrue. For example, Masonheimer (1980, cited in Ehri, 1986) found that although the English-speaking five-year olds in her California sample could name most (71%) of the uppercase letters correctly, the Spanish-speaking children could name very few (4%, or roughly one letter).

Letter naming, in short, is very important and warrants earnest assessment and support. On the other hand, both clinical report (e.g., Liberman, 1973, Vernon, 1971) and experimental evidence (Mason, 1980; Jenkins, Bausell, & Jenkins, 1972; Ohnmacht, 1969; Doehring, 1976) indicate that, given the opportunity, most children successfully learn their letters as such without too much trouble. Further, for children who know their letter names—but <u>not</u> for children who do not (Ehri & Wilce, 1979)—neither does learning the sounds of the letters seem a major obstacle (Jenkins et al., 1972; Mason, 1980; Ehri & Wilce, 1979; we discuss the relation of letter-name and letter-sound learning more fully in the section on Children's Writing).

Rather, reading difficulty asserts itself when "even when able to sound printed letters and letter groups, they cannot blend these to form whole words." (Vernon, 1971, p. 128; see also Chall, 1967; Critchley & Critchley, 1978); . How could this be? The step from having all of the sounds to inducing the word seems so self-evident. It is generally taken for granted by those touting the elegant simplicity of the alphabetic code.

Dyslexia: "Minimal Brain Dysfunction"

Given the seeming ease of the challenge alongside the fact that it nonetheless eludes children who seemed normal and intelligent in every other way, a dominant assumption has been that such difficulties reflect some underlying and relatively reading-specific neural aberration. The earliest explanations, for example, attributed the cause of otherwise inexplicable reading problems to a deficiency in those areas of the brain responsible for storing visual images; children with severe difficulties were said to suffer from congenital word blindness (Morgan, 1896; Hinshelwood, 1900,1917). Struck by observations of letter and spelling reversals, Orton (1925, 1937), ascribed the problem to an underlying syndrome he termed strephosymbolia or "twisted symbols." Based on his belief that visual patterns are stored in mirror images in the right and left halves of the brain, Orton theorized that such reversals reflect a delay in establishment of left-hemispheric dominance for language.

Although many of the older theories seem strange or unfounded from a contemporary perspective, all are intended to offer underlying cause for disturbances in information-processing which plausibly could disrupt the word-learning process of young readers. Among the proximal difficulties that such theories were intended to explain are deficiencies in visual-motor coordination, visual matching, visual feature extraction and trace persistence, spatial and directional orientation, figure-ground perception, visual information-processing speed, visual short- or long-term memory, intersensory mappings, cross-modality shifting, intersensory learning, temporal order perception, sequential ordering, and spatial ordering. Vellutino (1979) masterfully critiqued the vast experimental literature on these factors as they separate normal and reading delayed children. Extending the literature as necessary through work with his own, clean sample of 200 normal and reading-delayed children in grades two through six, he concluded that performance on tasks designed to tap these categories of factors was, at best, weakly or inconsistently associated with specific reading difficulty unless the tasks directly or indirectly entailed verbal processing or memory.

Regardless of the research findings, the nonscientific press continues to cite lack of coordination or balance among cerebral functions as the core cause for reading difficulties. Consider, for example, the broadly promulgated hypothesis that there exists some substantial and identifiable group of visually, globally oriented children for whom phonics is, by nature, inferior to visual or meaning-based approaches (see, e.g., Carbo, Dunn, & Dunn, 1986). Perhaps because of its fit with the folk psychology on right and left brains—this hypothesis has held remarkably long and strong sway among teachers and reading specialists. For example, a survey of special education teachers in Illinois (Arter & Jenkins, 1977), showed that 95 percent were familiar with this argument and, of those familiar with it, 99 percent believed that modality preferences should be a primary consideration in devising instruction for children with learning difficulties. In addition, nearly all believed this hypothesis to be well-supported by research. But it is not.

Instead, and regardless of children's apparent perceptual strengths and styles, successful intervention seems invariably to depend on helping them learn how to sound out words (for reviews see Arter & Jenkins, 1979; Barr, 1984; Bateman, 1979; Chall, 1967; Cronbach & Snow, 1977; Kampwirth and Bates 1980; Stahl, 1988, 1992; Robinson, 1972; Tarver & Dawson, 1988). By all indications, moreover, early intervention is more successful than later intervention (Carter, 1988; Vernon, 1971). No wonder, then, the claim by concerned citizen groups such as The National Right to Read Foundation that early intensive phonics instruction ought to offer a near-universal cure to America's reading ills.

Yet, if the problem were that simple, it surely would have been solved long ago. Again, instruction programs that include a solid, explicit, systematic strand of conventional phonics have been shown to bring more children along than those that do not (Adams, 1990; Aukerman, 1971, 1984; Bond & Dykstra, 1967; Chall, 1967, 1983). But neither are these programs ideal classroom solutions. Regardless of the instruction provided, the accessibility of phonics varies enormously across children: While some catch on in a wink, others just don't; while the logic and value of phonics is instantly self-evident to some, it stubbornly eludes others. For those children who have already taken off, a bitwise regimen of intensive, systematic phonics is

arguably not the most useful way to spend time; for those who have not yet caught on, it is useless. A far better solution would be to understand and address the reasons why phonics is more or less accessible to different children. This is where the most important breakthroughs of the last few years have been.

The Importance of Phonemic Awareness

The Perceptual Nonreality of Phonemes

If the cognitive revolution was triggered by theoretical malaise, it was fueled by a series of compelling arguments that human behavior could not be explained by any piecewise, bottom-up concatenation of simple sensory or motor events (e.g., Chomksy, 1965; Hebb, 1949; Lashley, 1951; Neisser, 1967). As relates to research on beginning reading, the most important of these arguments may well have been that, acoustically speaking, phonemes do not exist. This argument was made most forcefully in a classic paper by Alvin Liberman and his colleagues (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967).

Meanwhile, being close to these findings through her spouse and involved in reading research herself, Isabelle Liberman was quick to recognize the instructional significance of this claim. Others had mused that the problem for many young readers seemed to lie in developing an awareness of phonemes (e.g., Monroe, 1932, Savin, 1972; Vernon, 1971). In addition, several studies had documented the difficulty of training young children to break words into phonemes (Elkonin, 1973; Rosner & Simon, 1971). But the idea that phonemes were flatly unhearable put a different slant on these reports. Conventional phonics instruction, after all, was firmly predicated on the assumption that there existed some essential and available acoustical invariance within phonemic categories. Yet, if this were not so, then what was a child to make of such standard classroom verbiage as: "The sound of the letter b is /b/;" "Listen for the sound of the letter b in ball, blue, table, and crab;" "What is the first sound of the word bat?" "Name some words that end in the sound of the letter b." And so on.

To assess the reality of this problem more directly, Liberman, Shankweiler, Fischer, and Carter (1974) developed a straightforward sound-counting task, logically equivalent to the common classroom question, "How many sounds do you hear in the word ___?" Specifically, the task consisted of a set of 42 items, each comprised of one to three phonemes. The children were given a wooden stick and asked to tap out the number of phonemes in each item: For example, given the word mat, the child was to tap three times, once for each of its phonemes: /m/, /ă/, and /t/. A second, matched group of children were given an analogous task in which they were asked to tap out the number of syllables (one to three) in words. The children were drawn from middle-class preschool, kindergarten, and first-grade classrooms, tested near the end of the school year. For both groups, the test items were preceded by ample training, demonstration, and modeling and, even within the test trials, feedback was provided for incorrect responses. The children were deemed successful if they correctly tapped out six consecutive items.

Nearly all of the first-graders and roughly half of the kindergartners and preschoolers reached criterion on the syllable-tapping task, and some (50 percent of the first-graders, 16 percent of the kindergartners, and 7 percent of the preschoolers) did so without making a single error. Thus, the basic "play" of the game seemed well within reach for most of the children. Despite that, only 70 percent of the first-graders, 17 percent of the kindergartners, and none of the preschool children reached criterion on the phoneme-tapping task. Of those who did, all made errors and most took close to the maximum number of trials (and thus feedback) available. Further, on assessing the reading achievement of the oldest children the following fall, it was found that none of those in the top third of the class had failed the phoneme-tapping test the previous spring. In contrast, of those who had failed the phoneme-tapping task, half were in the lowest third of their class in reading achievement, and none were in the top third. (Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977).

In short, and as suspected, the sort of explicit phonemic awareness measured by the phoneme-counting task seemed strongly related to beginning reading acquisition. More

disturbingly, however, the data also suggested that, for many school-age children, this sort of sensitivity to phonemes was neither already established nor easy to acquire. At the same time, the steep increase increase in segmentation ability across the first-grade year left Liberman wondering whether phonemic awareness developed as enabler or consequence of emergent reading and writing. Clearly, with regard to instructional implications, this question is critical. Its answer, with hindsight, seems to be both.

The Causal Importance of Phonemic Awareness

In the intervening years, a variety of different tasks has been developed for assessing phonemic awareness. Relevant to issues of construct validity, the common variance of these tasks is generally very substantial (Stahl & Murray, 1994; Yopp, 1988; Stanovich, Cunningham, & Cramer, 1984; Wagner & Torgeson, 1987; Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993). Collectively, such work yields the conclusion that, even for normal language learners, awareness of phonemes is not a given, and is only weakly related to abilities to perceive and discriminate speech sounds (see Backman, 1983; Stanovich et al., 1984; Yopp, 1988).

Consistent with causal interpretations of phonemic awareness, longitudinal studies have demonstrated over and over that such measures of children's phonemic awareness are powerful predictors of subsequent reading growth, even when competed against, for example, various measures of IQ and nonphonological print/language sophistication (e.g., Bradley & Bryant, 1983; Byrne, Freebody & Gates, 1992; Foorman, Francis, Novy, & Liberman, 1991; Catts, 1991a,b; Hurford, Schauf, Bunce, Blaich, & Moore, 1994; Jorm, Share, MacLean, & Matthews, 1984; Juel, Griffith & Gough, 1986; Mann, 1984; Mann & Liberman, 1984; MacLean, Bryant & Bradley, 1987; Stanovich et al., 1984; Vellutino & Scanlon, 1987; Wagner & Torgeson & Rashotte, 1994, 1995). To give the flavor of this work, and because of its cognitive and pedagogical importance, we describe a sampling of these studies in more detail.

Tunmer and Nesdale (1985) administered the phoneme-tapping task along with a decoding test, a reading comprehension test, and the Peabody Picture Vocabulary Test (to measure verbal

IQ) to 68 first-graders from six different classrooms. Based on close statistical analysis of their data, Tunmer and Nesdale concluded that phonemic segmentation skills, as measured by the tapping task, were strongly, directly, and causally related to decoding abilities and that decoding abilities, in turn, were strongly, directly, and causally related to reading comprehension. IQ contributed directly, but weakly, to each of these abilities.

A direct peek at the children's patterns of performance tells the story just as well: All of the students who did well on the decoding test also passed the tapping task; all of those who failed the tapping task also failed the decoding test; an additional number of students passed the tapping task but failed the decoding test. Thus, it seems that phonemic segmentation skills were a necessary precursor to being able to decode, but they were not sufficient. Those who could decode could segment. Those who could not segment could not decode. The third group of children, who could segment but could not decode, were evidently lacking in their mastery of letter-to-sound correspondences. (See also Tunmer, Nesdale, & Herriman, 1988).

A similar pattern of results was obtained with children attending a lower middle-class school in Texas through a longitudinal study conducted by Juel, Griffith, and Gough (1986). In place of the tapping test, Juel at al measured phonemic awareness with a set of six, seven-item subtests measuring (1) segmentation (e.g., "Say no. What are the two sounds in no?"); (2) blending (e.g., "Say /n/, /ī/, /s/. What word is /n/, /ī/, /s/?"); (3) initial phoneme deletion (e.g., "Say top. Now say top without the /t/."); (4) deletion of last phoneme (e.g., "Say same. Now say same without the /m/"); (5) substitution of initial phoneme (e.g., "Say ball. Instead of /b/, begin a new word with /k/."); (6) substitution of final phoneme (e.g., "Say park. Instead of /k/ end a word with /t/.").

Through a hierarchical regression analysis, Juel et al. (1986) found that performance on the phonemic awareness measure at the beginning of first grade predicted 49% of the variance in the children's word recognition or decoding performance at the end of first grade after accounting for the contributions of IQ (block design and vocabulary subtests of the Wechsler Intelligence Scale for Children- Revised) and listening comprehension (IOWA test). Further, a comparison of end-

of-the-year phonemic awareness and decoding scores revealed the same pattern of results that Tunmer and Nesdale (1985) obtained: No students with average or above average word recognition abilities had low phonemic awareness scores, and all students with low phonemic awareness scores had below-average word recognition abilities.

In extending this study through the children's fourth year of school, Juel et al. (1988) also took periodic measures of their listening comprehension, their generation of ideas in oral story-telling (in response to pictures), and the amount of reading they did outside of school. Although these measures did not distinguish would-be good and poor readers in first grade, all diverged dramatically across the school years. Specifically, for children who were successfully learning to read, performance surged upwards on every one of these measures; for children who were not learning to read adequately, performance barely changed at all on any of these measures. Moreover, the likelihood that a child would be a good or poor reader by the end of fourth grade was almost wholly predicted by whether she or he was a good or poor reader at the end of first grade. This, in turn, was strongly predicted by the child's phonemic awareness at the beginning of first grade (Juel et al., 1988; Juel, 1994).

The common variance of the phonemic awareness measures in conjunction with their collective dissociation with indices of IQ, vocabulary, and general language development suggest that the phonemic tasks are tapping some relatively specific factor. At the same time, their predictive strength and the asymmetry of their contingency with word recognition are consistent with the notion that this factor is prerequisite to reading acquisition. Strengthening this view are studies showing that engaging children in activities designed to develop phonemic awareness hastens later reading and writing acquisition (e.g., Ball & Blachman, 1991; Bradley & Bryant , 1983; Byrne & Fielding-Barnsley, 1989, 1991; Castle, Riach, & Nicholson, 1994, Cunningham, 1990; Hatcher, Hulme, & Ellis, 1994; Tangel & Blachman, 1992; Vellutino & Scanlon, 1987; Wallach & Wallach, 1979; Williams, 1980).

The classic study in this category is a training study built on strictly <u>oral</u> language activities (no print) that was conducted with Danish preschoolers by Lundberg, Frost, and Peterson (1988).

Over the course of the preschool year, these children were engaged in a variety of games and activities involving nursery rhymes, rhymed stories, and rhyme production; segmentation of sentences into separate words and investigations of word length; clapping and dancing to syllabic rhythms and solving puzzles posed by a "troll" who could speak only in a syllable-by-syllable manner; and, finally, segmentation and blending of word-initial and then word-final and word-internal phonemes.

For their control group, Lundberg, Frost, and Peterson (1988) went to a district that had historically outscored that of the experimental children in academic measures. At the end of the training year, the performance of two groups was comparable in both letter knowledge and higher-order language comprehension. However, the experimental children were significantly superior to their controls in their measurable sensitivity to rhymes, syllables, word lengths and, most of all, phonemes. At the end of first grade—and thus a year after the training program had ended—the children were compared again, this time on measures of word recognition, spelling, mathematics, and a nonverbal IQ test (Ravens' Progressive Matrices). Although (and as expected, given the sampling strategy) the control children slightly outperformed the experimentals on both the math and IQ tests, the experimental children outperformed the controls on both the word recognition and the spelling tests. Retesting at the end of the second grade showed that the experimental children's advantage over the controls by these measures remained as great or even increased. Indeed, although the difference in the experimental and control children's spelling scores was significant in both first and second grade, the difference in word recognition scores did not reach statistical significance until the second grade.

Phonemic Awareness as a Consequence of Literacy Growth

Such longitudinal data notwithstanding, the prima facie case that phonemic awareness is not cause but consequence of literacy instruction is still simpler: People tend to demonstrate an awareness of phonemes only if they have tried to learn an alphabetic writing system. What, after all, are the alternatives? As discussed earlier, phonemic awareness appears to be relatively

independent of general intelligence, general language ability, and perceptual analysis. Could it be a developmentally emergent phenomenon? Evidently not, for a number of studies have shown that adult illiterates essentially lack awareness of phonemes (see Morais, 1991). Is phonemic awareness the product of some gradual tuning or refinement of more general phonological sensitivities? Again, this seems not be the answer; choosing two illiterate poets especially because of their exceptional sensitivity to phonetic contrasts among syllables, Morais (1991) found that the ability to isolate phonemes was beyond the reach of both. Nor could formal schooling per se be responsible because, as shown by Read, Yun-Fei, Hong-Yin, and Bao-Qing (1986), phonemic awareness generally eludes literate Chinese adults unless they have been schooled in an alphabetic writing system.

Although, as demonstrated by Lundberg et al. (1988), phonemic awareness can be trained in the absence of any linkage to print, vanishingly few children have experienced such specialized training. On the other hand, most children, when taught, do learn to read. Given an alphabetic script, the implication is that all such children do acquire phonemic awareness, for reading does not develop without it. Where does this phonemic awareness come from? For most students, it seems to emerge and grow rapidly in the course of their first year of reading instruction (e.g., Bentin, Hammer, & Cahan, 1991; Bowey & Francis, 1991; Cardoso-Martins, 1991; Liberman et al., 1973; Tunmer & Nesdale, 1988).

Logically, anything that is both cause and consequence must also be part and parcel. Thus, the story would be neat and complete—just teach the children to read—except for one thing. With or without reading instruction, gaining phonemic awareness is not easy for many children. This raises two subsidiary questions: Why is phonemic awareness hard? And what, more precisely, is its relation to reading?

The Difficulty of Phonemic Awareness

Historical Patterns

In one way or another, virtually all modern writing systems are parasitic on language. This was not always true. Linguistic mediation of visual communication evolved gradually and uncertainly in both time and levels of abstraction. In the earliest writing systems, referents were represented pictorially while meaning and messages were represented through complex scenes. Within pictographic genres, conventionalized icons for specific concepts or "words" seem to evolve irrepressibly. Nevertheless, the adoption of logographic systems counts as a relatively rare and distinct communication insight. A key distinction between pictographic and logographic systems is that, in the latter, the icons are arrayed and interpreted sequentially as guided by spoken language constraints. (DeFrancis, 1989; Gelb, 1963).

Similarly, although logographies seem inevitably to exploit the use of "sounds-like" symbols for extending their referential power, they evolved into syllabic writing systems only in the rarest of circumstances. More often, syllabic writing systems have become established through cultural borrowing or through their deliberate invention for one language system by somebody—a missionary, king, or emperor—who was literate in some other (DeFrancis, 1989; Gelb, 1963).

The evolution of our present writing system took thousands of years and depended no less on cross-cultural borrowing than on cross-linguistic inappropriateness and adaptation of that which had been borrowed. Due largely to record-keeping exigencies of foreign trade, ancient logographies were displaced by syllabaries. According to one story, at least, the syllabaries gradually degenerated into an alliterative shorthand which, when adopted by the Greeks, was serendipitously misconceived as an alphabet: The symbols were seen to represent the consonants per se (see Gleitman & Rozin, 1977). Even so, the denotation of vowel phonemes took hundreds more years to settle in (Balmuth, 1982; Mathews, 1966).

The point is that the notion that language can be successively decomposed into words, syllables, and phonemes is not a priori psychologically obvious or compelling. Moreover, the

historical ease and order with which cultures have become aware of these levels of abstraction and exploited them as unit of writing is mirrored in the developmental ease and order with which children normally do so.

Developmental Patterns: The Attentional Problem

Early reading instruction begins with the assumption that words are individually accessible units of language. The concept of a word and the ability to recognize stand-alone words are taken for granted. Moreover, the word word is nearly unavoidable in instructional settings. To make any sense whatsoever out of their classroom activities, children must already understand or quickly catch on to the idea of what a word is.

Yet, evidence concurs that children, like their ancestors, are not naturally prepared either to conceive of spoken language as a string of individual words or to treat words as individual units of meaning (Downing & Oliver, 1973-74; Ehri, 1975; Holden & MacGinitie, 1972; Huttenlocher, 1964). What children listen for is the full meaning of an utterance, and that comes only after the meanings of the individual words have been combined—automatically and without their attention. More picturesquely, "During this period, the word may be used but not noticed by the child, and frequently it presents things seemingly like a glass, through which the child looks at the surrounding world, not making the word itself the object" (attributed to A. R. Luria by Downing, 1979, p. 27).

Perhaps because of their status as conceptual handles, words gain awareness quite easily, once pointed out. Even in a single sitting, young children can make great progress in segmenting sentences into individual words, although they are extremely resistant to conceding word status to function words and prepositions (Engelmann, 1969; Fox & Routh, 1975). More often, argues Ehri (1976, 1979), the concept of word is evoked through exposure to print. In print, unlike speech, words are physically separated one from the next. As children become aware of the one-by-oneness of words in print, they begin to notice and isolate words in speech. This insight apparently requires no great amount of reading sophistication, for Ehri (1979) has shown that

word awareness increases dramatically along with the earliest signs of emerging reading ability. Interestingly, the convention of inserting spaces between printed words popped in and out of practice for hundreds of years, becoming firmly established only with the advent of the printing press.

Like words, neither are syllables spontaneously evident. Unlike words, however, syllables are punctuated physically in the speech stream. Perhaps for that reason, awareness of syllables has also proved relatively easy to establish, both developmentally and historically, once their existence is pointed out. On the other hand, and in contrast with words, the defining characteristic of syllables is strictly phonological. Perhaps this is why the ability to detect syllables in speech or to segment syllables from speech has been shown to predict future reading (Lundberg, Olofsson, & Wall, 1980; Mann & Liberman, 1984), to correlate with the reading progress of beginners (Morais, Bertelson, Cary, and Alegria, 1986; Treiman & Baron, 1981), and to differentiate older disabled or dyslexic readers from normal first graders (Mann, 1984; 1986; Morais et al., 1986). Syllable awareness tends to precede phonemic awareness both developmentally and historically. Even so, awareness of syllables does not lead readily to awareness of phonemes.

As with words and syllables, the most basic obstacle to phonemic awareness seems to be the normal attentional dynamics of language processing. That is, in normal speaking and listening, the processing of the subunits is essentially automatic, allowing attention to be focused not on the sounds of language, but on the meaning and message that they encode. Even ignoring issues of comprehension, to focus on any individual word, syllable, or phoneme would be too time-consuming; we would quickly lose track of the rest of the spoken stream. However, the challenge of developing phonemic awareness clearly involves much more, and is much more difficult, than a mere redirection of attention.

Beyond Attention: The Special Difficulty of Phonemes

All speakers must "know" about phonemes at some level, or they could not produce or understand speech. Indeed, at one month of age, infants make phonemic distinctions between elementary speech-like sounds. They not only discriminate between such highly similar sounds as /ba/ and /pa/ but they also lump physically in-between sounds into one category or the other (Eimas, Siqueland, Jusczyk, & Vigorito, 1971). Shortly thereafter, babies begin to practice the phonemes of their language, quickly moving on to the abilities to produce and distinguish them in the rapidly flowing permutations and combinations of continuous speech. Yet time and use do not serve to reveal the phonemes. As one example, adults can push a button faster when listening for a whole word than when listening for a single phoneme such as /s/, and this is true even when the phoneme is the first sound of the word. Evidently, they can consciously access the phoneme only through the time-consuming and retrospective process of taking apart the syllable that they have already perceived by virtue of its presence (Savin & Bever, 1970; Warren, 1971).

Consistent with such findings, many speech scientists subscribe to the view that phonetic processing is carried out by a precognitive, biologically specialized subsystem that is modular in a strong sense of that word and thus relatively impenetrable to conscious awareness and to non-speech knowledge and processes (see Liberman & Mattingly, 1989). If so, however, then it follows that there will "ordinarily [be] nothing in children's experience with speech that will acquaint them with the alphabetic principle—that is nothing to make them [consciously] aware that all words are specified by an internal phonological structure, the shortest elements of which are the phonemes that the letters of the alphabet represent...Saying 'buh a guh' to the child does not necessarily help [her to grasp the underlying phonemic structure of the word bag] all that much, since 'buh a guh' is the wrong word. At all events, we can now see that the normal processes of speech not only fail to reveal the internal structures of words, but may, indeed, obscure them" (Liberman & Liberman, 1990, pp 60-61).

Significantly, it was the last part of this message—that the sounds of phonemes spoken one at a time bear little resemblance to their sounds in running speech—that registered most clearly in the educational community. In response, many instructional programs were redesigned in the 1970s to discourage both teachers and students from voicing the phonemes in isolation. The purpose, of course, was one of avoiding referential confusion; the effect, however, was an untenable loss of referential clarity (see Adams, 1990). In the absence of the direct alternative, word mediation became the most widespread technique for introducing or discussing the sounds of individual phonemes, e.g., "The letter f makes the sound you hear at the beginning of food, father, and frost."

The uselessness of such instruction for children who do not already have phonemic awareness should be obvious. Where attention was turned to multiple phonemes, as for example in blending, the bind was even worse. The following excerpt from a teachers' guide was originally cited in a paper by MacGinitie (1976, p. 372): "The teacher is instructed to write the word girls on the board. The teacher then says, 'You can find out what this word is. With what consonant does it begin? With what consonant does it end? You know the sounds that g and r and l and s stand for. I am going to say something and leave out this word at the end. When I stop, think of a word that begins with a sound g stands for, ends with the sounds r and l and s stand for and makes sense with what I said.'" Thus, just as the very value of phonics instruction was coming under assault by the whole language movement, its endorsed conduct was made essentially unmanageable—and especially for those children who needed it most. No wonder so many teachers turned away.

Auditory versus Motoric Conceptions of the Phoneme

Linguists have long distinguished between phonetics and phonemics. Whereas phonetics is concerned with all perceptible differences among speech sounds, phonemics is concerned with only the functional differences in speech sounds or, roughly, the differences captured by the graphemic conventions of the written language. In contrast to phonetics, speech scientists found

they could define phonemes quite neatly and systematically in terms of their place and manner of articulation (e.g., Jones, 1956; Jakobson, Fant, & Halle, 1961). Having done so, they soon discovered further that the perceptual confusability of phonemes generally clustered on these articulatory dimensions (e.g., Miller & Nicely, 1955). Ultimately, the view emerged that these motorically-based conceptions of phonemes were not merely descriptively convenient but, indeed, psychologically real. In particular, the view emerged that the phonemes were essentially undiscriminable except as the listener might manage to reconstruct the speech signal in terms of the underlying sequence of articulatory gestures through which it was generated by the speaker (Liberman et al., 1967).

From this perspective, the practice of encouraging children to articulate each phoneme at issue would seem to make far more sense than discouraging them from doing so. If, in fact, phonemes are defined by their ideal place and manner of articulation, then how better might one anchor their identities than by asking children to produce and explore them motorically? Indeed, successful phonemic awareness programs commonly engage the children in articulation of the individual phonemes (e.g., Ball & Blachman, 1991; Byrne & Fielding-Barnsley, 1991; Lundberg et al., 1988; Wallach & Wallach, 1979; Williams, 1979). In addition, speech therapists have long pointed to the value of articulatory training in promoting reading (e.g., Van Riper & Butler, 1955). In this vein, whether used remedially or with entering first-graders, the Auditory Discrimination in Depth (ADD) program (Lindamood & Lindamood, 1975), which begins by engaging students in a systematic and reflective exploration of the articulatory features and voicing of the phonemes, has been shown to accelerate reading growth dramatically (see Truch, 1991).

A study by Skjelfjord (1976) provides a closer view of how such articulatory training may hasten children's phonological awareness. The subjects were Norwegian preschoolers, roughly six years old. Each lesson focused on one particular phoneme. After the children heard a story containing several instances of the phoneme, they were asked to find out how the sound was produced by trying to "feel it in the mouth." They were then given pictures and asked to find out

if the phoneme was present in the illustrated words, again by trying to feel it in the mouth. Finally, the children were asked to try to find out whether the sound was found in the initial, medial, or final position in the word. These exercises lasted 10 to 20 minutes a day, and three phonemes were covered every second week until all 27 of the Norwegian phonemes had been covered. The week before the first lesson and every odd week thereafter were spent individually testing the children, first on their ability to identify either a taught or as-yet untaught phoneme in a specified position of several three-phoneme words and then on their ability to identify all three phonemes of a nonword in sequence.

In the pretest, the children's responses tended to be spontaneous and swift but they evidenced little ability to analyze the words into phonemes. Forty-eight percent of the answers showed no analytic ability, and 15 percent were syllable-sized answers. Meanwhile, although the children did produce a number of phoneme-sized responses (37 percent), these consisted almost exclusively of vowels. Moreover, the vowels and syllable-sized units reported in these early test sessions reflected almost total indifference to the position requested.

By the second test session, after only one week of training, the phoneme-sized responses rose to 63 percent while the nonanalytic responses fell to 22 percent; by the final session, these percentages were 95 and 1. Moreover, the students were nearly as successful at finding untaught as taught phonemes, suggesting that their performance was based as much on the strategy of feeling the segments as on familiarity with the specific phonemes. In keeping with this, improvements in the children's performance was marked by a shift from the rapid responding of early trials to slow and laborious whispering of the words prior to giving an answer. Alongside, the vowels shifted from the most frequent to the most difficult of the phonemes for the children to report, which Skjelfjord tentatively attributes to the vowels' lack of articulatory distinctiveness.

Although the children's ability to report the requested position improved markedly alongside their phonemic sensitivity, it remained error-prone. From observations of the children, Skjelfjord concluded that the reason for this difficulty was that the children were not selectively listening

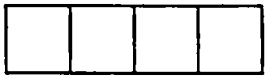
for the sound in the named position. Instead, they determined their responses by slowly uttering the whole word, phoneme by phoneme, and then deciding—retrospectively and sometimes incorrectly—which of the uttered phonemes occurred in the named position. Finally, Skjelfjord observed, in a number of instances the students uttered all of the sounds in the test word correctly, only to report some sound that was similar to but different from any of those just uttered. This, he conjectured, reflected the students' awareness of the phonemes' contextual lability. Rather than report the sound as perceived, they responded with a sound they had previously learned and that they judged could be its prototype.

Skjelfjord's (1976) arguments and observations interlace provocatively with Liberman et al.'s (1967) hypothesis that the consonant phonemes are "hearable" only as the listener can reconstruct their underlying articulatory gestures. As such, his work points out a major limitation to such articulatory training even as they underscore its utility. Yes, phonemes are defined by an ideal place and manner of articulation. In reality, however, they become physically blurred and compromised as the speaker rushes from one to the next in a way that sacrifices precision to comfort and efficiency. In consequence, articulatory analysis of functional speech can give back no better than a lumpy distribution of noisy phonemic tokens; nor does it afford any means of insight into the ideal nature of the types they represent or even how many such types there might be. In short, toward awakening the insight that speech consists of series of phoneme-sized vocal gestures, activities that engage students in reflective articulation are arguably necessary and clearly valuable. Toward helping the students to identify the phonemes, however, they are not sufficient.

From Awareness of Phonemes to the Alphabetic Insight

Suppose you were working with Skjelfjord's (1976) young students, and you wanted to make it easier for them to enumerate the phonemes. Very likely, the first thing you would try would be some sort of visual mnemonic. One widely used technique (see, e.g., Clay, 1979), invented by

the Russian psychologist, Elkonin (1973), is to demarcate the separate phonemes with empty squares,



asking the children to slide out counters or bingo marker to fill the squares, left-to-right, for each phoneme they hear. The advantages of the Elkonin procedure over Liberman et al.'s (1973) tapping task are that it visually emphasizes the sequentiality of the sounds even as it results in an inspectable and, thus, discussable record of the effort. Another approach, championed by Lindamood and Lindamood (1975), is to ask the children to represent the string of phonemes with a row of colored blocks. The advantage of using blocks over bingo markers is that the colors of the blocks can be made to correspond to the phonemes they represent. Thus, for example, by letting the blue block correspond to /p/s in pot, top, and pop, the child is visually induced to consider the underlying similarities and differences of the phonemes as well as their order.

In terms of mnemonics, of course, if the goal is one of phoneme identification, then having a distinct visual symbol for each phoneme ought to be still better. In keeping with this, positive effects on reading have been obtained by pairing the phonemes with distinctive letter-like symbols during training (Fox and Routh, 1984). Yet, the letters of the alphabet also lend themselves well to this purpose, and do so with direct downstream value. As demonstrated by Lundberg et al. (1988), training phonemic awareness in the absence of print can significantly hasten later reading and spelling growth. Across studies, however, the gains have been more consistent and robust when phonemic awareness has been trained together with letter-sound correspondences than when it has not (Ball & Blachman, 1991; Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1989, 1991; Goldstein, 1976; Treiman & Baron, 1983; Vellutino & Scanlon, 1987; Wallach & Wallach, 1979; Williams, 1980).

One advantage of training the letters and sounds together is surely that the letters serve to anchor the phonemes perceptually. Equally important, however, may be the value of the letter-sound pairings for persuading the children that words must be treated differently from other visual patterns. In particular, young children are inclined to examine words, not as any left-to-right sequence of separately informative symbols, but more holistically in terms of overall visual pattern and special features (see, e.g., Byrne, 1992; Masonheimer, Drum, & Ehri, 1984). And no wonder: This, after all, is the right approach for virtually every other visual stimulus in their world or ours, except strings of letters and numbers. The suggestion, in short, is that awareness of letters and spellings, on one hand, and of phonemes, on the other, may well promote each other. In support of this, we turn to a series of studies by Byrne and his colleagues (see Byrne 1992).

As noted by Gough and Hillinger (1980), beginning readers are generally faster to learn lists of dissimilar than similar words. Exploring this effect with preschoolers, Byrne (1992) found that it was the visual similarity more than the phonological similarity of the words that made the difference. Further, the visual similarity or distinctiveness of the words seemed to derive almost entirely from their initial or leftmost letters. To ask whether this initial letter salience might be a useful step toward inducing the alphabetic principle, Byrne tried training the children to recognize fat and bat and then testing their ability to choose between initial-f and initial-b words such as fun versus bun and big versus fig. But the children's transfer performance was at chance.

Continuing with the train-transfer paradigm, Byrne set out to ask why children perform so poorly in the transfer task. Is it the logic of the task? Is it that children are disinclined to treat visual patterns analytically, as a string? (No, they figure it out if the separate symbols represent words rather than phonological information.) What if the initial symbol-sound correspondence is restricted to s-/s/ versus m-/m/? After all, /s/ and /m/ seem especially salient as phonemes go. (Transfer performance was still at chance.) What if the number of items in the training set is expanded so that finer discriminations are required in the training phase? (No matter.) What if the children are first trained to segment the words, as in "s...at" (only 8 of 12 mastered this task),

then will they catch on? (No.) What if these same children are also taught to discern which of a set of spoken words begin with the same sounds as /sat/ versus /mat/ (only 5 of the 12 eventually managed to do so), then would they learn to discriminate the printed words on the basis of the correspondence between their initial letters and sounds? (Again, transfer performance was at chance.)

Be careful not to miss the point here: Byrne's young subjects blithely learned the words that went with the training stimuli in each of these experiments. The problem was that, time and again, doing so neither involved nor provoked any transferable appreciation of the underlying print-speech relationships.

And so, Byrne asked, what if, in addition to segmenting and recognizing initial sounds, these children are also taught that the letter s says /s/ and the letter m says /m/. At last: Not only were the letter-sound pairings easy for the children to learn, but now training on sat and mat transferred readily to choice discrimination of sow versus mow, set versus met, and so on. However, this was true if and only if the children had also succeeded in the segmentation and first-sound matching tasks: Those who had succeeded in both of the speech tasks made no errors on the reading challenge; those who had failed at both tasks performed at chance.

Through further study, Byrne and his colleague, Fielding-Barnsley, have generalized and extended these findings (Byrne & Fielding-Barnsley, 1989, 1991). Learning to segment the initial consonant from a /consonant-vowel-consonant/ word is hard for preschoolers. The ability to segment, in turn, appears necessary but not sufficient for hearing that, for example, /sad/ and /sow/ begin with the "same" sound as /sat/. Finally, provided that the children can hear the initial similarity between such words as /sat/ and /sow/, teaching them that the letter s says /s/ and m says /m/ leads easily to the ability to discriminate between such printed pairs as sat-mat, and sow-mow. But there is more: Having provided all this support with s-/s/ and m-/m/, Byrne and Fielding-Barnsley (1991) have further demonstrated that the mere teaching of f says /f/ and b says /b/ is generally adequate for the children to infer that, for example, of printed fin and bin, the first says /fin/.

Back to Dyslexia

As evidence accrued for the strength of the relationship between phonemic awareness and reading growth in the general population, the question inevitably arose as to whether phonological difficulties might constitute the elusive core deficit underlying dyslexia. Consistent with this hypothesis, reading-disabled children and adults evidence weak phonological processing across a variety of tasks, including poor short-term memory for phonological information and difficulties in repeating spoken pseudowords (see Brady, 1991), difficulties in naming objects (Wolf, 1991) or retrieving words (see Katz, 1986), and less sharpness in phoneme discrimination (e.g., Lieberman, Meskill, Chatillon, Schupack, 1985). Inasmuch as such phonological difficulties appear early in childhood, they cannot be dismissed as consequences of reading difficulties.

The concept of specific reading disability or dyslexia was originally invented because of the clinical need to recognize—even without the ability to explain—the occurrence of children with marked reading disability who were otherwise earnest, healthy, well-nurtured, and cognitively advanced. Given the failure, across much research, to identify any other more specific diagnostic index (see Critchley & Critchley, 1978; Vellutino, 1979; Vernon, 1971), the criterion by which dyslexia was identified was broadly formalized, by both clinicians and policy makers, as a discrepancy between a child's reading and her or his IQ or nonverbal achievement that could not be ascribed to environmental factors (see Lyon, 1995). As these criteria were equally applied to the disbursement of special funds and allowances for remedial assistance, dyslexia came to be known as a rich kids' syndrome.

Although a number of people (see especially Siegel, 1989, 1992) have adduced a number of very good reasons for mistrusting and even disavowing the discrepancy definition, it prevailed in part because of the firm belief that reading disability was a discrete syndrome—etiologically distinct and symptomatically distinguishable from "garden-variety" reading difficulties—and otherwise because of the simple need for some screening rule. As it turns out, however, reading ability or disability is normally distributed; it is "not an all-or-none phenomenon but, like

hypertension and obesity, occurs in varying degrees of severity" (Shaywitz et al., 1992, p. 149). Furthermore and regardless of whether or not it is "specific"—that is, regardless of a child's IQ, socio-economic status, or achievement in other areas, and despite the co-existence of other behavioral syndromes such as attention deficit disorder—reading disability is robustly associated with poor phonological sensitivity and a marked difficulty in decoding pseudowords (Fletcher et al., 1994; Shankweiler et al., 1995; Stanovich & Siegel, 1994). This fact, in turn, carries two important practical implications with respect to diagnosis and treatment of reading disability.

First, the discrepancy-based definitions of reading disability are educationally counterproductive because they inappropriately exclude children who have linguistic, performance, or emotional difficulties in addition to low reading scores. Second, the discrepancy-based definitions are risky in any case because, by nature of the criteria on which they rest, they do not afford diagnosis of reading disability until well into a child's school career (i.e., a first-grader cannot be a "grade level behind" in reading). Moreover, given the responsiveness of reading and spelling growth to early phonemic intervention together with the persistence of phonological and decoding difficulties among dyslexics diagnosed even a few years later in life (Bruck, 1990, 1992), the pressing question is: To what extent could the prevalence or degree of reading disability be reduced by giving the children proper guidance and assessment early in the acquisition process? (Adams & Bruck, 1993).

From Letters and Sounds to Spellings and Sounds

In summary, research both demonstrates and explains the importance of letter-sound instruction for children. Moreover, concurring with age-old pedagogical conventions, the acquisition of word-initial letter-sound pairs seems universally and necessarily the first real entry into alphabetic learning. Yet, these studies also bound the value of such instruction from both below and above.

On one hand, this research affirms that letter-sound knowledge alone is not sufficient to seed the alphabetic insight, for the ability—logical, perceptual, and mnemonic—to assimilate letter-

sound instruction is itself predicated on a basic awareness of phonemes and a relatively comfortable familiarity with the letters of the alphabet (see Adams, 1990; Share, 1995). As discussed above, phonemic awareness is difficult, and it is far more difficult for some children than others. Similarly, the letters of the alphabet are ill-designed for any crash course; to the young child, they surely look more like each other than anything else she or he has been asked to learn before. The implication is that movement into reading should be significantly accelerated—and failure significantly mitigated—if children are given ample opportunity to play with the letters and to explore their sounds prior to formal reading instruction, ideally in preschool and kindergarten. Indeed, it is precisely this outcome that is so resoundingly demonstrated by the training studies we have reviewed.

On the other hand, these studies beg the question of how any usefully detailed knowledge of spellings and sounds might grow from this word-initial alphabetic insight. The quick answer is that this does not happen instantly or automatically. The ability to "hear" the phonemic structure of the rest of the word emerges gradually.

Toward gaining a better understanding of this process, Stahl and Murray (1994) analyzed children's performance across a battery of phonemic awareness tasks. At the most primitive level, the children in Stahl and Murray's study were capable only of dividing the (monosyllabic) words into two parts: the initial consonant(s) or <u>onset</u>, and the balance of the word or the <u>rime</u>, e.g., /c-at/, /tr-ick/. The ability to separate the rime into its vowel and its consonant coda came next. The ability to analyze consonant clusters came still later, with isolation of the last consonant of word-final clusters preceding isolation of the leading consonant of word-initial clusters. In other words, the children were inclined to respond to sounds such as /pl/ and /dr/ as though they were each comprised of a single vocal gesture. Arguably the children are correct—except that the spelling conventions of English have recognized that these sounds adequately can and, therewith, decreed that they properly should be conceived as a concatenation of two separate gestures, /p/-/l/ and /d/-/r/ (see also Share, 1995; Treiman, 1993).

Thus, the chicken-egg relationship between phonemic awareness and letter knowledge continues well beyond the basics. Perhaps for this reason, both continue, independent of one another, to exert a significant influence on word recognition and reading growth well into the primary years (Muter et al., 1995; Wagner et al., 1995).

How can children's learning of word-internal spelling-sound connections best be fostered? Synthetic phonics, or the practice of teaching children to read words by sounding them out, offers itself as one possibility. However, children are very good at learning what a word looks like (at least for the duration of the instructional foray), and they are not very good at paying attention to noninstrumental verbiage. After all, why sound out cat if you can already recognize it?

An alternate strategy, urged in a prescient thought-piece by Lewkowicz (1980), is to engage the children in inventive spelling. Because the memory burden of each successive sound is relieved as soon as each is written, spelling affords a workspace for phonemic analysis of words that is cognitively easier than aural segmentation tasks (for empirical affirmation see Stahl & Murray, 1994). Indeed, ample early experience in spelling independently seems not—as once feared— to obstruct but to promote children's ability to learn conventional spellings when taught and, significantly, to learn them in a way that translates readily to improved word recognition and fluency in reading (Uhry & Shepherd, 1990). More generally, because independent spelling is a way of engaging children in thinking actively and reflectively about the sounds of words in relation to their lettered representations, it proves itself a powerful medium for developing (Clarke, 1988; Griffith, 1992) and evaluating (Gerber, 1985; Mann, Tobin, & Wilson, 1987; Tangel & Blachman, 1994) their growing phonemic and orthographic awareness . Finally, because the output of independent spelling is a scrutible record of the child's efforts, it is also an invaluable medium for studying the development of the knowledge and understanding on which it depends. In view of these considerations, discussion of early writing and spelling is in order before returning to issues of reading development.

Children's Writing as a Window on the Cognition of Early Literacy

Jamie was a 3 1/2-year-old Scottish child (Jones, 1990). Asked by an adult to write a shopping list for a teddy bear who had been knocked down by a car and was not feeling well enough to write it himself, Jamie produced the string of symbols depicted in Figure 1. Some of the symbols could be os, but others are not real letters. Nevertheless, they look a good deal like letters. The symbols are arranged in a linear sequence, as are letters in real writing. Jamie, like many children of this age, has already begun to distinguish writing from drawing.

INSERT FIGURE 1 ABOUT HERE

Five-year-old Bobby was told by his mother that he must wear a jacket or sweater when he went outside so that he would be warm enough. Indignant, Bobby got a piece of paper and a pencil and wrote the note depicted in Figure 2. Bobby's message, unlike Jamie's, is made up wholly of real letters. "Why should I be warm enough?" it demands. Bobby was in a combined kindergarten/first-grade program that emphasized the usefulness of writing. This was the first time that he had written a complete sentence on his own outside of school without asking an adult for help in spelling words or forming letters. Bobby could read only a few words at the time he produced this message. He wrote in capital letters without leaving spaces between words. His writing would be hard to decipher if one did not know what prompted the message.

INSERT FIGURE 2 ABOUT HERE

Trevor was in a whole-language first grade class in a middle-class suburb. He was learning to read and kept a word bank of words that he was able to recognize. Children in this classroom began to keep a daily journal once they had accumulated a number of words in their word banks. Figure 3 shows sections from Trevor's earliest journal entries. On October 5 his entry read, "When I go outside I ride my bike and I play on my bike ride." The next day he wrote, "I like to

eat pizza and I like to drink pop." Trevor's writing is about the here and now. It is hard to decipher because there are no spaces between words and because there are many misspelled words, such as "pa" for play and "grak" for drink. As we will see, though, most of Trevor's spelling errors are typical of those of beginning writers. His spellings are not as random or unmotivated as they might first appear to be.

INSERT FIGURE 3 ABOUT HERE

Jillian was a classmate of Trevor's. When she began writing in her journal, her writings were very similar to Trevor's. She improved rapidly, by late March producing the story in Figure 4. This story depicts the events of the preceding spring involving the growth of a sunflower. Jillian now puts spaces between words and uses primarily lower-case letters, but she does not include punctuation. Although she makes numerous spelling errors, such as "bigr" for bigger and "seds" for seeds, her story is nevertheless readable. Jillian's teacher was so pleased with this work that she had it "published", or typed up for Jillian to share with her classmates.

INSERT FIGURE 4 ABOUT HERE

Shayna and Missy (Juel, 1994) were fourth graders who participated in the longitudinal study, discussed earlier, by Juel and colleagues (Juel, 1994; Juel et al., 1988). They attended a large elementary school in Austin, Texas that served a lower-class neighborhood. As part of Juel's study, Shayna and Missy were shown a colorful pictures of animals in a classroom and were asked to write a story about the picture. Shayna, a poor reader and writer, produced the relatively simple description shown on the left side of Figure 5. Missy, a good reader and writer, produced the more elaborate story shown on the right side of Figure 5. Missy's story has a more expressive and varied vocabulary than Shayna's, including some less common words such as arrangements and sandstorm. Missy shows an awareness of the reader and a playful attitude

toward language, telling the researchers that she wrote "very" a large number of times so that the reader would realize how long the trail felt to the hikers. Missy also stated that when writing "they hiked for hours and hours," she started a new line for the "and hours" to emphasize the length of the hike.

INSERT FIGURE 5 ABOUT HERE

How does a child move from the primitive productions of Jamie and Bobby to the more advanced levels of writing development exemplified by Missy? Why do some children, like Jillian, progress rapidly, whereas other children, like Shayna, progress more slowly? In the following sections, we will address these questions by reviewing research on the development of writing and spelling ability.

The Precursors of Alphabetic Writing

Preschoolers may "write" by making marks with a crayon or pencil, even before they know the conventional letters. Their writing, unconventional as it is, is noticeably different from their drawing. For example, Jamie (Figure 1) used a linear string of discrete units to write a grocery list—a different configuration than typically found in drawing.

The results of Tolchinsky-Landsmann and Levin (1985) support the idea that children distinguish between writing and drawing from an early age. These investigators worked with middle-class Israeli children aged 3, 4, and 5. The children were asked to both write and draw utterances such as "a house" and "a red flower". By the time the children were 4, adults could easily tell which of the children's productions were meant as writing and which were meant as drawing. The 4-year olds' writings generally consisted of linearly arranged strings of units separated by blanks. The writings tended to be smaller in size than the drawings. When writing, the 3-year olds either used characters of unidentifiable origin, mostly undifferentiated into units, or nonletters that bore some resemblance to Hebrew letters. Four-year olds used a combination

of real Hebrew letters, digits, and letters of the Roman alphabet, which these children had probably seen in addition to Hebrew letters. It was not until the age of 5 that children predominantly used real Hebrew letters in their writing. Still, these letters were often not the ones found in the conventional spelling of the utterance. The majority of 5 year olds wrote in the direction that is standard for Hebrew, from right to left.

Further support for the idea that children differentiate between writing and drawing from an early age comes from Ferreiro and Teberosky's (1982) case studies of Argentinian children. When asked to write words or sentences, some 4 and 5 year olds produced curved characters linked together by wavy lines that resembled cursive writing. Other children produced separate characters composed of curved and/or straight lines that resembled print, like Jamie (Figure 1) did.

Lavine (1977) tested children's ability to differentiate between writing and drawing by asking them to sort cards containing various kinds of graphic displays. The children in this study were American preschoolers aged 3, 4, and 5. Lavine asked the children to put those cards that had writing on them into a play mailbox and those that did not have writing on them into another container. Even the 3 year olds accurately discriminated writing from pictures. Although some of the 3 year olds tested by Tolchinsky-Landsmann and Levin (1975) did not differentiate between writing and drawing in their own productions, they may have been able to do so in a task like Lavine's, in which examples of writing and drawing were shown to them. The children tested by Lavine appeared to use linearity as one criterion for writing: They considered linearly arranged displays as writing more often than nonlinear displays. In addition, displays that included a variety of symbols were more likely to be labeled as writing than those in which the same symbol was repeated several times. As long as the units in a display looked similar to letters, the 3 and 4 year olds accepted them as writing. It was not until age 5 that children showed signs of differentiating Roman letters from similar-looking nonletters.

Lavine's (1977) results, together with those of Tolchinsky-Landsmann and Levin (1975) and Ferreiro and Teberosky (1982), indicate that children begin to grasp the characteristics of writing

from an early age. They learn about the superordinate features of writing, such as its linearity and its size, before they learn about the detailed characteristics of its units. This learning reflects the exposure to print that children have in a literate society. Even before they learn to read, children see words on street signs, cereal boxes, and food cans. They see words in books and newspapers. As a result of this exposure, children begin to learn about the salient characteristics of writing from an early age.

Although children as young as 3 or 4 know that writing looks different than drawing, they do not yet understand why. As discussed earlier, the notion that written symbols might represent the sounds of language is relatively abstract. Thus, many young children seem to believe instead that the written forms of words reflect their meanings. Variations in the written forms of objects' names, they believe, correspond to differences in the properties of the objects themselves in much the same way that variations among pictures mirror variations among objects. For example, 4-year-old Gustavo (Ferreiro & Teberosky, 1982) wrote the word pato (duck), using a wavy line. The researchers then asked him to write oso (bear). They asked the child whether the word for bear would be longer or shorter than the word for duck. Gustavo replied the word for bear would be bigger. Because bears are bigger than ducks, Gustavo reasoned, the word for bear must be longer than the word for duck.

The results of several studies support the idea that young children consider the meanings of words when they write. Levin and Tolchinsky Landsmann (1989) asked 5- and 6-year-old Israeli children to write pairs of nouns such as elephant and ant, cucumber and tomato, and ball and rope. Children sometimes indicated the size of an object by using more marks for a larger object (e.g., elephant) than for a smaller object (e.g., ant). They sometimes indicated the color of an object by choosing a red marker to write tomato and a green one to write cucumber. Representation of shape was also noted, especially among the 5 year olds. For example, these children might use one or more round letters to write ball and a widely spaced string of letters to write rope.

Levin and Korat (1993) followed up these findings by focusing on children's tendency to use many marks for words that denote several objects or large objects and relatively few marks for that denote few objects or small objects. They asked 5- and 6-year-old Israeli children to write words such as tree, forest, coop, and chicken. The Hebrew word for tree contains one syllable whereas the word for forest contains two syllables. For this pair of words, then, the longer-sounding word denotes a group of many objects and the shorter-sounding word denotes a single object. The situation is reversed for coop and chicken: The Hebrew word that refers to a collection of chickens is, like the English word coop, shorter than the word that refers to a single chicken. Levin and Korat counted the number of characters that children wrote for each word. For pairs like tree and forest, where longer words denoted more or bigger objects, both 5 and 6 year olds produced more signs for the longer words. For pairs like coop and chicken, where longer words denoted fewer objects, 5 year olds did not produce more signs for the longer words, although 6 year olds did. Overall, Levin and Korat's results suggest that semantic cues play a role in early writing but that their role decreases as children grow older.

In a related study of children's use of semantic cues, Lundberg and Tornéus (1978) showed Swedish nonreaders two printed words. For example, one word might be arm and the other word might be ambulance. The researchers asked the children which printed word was arm. Children did better if the word denoting the smaller object was written with fewer letters, as in this example, than if the word denoting the larger object was written with fewer letters.

Further evidence for the primacy of meaning in early writing, according to Ferreiro and Teberosky (1982), is that young children expect nouns to be represented in print but do not understand that verbs can also be represented. Support for this suggestion comes from the findings of Tolchinsky Landsmann and Levin (1987) with Israeli children. These researchers asked 4, 5, and 6 year olds to write words, phrases, and sentences. When a noun was added to a phrase or sentence, the children were apt to write an additional character. They were less likely to add a character when a verb was added. For example, five-year-old Yafit used one character to write words that corresponded to single objects, such as wave and wheel. She used a single

sign to write Tali (a girl's name), two signs to write the phrase Tali and Eran (the names of a girl and a boy), and three signs to write the sentence Tali and Eran are building a tower. When asked to read what she had written, Yafit divided the spoken sentence into three units, Tali / and Eran / are building a tower. She pointed successively to each of the three signs she had written while saying each unit. Thus, the number of units in Yafit's writing corresponded to the number of people or objects referred to. Yafit used a single character to write a girl, a girl is dancing, and a girl is dancing and singing. Only nouns, she seemed to believe, deserved representation in print.

As children progress, they discover that writing represents the spoken form of language. All of the words in a spoken utterance are symbolized, not just the nouns. This realization may come about as children observe that the number of separate units in a written sentence is typically greater than the number of objects referred to. Moreover, the physical features of a word and of the letters it contains do not necessarily correspond to the physical features of the corresponding object. For example, the written word Dad has fewer letters than the written word Bobby, even though Dad is bigger and older than Bobby.

Ferriero and Teberosky (1982) proposed that, mirroring history, children at first conceive the correspondence between writing and speech to be at the level of the syllable. For example, 5-year-old Erik wrote two characters for the bisyllabic words sapo and oso but three characters for the trisyllabic word patito. Similarly, the 5- and 6-year-old Israeli children studied by Levin and Korat (1993), Levin and Tolchinsky Landsmann (1989), and Tolchinsky Landsmann and Levin (1987) tended to use more characters to write phonologically longer words than phonologically shorter words. However, inasmuch as phonologically longer words contained more phonemes as well as more syllables than do phonologically shorter words, the results of these studies do not provide unambiguous support for the syllabic hypothesis. (see Jones, 1990.)

Some children, as observed by Ferreiro and Teberosky (1982), use their own invented letter forms to represent syllables. Other children use real letters but do not do so in a consistent manner; they represent a given syllable with one letter on one occasion and with another letter on a second occasion. Still other children develop stable spellings for certain syllables, often relying

on their knowledge of letter names. Regardless of such variations, such research challenges the assumption (Gentry, 1982) that children are stringing letters together in a random manner even where their spellings bear no obvious relationship to the sounds in spoken words.

Bobby (Figure 2) appears to understand that writing symbolizes the words of a spoken utterance, the verbs as well as the nouns. For the most part, he seems to relate print and speech at the syllabic level, using letters to represent syllables. Thus, he writes the monosyllabic words should and be with one letter each -- c for should and b for be. The use of b for be reflects the letter's name; the use of c for should may reflect the similarity between the name of the letter c, /sē/, and the first sound in the spoken form of should, /sh/. Bobby's spellings of why as "ye" and I as "ie" reflect a syllabic hypothesis overlaid with the effects of experience. Bobby's older brother had told him that, when a letter says its name, an e should be added to the end of the word. Thus, Bobby included an e after his y spelling of why and his i spelling of I. The syllabic hypothesis also shows through in Bobby's two-letter spelling of enough. He uses n to symbolize the first syllable of this word and f to symbolize the second syllable. Note that Bobby's choices of letters to represent syllables are often influenced by his knowledge of letter names.

Had Bobby not attempted the word warm, we might have concluded that he linked writing and speech solely at the level of syllables. However, Bobby's "wom" spelling of warm reveals the beginnings of the idea that letters in print reflect the individual phonemes in the spoken forms of words. Bobby seems to have segmented the spoken word warm into three units of sound, writing w for the initial /w/, o for the middle part of the word, and m for the final /m/. His failure to represent the /r/ with a separate letter is typical of beginning spellers and is discussed below. Bobby's case forms a bridge between what we have called the precursors of alphabetic writing and the emergence of the alphabetic principle.

The Alphabetic Principle Emerges

When children first begin to relate print and speech, they tend to do so at the level of syllables. However, this syllabic hypothesis turns out to be untenable. Children may begin to

realize that the syllabic hypothesis is unsatisfactory when they learn to write or recognize their own name and try to understand why it is spelled as it is (Ferreiro & Teberosky, 1982). At the age of 3 1/2, for example, Bobby knew that his name was spelled as b, o, b, b, y. He seemed to understand the function of the bs since he could hear the syllable /bē/ in the spoken form of his name. However, he was puzzled about the function of the o and y in the spelling of his name. After all, there was no /ō/ or /wī/ in the name's spoken form. Having heard his parents and his older brother discuss the silent k of knife and other orthographic peculiarities of English, Bobby offered a conclusion: The o and y in his name were silent letters. Solutions such as these, creative as they are, cannot last forever.

As children begin to learn the conventional spellings of words such as Dad, Mom, and stop, they observe that the number of letters in a word's spelling does not usually match the number of syllables in its spoken form. Their beginning experiences with print force children to go beyond the syllabic hypothesis and to relate print and speech at a more fine-grained level. At age 5, Bobby shows the beginnings of alphabetic writing in his spelling of warm (Figure 2).

Trevor (Figure 3), a year older than Bobby and with more knowledge of reading, shows a stronger grasp of the alphabetic principle. Trevor uses the alphabetic principle more or less consistently instead of only sporadically, as Bobby does. For example, the spoken word eat contains two phonemes, /ē/ and /t/. Trevor uses e to symbolize the first sound of this word and t to symbolize the second. His choice of e for /ē/ is surely motivated by the fact that /ē/ is the name of the letter e. The spoken word pop has three sounds, /p/, /ŏ/, and /p/, and Trevor spells it with three letters -- p for the two /p/s and a for the /ŏ//. Trevor seems to fall back on a syllabic strategy when he writes like as "l" on the second line of his October 6 journal entry. On the first line of this entry, though, he writes this same word as "lak", with one letter for each of its three sounds.

Trevor does not always succeed in dividing words into individual phonemes and representing each phoneme with a letter or letter group. For example, he fails to spell the /l/ of play, writing "pa". He does not use a separate letter to represent the /ng/ of drink, the nasal sound that

precedes the final /k/. He also chooses an unconventional letter to spell the initial /d/ of this same word, resulting in the apparently odd—but, as we shall see, developmentally common—spelling "grak" for drink. The only spelling of Trevor's that is at all unusual is "aco" for and, which he produces on both October 5 and 6. The next day, though, he switches to "ad" -- again failing to represent the first phoneme of a final cluster.

Jillian (Figure 4) makes some of the same kinds of spelling errors as Trevor. For example, she omits the second consonant of the initial /st/ cluster when spelling still as "sile". She fails to spell the first consonant of the final cluster when writing "plat" for plant. Although Jillian is a better speller than Bobby or Trevor, she too sometimes uses the names of letters as a guide to spelling. For example, she spells the /ē/ of seeds with e, the letter that has this name, rather than with the conventional ee.

Most of the research on children's writing has focused on children whose spellings are similar to Trevor's and Jillian's. These children have grasped the alphabetic nature of English writing but have not fully mastered the system. The pioneering research in this area was carried out by Charles Read (1975). Read studied 32 children from the United States who began to write as preschoolers, generally when they were between about 2 1/2 and 4 years old, and in advance of reading or reading instruction. All in all, Read examined a total of over 2,500 spellings. Read carried out detailed analyses of the children's errors in an attempt to understand the reasons behind them. His results suggested that children approach the task of spelling primarily by trying to symbolize the sounds in words rather than by trying to reproduce memorized strings of letters. However, because the children in Read's study began to write much earlier than average, Gibson and Levin (1975) suggested that Read's results might not generalize to children who learn to write at school.

In answer to this reservation, Treiman (1993) gathered a large collection of first graders' writings and performing detailed linguistic analyses of their spellings. Treiman's study differed from Read's (1975) in that it examined children who were not precocious or advanced but who were learning to read and write at school. Although school policy dictated that the children be

given some instruction in phonics, the children's teacher, who was a strong believer in the whole-language approach, put most stress on independent writing. Because the teacher believed that children should figure out the spellings of words on their own, she did not tell the children how to spell a word even if they asked. After children had finished writing, they brought their work to the teacher or teacher's aide and read aloud what they had written. The adult wrote the child's words on the paper, using conventional spelling, and also wrote the date. At the beginning of the school year, some children spent their writing period drawing pictures and writing their names. Other children produced strings of letters that bore no obvious correspondence to the sentences that they read back. As the school year progressed, the children's written productions showed increasing understanding of the alphabetic principle. Their texts grew longer, with print occupying more and more space on their papers and pictures less. Treiman collected a total of 5,617 spellings from the writings of 43 children who were in this same teacher's first-grade class during two successive school years.

Errors in Early Spelling

Naturalistic data such as those analyzed by Read (1975) and Treiman (1993) allow us to see the spellings that are produced by children engaged in meaningful writing. It happens, however, that children do not necessarily choose to spell those words that might best shed light on their operating principles. Further, those words that they do choose to spell differ in a number of ways. To compensate for these sorts of weaknesses, a number of experimental studies have been conducted in which children are asked to spell words—or, to eliminate familiarity factors, nonwords— of particular types. The combination of naturalistic data and experimental data allows stronger conclusions about spelling development than afforded by either type of data alone.

In the following sections, we will discuss four conclusions about early alphabetic spelling that are suggested by the results of the naturalistic and experimental research. To anticipate, the first conclusion is that certain spelling errors accurately reflect aspects of words' sounds that may

not be obvious to adults. A second conclusion is that children's omissions of letters also tend to be phonologically based rather than random. Third, children's knowledge of letter names has an important influence on their early spellings. Fourth, in addition to trying to represent the sounds of words, children also try to reproduce the kinds of letter patterns they have seen in print.

Unconventionalized Sensitivity to the Sounds of Words

A child who misspells plaid as "plad" has clearly used the alphabetic principle. This child has analyzed the word into individual phonemes—/p/, /l/, and /ã/ and /d/—and has chosen a reasonable letter to symbolize each. The child's only error is in picking a rather than ai to represent the vowel. The letter a is in fact the most typical spelling of /ã/ in English; it is the ai in the conventional spelling of plaid that is unusual. Misspellings such as "plad" for plaid are often called phonetic errors and are generally taken to indicate that a child is successfully using the alphabetic principle.

Read (1975) observed that some of children's errors, although not phonetic in the sense just described, nevertheless accurately represented aspects of words' sounds. For example, the children in his study sometimes spelled /d/ before /r/ as g or j, as in "gradl" for dreidel or "jragin" for dragon. This is the same kind of error that Trevor (Figure 3) makes when spelling drink as "grak". Similarly, the children sometimes symbolized /t/ before /r/ as ch, for example spelling try as "chrie" or truck as "chrac". These errors make sense phonetically. When /d/ occurs before /r/, the contact between the tongue and the top of the mouth is made further back in the mouth than when /d/ occurs before a vowel. Also, the closure is released more slowly than when /d/ precedes a vowel. This gives /d/ before /r/ a degree of frication or turbulence that is similar to (although not as marked as) the frication that occurs in /j/ . Likewise, /t/ becomes similar to /ch/ when it occurs before /r/. Errors such as "gradl" for dreidel and "chrie" for try are thus reasonable spellings that reflect the sound properties of the words.

The occurrence of such spellings such as "jrad" for drowned and "chrap" for trap in Treiman's (1993) naturalistic first-grade data confirms that such errors on /d/ and /t/ before /r/ are

not confined to precocious spellers. Further, the same kinds of errors have been documented in experimental studies in which kindergartners and first graders were asked to spell or provide the first letters of words and nonwords with initial /tr/ and /dr/ (Read, 1975; Treiman, 1985c). Such errors cannot be ascribed to any general confusion of d with g or j for they tend not to occur except when /d/ is followed by /r/ (Treiman, 1985c; Treiman, 1993). Moreover, children who make the errors for /dr/ tend to do the same for /tr/ (Treiman, 1985c). The errors seem to be based on the sound properties of words.

A similar tendency to represent sounds in unconventional but plausible ways is associated with certain consonants -- stop consonants -- when they occur after /s/. English has two series of stop consonants: the voiceless stops /p/, /t/, and /k/ and the voiced stops /b/, /d/, and /g/. These sounds are called stops because the flow of air is completely obstructed for a short period of time, a small burst of sound being produced when the obstruction is released. At the beginnings of words, voiced and voiceless stops contrast with one another. The vocal cords begin to vibrate sooner for the voiced stops /b/, /d/, and /g/ than for the voiceless stops /p/, /t/, and /k/. Thus, English speakers distinguish cot, which begins with the voiceless stop /k/, from got, which begins with the voiced stop /g/.

In contrast, voiced and voiceless stops are not distinguishable from one another when they occur after initial /s/. The English writing system assumes that stops are voiceless in this context and so Scot is spelled with c rather than g. In terms of certain phonetic properties, though, the second sound of Scot is more similar to /g/ than to /k/ (Klatt, 1975; Lotz, Abramson, Gerstman, Ingemann, & Nemser, 1960; Reeds & Wang, 1961). If one takes a tape recording of Scot and erases the portion corresponding to the initial /s/, speakers of English will almost always report hearing got rather than cot.

Children's tendency to symbolize stops after /s/ with letters that are appropriate for the voiced stops /b/, /d/, and /g/ has been documented (Treiman, 1985d). In this study kindergartners and first graders were asked to choose between a spelling representing a voiced stop (e.g., b) and a spelling representing a voiceless spelling (e.g., p) to represent the second

consonant of syllables like /spō/. The children selected for this particular study were able to choose l over f as a spelling for the second consonant of /slē/, demonstrating that they could choose the conventional spelling for the second consonant of a cluster provided its sound was unambiguous. Nevertheless, stop consonants after /s/ were often categorized as voiced, especially by the kindergartners.

A third case in which children spell sounds in an unconventional but plausible manner involves syllabic /r/. In most varieties of American English, a word like her does not contain a separate vowel as it is pronounced. Rather, the /r/ takes the place of the vowel and is said to be syllabic. The children in the naturalistic studies of Read (1975) and Treiman (1993) often omitted the vowels in these contexts, producing many errors such as "hr" for her and "brutr" for brother. Jillian (Figure 4) made the same sort of error when she spelled bigger as "bigr" and sunflower as "sunfliwr".

Indeed, the precocious spellers studied by Read (1975) and the kindergarteners studied by Treiman, Berch, Tincoff, and Weatherston (1993) omitted the es of words like her and brother more often than they included them. Moreover, Treiman, Berch, Tincoff, and Weatherston (1993) found that even the first graders in their study who were average to above-average readers and who had surely seen common words such as her, work, and mother, omitted the vowel between one-third and two-thirds of the time when spelling syllabic /r/. This problem cannot be explained as an across-the-board failure to include vowels or middle letters in spellings, for children are less likely to omit the vowels of words like war (which have a true vowel in the middle) than of words like her (which have a syllabic /r/). Nor is the problem peculiar to the letter r for, as illustrated by Jillian's spelling of bumblebees as "bamblbs," children exhibit a similar tendency to omit vowels from their spellings of syllabic /l/ (Treiman, 1993; Treiman, et al., 1993).

Rather, the spelling errors seem to reflect the children's perception of the sound properties of the words. Thus, young British children were found to produce errors like "ble" for blur and "docke" for doctor. In the dialect of these children, her is pronounced without a final /r/.

American children, in contrast, were more likely to make errors like "blrr" and "dkr" (Treiman, Goswami, Tincoff, & Leevers, 1996).

In short, children's tacit analyses of spoken words do not always match those of adults. This in turn leads to several other relevant observations. First, the division between phonetic and nonphonetic errors that forms the basis of many schemes of classifying spelling errors (e.g., Boder, 1973; Bruck & Waters, 1988; Finucci, Isaacs, Whitehouse, & Childs, 1983; Nelson, 1980) may be misleading when applied to young children. As we have seen, errors such as "gradl", "sgie", and "hr" reflect fine sensitivity to the sounds of spoken words. We would miss this sensitivity if we categorized a misspelling like "gradl" for dreidel as phonetically incorrect on the grounds that /d/ is never symbolized as g in English. A child who makes a so-called nonphonetic error is not necessarily failing to attend to the sounds of words when spelling.

Second, people have long blamed the irregularity of the English writing system for children's difficulties in learning to write and read and have urged that the writing system be reformed (Venezky, 1980). Yet, spelling reform cannot eliminate all of children's problems during the early stages of learning; not, at least, if spelling-sound regularity is defined from the viewpoint of literate adults. Learning to read and write seems to shape people's conceptions of speech, causing changes in their classification of certain potentially ambiguous sounds (see Derwing, 1992; Fowler, 1991).

Third, these studies indicate that for children mastering the alphabetic principle, spelling is a creative, language-based process rather than a process of rote visual memorization. Children's sound-based errors show that spelling is to a large extent a process of symbolizing the linguistic structure of spoken words.

Omissions of letters

Bobby, Trevor, and Jillian all produced errors in which they omitted consonant phonemes. For example, Trevor spelled play as "pa", omitting the second consonant of the initial cluster, and Bobby spelled warm as "wom", deleting the first consonant of the final cluster. In fact,

children often omit the internal phonemes of both initial and final consonant clusters. Though the factors that regulate these errors seem to be slightly different, both seem to be rooted in still-unconventional analyses of the words' phonemic structure.

In analyzing his collection of preschoolers' writings, Read (1975) noticed that the children frequently failed to symbolize the nasal consonants /m/, /n/, and /ng/ when they occurred as the first phoneme of a final consonant cluster, for example, spelling and as "ad" or stamps as "staps". These omissions were more common if the following stop consonant was voiceless, as with the clusters /nt/ and /ngk/, than if it was voiced, as with /nd/. (See also Read, 1986; Snowling, 1994). As it happens, there are position effects in spelling such that letters in the middle of a word are more likely to be omitted than letters at the beginning or at the end of a word (Jensen, 1962; Kooi, Schutz, & Baker, 1965; Mendenhall, 1930; Treiman, Berch, & Weatherston, 1993). However, position alone cannot explain why n is more susceptible to omission before letters such as t and k, which stand for voiceless stops, than before letters such as d, which stand for voiced stops. Read's (1975) hypothesis was that these errors related to the sound properties of nasals in final clusters and, in particular, to the fact that nasals are very short before final consonants, especially if these consonants are voiceless (Malécot, 1960).

The first graders in Treiman's (1993) study made the same kinds of nasal omission errors as Read's (1975) preschoolers, for example, spelling think as "theeck" and stand as "stad". Importantly, though, the first graders' omissions of consonants in final clusters were not restricted to nasals. As Marcel (1980) found among older, poor spellers, Treiman's first-graders also tended to omit liquids in final clusters, as in "hos" for horse and "od" for old. And they omitted obstruents such as /t/ and /s/, as in "las" for lets and "foret" for forest. (Obstruents include stop consonants such as /t/ and /d/, together with sounds such as /s/ and /z/.) Thus, Treiman's (1993) data indicate that children are inclined to omit the interior phonemes of final consonant clusters in general. Indeed, across two-consonant final clusters such as /rs/ and /ld/, the children omitted the first consonant 25% of the time but the final consonant at less than half that rate. With three-consonant final clusters such as /mps/, the first and second consonants of

the cluster both had omission rates of 25% or more; again, the final consonant was omitted much less often.

To further examine the breadth of consonant omissions in final clusters, Treiman, Zukowski, and Richmond-Welty (1995) asked first-graders to repeat and then spell nonsense words such as /jink/, /sanch/, and /dulb/ that had various types of final clusters. As observed by Read (1975), nasals were frequently omitted before voiceless obstruents, with omission rates ranging from 57% to 81% across experiments. In addition, nasals before voiced obstruents were omitted at rates betwen 42% to 51%; liquids that were the first phonemes of final clusters between 40% and 63%; and obstruents as the first elements of final clusters between 13% to 23%. Because the children in this study had been asked to repeat each item before spelling it, the researchers were able to reject the possibility that their failures to spell consonants reflected failures to pronounce them. Rather, their explanation for these errors was that children analyze spoken syllables differently than adults do.

In particular, children seem to treat liquids and nasals as qualities of the vowel that precedes them rather than as phonemes in their own right. Because children consider /r/-ness to be a quality of the vowel rather than a separate unit, they do not use the separate letter r in spelling born, producing "bon". With lets, in contrast, the obstruent /t/ is less likely to be grouped with the vowel and is more likely to be spelled. To corroborate this hypothesis, Treiman et al. (1995) asked the children pronounce the nonwords sound by sound, putting down one token for each sound. For nonwords such as /morl/, children often used just three tokens and pronounced just three sounds: /m/, /or/, and /l/. These same children performed the phoneme counting task very accurately with syllables that did not contain such blends.

As illustrated by Trevor's spelling of play as "pa," young children also tend to omit the internal consonants of word-initial clusters. In Treiman's (1993) study of first graders' classroom writings, children omitted the second consonants of two-consonant syllable-initial clusters almost 25% of the time. Examples include "sak" for snake, "afad" for afraid, and "set" for sweat. With three-consonant initial clusters, both the second and the third consonants were omitted at rates of

25% or more. In contrast, the first consonants of initial clusters were rarely omitted. Omissions of consonants in initial clusters have also been reported in other studies of young children's writing (Bruck & Treiman, 1990; Miller & Limber, 1985; Treiman, 1991). Moreover, while some children rarely make such errors, a few children do so very frequently (Treiman, 1991). Of note, whereas omissions of consonants in final clusters vary with the phonological makeup of the cluster, no such influences have been detected for initial clusters (Treiman, 1991, 1993). For all types of syllable-initial clusters, the interior phonemes appear more likely to be omitted than the exterior phonemes.

Among normal children, in short, failures to spell consonants in initial clusters do not seem related to failures to pronounce these consonants (Bruck and Treiman, 1990; Treiman, 1991). Nor do they seem to reflect serial position effects, for children are much more likely to omit the l of blows than the l of along, even though l is the second letter in both words (Treiman, 1985b). Instead, the spelling data suggest that children are disinclined to break the initial clusters, or onsets, of syllables into two separate phonemes, treating them instead as a single spoken unit. In effect, they consider snow to contain the initial consonant unit /sn/ followed by the vowel /ō/. This suggestion is consistent with the evidence discussed earlier that the onsets of syllables form cohesive units for both children and adults (Goswami & Bryant, 1990; Treiman, 1985a, 1989, 1992; Stahl & Murray, 1994).

How might children be taught to analyze the internal structure of words? Extra drill on individual letter-sound correspondences is unlikely to eliminate the errors, for children who produce, for example, "pat" and "so" for pant and snow usually spell /n/ with the appropriate letter when the sound occurs at the beginning of a word. Neither do the necessary insights follow readily from reading experience for, as found by Treimanet al. (1995), first graders who had learned to read such words as went frequently omitted consonants in clusters when spelling similar nonsense words.

Perhaps a faster and more efficient way to get children to revise their analyses of words like pant and snow is through phonemic awareness activities designed toward that end. For example,

children could learn a secret language in which words are said without their first consonants. Thus, sat becomes at and Ned becomes Ed. Given a word like snow, children's first response is likely to be oh (Bruck & Treiman, 1990). Yet, designed and played properly, such a game could lead them to notice that no is actually a better answer. If such activities result in improved spelling, it would be yet another demonstration of the value, discussed earlier in this chapter, of helping children to develop phonemic awareness (e.g., Ball & Blachman, 1991; Bradley & Bryant , 1983; Byrne & Fielding-Barnsley, 1989, 1991; Goldstein, 1976; Lundberg et al., 1988; Treiman & Baron, 1983; Vellutino & Scanlon, 1987; Wallach & Wallach, 1979; Williams, 1980).

In general, linguistic factors that influence the perceptual salience of phonemes seem also to influence the ease with which they are represented. Thus, other linguistic variables that have an effect on children's tendency to omit consonant and vowel phonemes include the position of the phoneme in the word, the length of the word, and the stress of the syllable (Stage & Wagner, 1992; Treiman, 1993; Treiman, Berch, & Weatherston, 1993). Moreover, English has more clusters than many other languages of the world, and this may well be a factor in making learning to spell difficult for young English speakers. In future research, it will be useful to examine beginning spelling in other languages that have many consonant clusters. Caravolas and Bruck (1993) have made a start in this direction by studying Czech; their results indicate that Czech children, like English-speaking children, are more likely to omit the interior phonemes of consonant clusters than the exterior phonemes of these clusters.

In any case, the results on phoneme omissions underscore the fact that spelling is a linguistic process, not just a process of rote visual memorization. In turn, a better understanding of how children spell and why they make the errors that they do depends on a better understanding of the phonological structure of the language.

The Role of Letter Names in Beginning Spelling

Middle-class North American children typically learn to sing the alphabet song well before they begin formal schooling. They learn the names of the letters, and they learn what many of the letters look like. Parents, children's television programs, and preschools are just some of the sources from which children acquire this information. In one study (Mason, 1980), almost two-thirds of four-year olds were said by their parents to "very often" recite the alphabet without error and over half of the children could recognize more than 20 letters of the alphabet by name. In another study (Worden & Boettcher, 1990), children could recite or sing 5 or more letters of the alphabet by the age of four and were almost perfect by the age of five. Shown uppercase letters and asked to name them, the four-year olds were correct on about 14 of the 26 letters, and the five-year olds were correct on about 22. In contrast, the four-year olds could provide the sounds for only about 6 letters, and five year olds for only 8.

Given that children enter school with a good deal of knowledge about letter names, what role, if any, does this knowledge play in learning to write and read? One might argue that letter-name knowledge cannot directly benefit spelling or reading because written letters symbolize phonemes and not the letters' names. After all, bat is pronounced /băt/ rather than /bē/-/ă/-/tē/. However, most English letter names contain the phoneme that is commonly represented by the letter. Thus, a child who does not know or has forgotten how to spell the sound /b/ might search his or her memory for a letter name that contains /b/. Furthermore, this strategy will succeed with most of the phonemes—but not all.

For example, the English phonemes /g/ and /h/ do not occur in the name of any letter. If children use the names of letters to remember or figure out their sounds, they should have more difficulty spelling phonemes such as /g/ and /h/ than phonemes such as /b/, /t/, and /l/. The spellings of Treiman's (1993) first-graders were consistent with this hypothesis, but Treiman, Weatherston, and Berch (1994) have provided firmer evidence.

In the latter study, preschoolers and kindergarteners were asked to supply the first letters of syllables like /bŏ/, /lŏ/, and /gŏ/ and, in another condition, the last letters of syllables like /ŏb/,

/ŏl/, and /ŏg/. Children were required, not to write, but only to say the first or last letters of the spoken syllables. Again, while the phonemes /b/ and /l/ occur in the names of the letters b and l, the name of the letter g does not contain the phoneme /g/. Correspondingly, Treiman and her colleagues found that children indeed did better on syllables for which letter-name knowledge could help them (e.g., /bŏ/ and /lŏ/ in the supply-the-first-letter task; /ŏb/ and /ŏl/ in the supply-the-last-letter task) than on syllables for which letter-name knowledge was misleading (e.g., /gŏ/ and /ŏg/). Moreover, children did better with letters like b, where the phoneme that the letter symbolizes is at the beginning of its name, /bē/, than with letters like l, where the phoneme that the letter symbolizes is at the end of its name, /ĕl/. This difference may arise because /b/ is in the salient onset position of the letter name /bē/. As discussed earlier, children gain the ability to segment syllables into their onsets and rimes at an early age (e.g., Bowey & Francis, 1991; Kirtley, Bryant, Maclean, & Bradley, 1989; Treiman, 1985a, 1992). In contrast, the /l/ of /ĕl/ is in a less salient position in the spoken syllable and is more difficult to separate from the vowel.

A few English letter names suggest the wrong spellings for sounds. For example, the /w/ sound occurs at the beginning of the name of the letter y but /w/ is never spelled as y in English. Instead, /w/ is typically spelled with the letter w, which has the unusual name "doubleyou". Thus, Trevor spelled when with initial y in one of his earliest first-grade journal entries (Figure 3), although w spellings of /w/ began to emerge soon afterwards. The preschoolers and kindergarteners studied by Treiman, Weatherston, and Berch (1994) spelled /w/ as y between 17 and 18% of the time. For example, some kindergarteners spelled wet as "yat" and work as "yrk". For the most part, these errors are gone by first grade (Treiman, 1993; Treiman et al., 1994). Nevertheless, early errors like "yrk" for work suggest that some children's initial ideas about the sounds that letters make are influenced by their knowledge of the letters' names.

Another way in which letter-name knowledge can affect early spelling is exemplified by errors such as Trevor's "et" for eat and Jillian's "seds" for seeds. In these cases, children spell a vowel with the letter that has that name rather than with the conventional spelling. These kinds of spellings are very frequent for vowels (Beers, Beers, & Grant, 1977; Read, 1975; Treiman,

1993). Letter-name spellings of vowels are often correct, as in he and bacon and perhaps this is why letter-name spellings of vowels persist longer than letter-name spellings which are never correct, such as y for /w/.

Just as children sometimes spell a single vowel phoneme with the letter that has that name, they sometimes spell a sequence of phonemes with the letter that has that name. Examples are "lefit" for elephant, "frmmr" for farmer, and Jillian's "bamblbs" for bumblebees (Figure 4). In these cases, first graders use a single consonant letter to symbolize all of the phonemes in the letter's name. For example, the l of "lefit" represents the entire syllable, /ĕl/. Such letter-name spellings with consonants have been noted by a number of researchers (e.g., Chomsky, 1979; Ehri, 1986; Gentry, 1982; Read, 1975; Treiman, 1993, 1994).

According to Gentry (1982), beginning spellers use a letter-name strategy whenever it is possible to do so. When they encounter a phoneme or sequence of phonemes that matches the name of an English letter, they spell it with the corresponding letter. This claim may be too broad, however. First, children may be particularly apt to produce letter-name spellings for vowels. Even for consonants, letter-name spellings appear to be more frequent in some cases than in others. In Treiman's (1993) study of first graders, children sometimes used the consonant letters r, l, m, and n to spell their names. Errors such as "bl" for bell were more common than errors such as "bl" for ball. However, letter-name spellings did not occur at levels significantly above those expected by chance for letters such as b and d. For example, an error such as "bt" for beat was not more common than an error such as "bt" for boat.

To verify that letter-name spellings do not occur equally often for all consonants, Treiman (1994) asked children to spell syllables that contained various types of letter-name sequences. In the first experiment, first graders spelled /vär/, which contains the name of the letter r, /vĕl/, which contains the name of the letter l, and /pĕm/ and /kĕf/, which contain the names of m and f. If children use a letter-name spelling strategy whenever it is possible to do so, they should spell these nonwords as "vr", "vl", "pm", and "kf". The first graders, who were tested in October and November, did make some of these letter-name errors. However, the errors were by far most

frequent for nonwords containing the name of r. For nonwords like /vär/, 41% of the children's spellings were letter-name errors such as "vr". The letter-name errors occurred less often for l, with a rate of 9% errors such as "vl" for /vĕl/. Vowel omissions in spellings of nonwords containing the names of m, n, f, and s were even less common, occurring between 2 and 4% of the time. Again, the results suggest that some letter-name sequences are more likely to be spelled as units than others.

Treiman's (1994) second experiment was designed to investigate these differences further. In addition to examining letters with vowel + consonant names, the second study also included letters with consonant + vowel names. Children were screened to ensure that they knew the names of the critical letters. The children were asked to spell syllables containing phoneme sequences that matched the names of English letters. The letters considered were r, l, m, n, f, s, t, p, and k. For example, /gär/ contains the letter name for r, or /är/, /zĕf/ contains the letter name for f, or /ĕf/, and /tēb/ contains the letter name for t, or /tē/. Kindergartners and first graders produced most consonant + consonant spellings for syllables containing the name of r. Indeed, kindergarteners made errors like "gr" for /gär/ 61% of the time and first graders did so 50% of the time. Syllables containing the letter-name l were the next most likely to receive letter-name spellings, with 41% such errors for kindergarteners and 19% for first graders. Letter-name spellings were less common for syllables that contained the names of the letters m, n, f, s, t, p, and k. Nevertheless, children did produce more letter-name spellings for these syllables than for control syllables that did not contain letter-name sequences.

How can we explain the observed differences among consonant letters in their susceptibility to letter-name spellings? These differences may reflect, in part, the sound properties of the letters' names (Treiman, 1993, 1994). To spell a word such as far, children attempt to divide the spoken word into individual sounds or phonemes and to represent each phoneme with a letter. However, the /är/ sequence in this word is difficult to segment. As we argued earlier, children tend to group vowels and following /r/s, treating them as a single unit. Given this fact, and given the strong association that children have between /är/ and r, they may spell far as "fr". The

unusual nature of the name of r may further contribute to this error. The vowel phoneme in the name of r, /ä/, occurs in no other English letter name. In contrast, the recurrence of vowel phonemes across other consonant letter names may help children to understand that the letters are used to represent the consonant phonemes that distinguish their names. Thus, a child may come to realize that the letter names /bē/, /dē/, /pē/, /tē/ and so on share the vowel /ē/ and that the letters b, d, p, and t symbolize the consonants that distinguish these letter names. The same may be true for the letter names /ĕl/, /ĕf/, /ĕm/, /ĕn/, and /ĕs/. How much of a contribution the uniqueness of the vowel in /är/ among the letter names of English makes to children's use of r letter-name spellings remains to be investigated.

In summary, children who learn the names of letters at an early age, as most North American children do, use this knowledge as a guide to sound-spelling correspondence. The extent to which they do so depends on their experience with print, their phonological analysis abilities, and the sound properties of the letter names themselves. Children's misspellings of words do not reflect simple lapses in the memorization and recall of letter strings. Were this the case, we could not explain why errors like "br" for bar are more common than errors like "bd" for bad. Instead, children's errors reflect the knowledge that they bring with them to the spelling task. Children's knowledge of letter names and their knowledge of phonology help to explain the high rate of misspellings errors like "br" for bar.

The misspellings reviewed in this section again challenge the dependence of productive letter-sound learning on rote, paired-associate memory. Rather, children who know the names of letters and who have enough phonological analysis ability to divide the letter names into smaller units use this knowledge to help them learn sound-spelling correspondences. For English, in which the names of letters are not always good guides to the letters' sounds, this strategy can lead to errors like "yrk" for work. Conversely, languages in which letters' names are more reliable guides to sound may offer an advantage as compared to English. In comparing children's learning of reading and writing across orthographies, therefore, it may be necessary to take into account the systems of letter names as well as the regularity of sound-spelling correspondence

and other factors. Note, too, that children in English-speaking cultures where letter names are less strongly emphasized in early education may not make some of the errors that North American children do.

The Influence of Orthographic Experience on Children's Spellings

As we discussed in the previous section on the precursors of alphabetic writing, children in a literate society have a good deal of experience with print even before they learn to read and write. As a result of this experience, prereaders begin to learn about the salient visual characteristics of print, such as the fact that it consists of strings of units arranged in a linear pattern. With time, children focus more and more on the letters within printed words and on how they are arranged. In this section, we discuss children's developing knowledge of the letter patterns in printed words and the way in which this knowledge affects their spelling.

The words of English, or of any other language, are not random strings of letters. Instead, the letters are arranged in certain patterns. Some of the patterns reflect the sound patterns of the spoken language. For example, printed words do not begin with bw because spoken words do not begin with /bw/; /bwăt/ is not a possible word of English. Printed words generally contain at least one vowel letter because spoken words generally contain at least one vowel sound; /pd/ is not a possible word of English.

Other constraints on the arrangements of letters in printed words are not motivated by sound but instead are purely orthographic. For example, ck may occur in the middles and at the ends of English words, as in packet and pack. This digraph (or two-letter sequence) does not occur at the beginnings of words. The ban against initial ck does not reflect a ban against the initial /k/ sound; many words begin with /k/ spelled as k or c. Rather, the nonoccurrence of initial ck is an orthographic feature of English. Other orthographic patterns involve doublets, or two-letter spellings in which the two letters are identical. Certain letters may occur as doublets, such as the double e of peel and the double l of ill. Other letters, such as v and j, rarely double. Doublets

typically occur in the middles and at the ends of words, as in supper and inn; they rarely occur at the beginnings of words. Venezky (1970) has described a number of such orthographic patterns.

Do beginning spellers appreciate these orthographic patterns? The results of several early research studies suggested that they do. Rosinski and Wheeler (1972) presented first, third, and fifth graders (tested in October) with pairs of nonwords such as tup-nda and dink-xogl. Within each pair, one nonword was orthographically regular and pronounceable and the other was orthographically irregular and unpronounceable. The children were instructed to point to the item in each pair that was more like a real word. The first-graders performed at chance levels, whereas the third- and fifth-graders performed significantly above chance. In a similar study, Niles, Grunder, and Wimmer (1977) used pairs such as ateditol-ijhbwstt. First through sixth graders (tested near the end of the school year) were able to pick the correct item at better than chance levels, whereas kindergarteners performed at the level of chance. However, a problem with these early studies is that orthographic regularity and pronounceability were confounded in the nonword pairs. Thus, the children could have been using one or both of the features as a basis for their decisions.

Treiman (1993) attempted to get around the confounding effects of pronounceability in testing children's knowledge of orthographic constraints. Her orthographic constraints test included 16 pairs of nonwords. Each pair tested a constraint or regularity of the English writing system. One nonword in a pair conformed to the regular pattern while the other word did not. However, both nonwords were pronounceable. For example, one pair was ckun and nuck. Children were asked which item looked more like a real word. If children make their judgments on the basis of sound only, both items would be equally likely to be chosen. However, if children consider orthographic acceptability in making their judgments, the item that conforms to the orthographic constraint should be chosen more often. Treiman found that middle-class kindergartners (tested in May), first graders (tested in March), and second graders (tested in May) all chose the conforming item significantly more than 50% of the time. The percentages of

correct responses were 56% for kindergarteners, 62% for first graders, and 83% for second graders. The above-chance performance of kindergarteners and first graders supports the idea that knowledge of orthography begins to emerge from an early age.

The tests used by Niles et al. (1977), Rosinski and Wheeler (1972), and Treiman (1993) contained a variety of nonword pairs. Knowledge of no one constraint was explored in detail. Two further studies, however, specifically investigated children's knowledge of double consonants and vowels (Cassar, 1995). Cassar's first study focused on consonants. In English, consonant doublets may occur in the middle or at the end of a word but not at the beginning. In addition, medial doublets normally follow short vowels in words of more than one syllable, as in latter. Single consonants normally follow long vowels, as in later. Pairs of nonwords were designed to test children's knowledge of these conventions. In pairs testing knowledge of position, one nonword contained an initial doublet and the other nonword contained a final doublet. An example is nnus and nuss. If children know where consonants doublets may occur, they should judge that nuss is more likely to be a word than nnus. In pairs examining the phonetic environment for doubling, one nonword contained a medial single consonant, as in salip, and the other contained a medial doublet, as in sallip. Cassar asked whether participants listening to pronunciations for the nonwords chose salip for a pronunciation with /ā/ in the first syllable and sallip for a pronunciation with /ă/.

The participants in Cassar's (1995) first study were children in kindergarten, first, second, third, sixth, and ninth grades, as well as college undergraduates. One group at each grade level was assigned to an auditory condition in which they chose which spelling looked best for the word they heard. The other group was assigned to a visual condition in which they viewed pairs of spellings and chose the one they thought looked more like a real word. For the pairs testing knowledge of position (e.g., nuss and nnus), even kindergarteners tested in the first semester of the school year picked the final doublet spellings significantly more often than chance. Not until sixth grade and above did children show clear knowledge of the correspondence between short

vowels and spellings with medial doublets. That is, only the older children reliably chose sallip for /sălĭp/ andsalip for /sālĭp/. These latter results support Henderson's (1985) claim that knowledge about the complex pattern of short vowel plus double consonant in two-syllable words develops later than the first few years of elementary school. However, young children's above-chance performance on the test of knowledge about the positions of consonant doublets suggests that knowledge of simpler orthographic patterns emerges much earlier in the course of spelling acquisition.

Cassar's (1995) second study further investigated children's knowledge of double consonants and also investigated their knowledge of double vowels. As in the first study, an orthographic choice test employed pairs of nonwords. One nonword in each pair contained an acceptable vowel or consonant doublet. The other nonword contained an unacceptable doublet. The doublets occurred in the medial or final positions of the spellings, both of which are acceptable for doublets. Sample pairs are noss and novv and geed and gaad. If children know which letters are allowed to double, they should choose noss and geed as more word-like than novv and gaad. Kindergarten, first, and second grade children were tested during February. First and second graders, but not kindergarteners, chose spellings containing allowable doublets over spellings containing unallowable doublets. That is, they judged that noss and geed were more like real English words than novv and gaad. By first grade, then, children have some appreciation for which letters may double and which letters may not. Different children served in Cassar's first and second studies and so comparisons between the two studies must be made with caution. However, it appears that knowledge of which particular letters may double, as tested in the second study, may develop later than knowledge of where double letters may occur in words, as tested in the first study.

The results of a study by Pick, Unze, Brownell, Drozdal, and Hopmann (1978) speak to children's developing knowledge of another orthographic constraint -- the fact that words are rarely composed of all consonants or all vowels. In this study, children were asked to sort cards

with various types of letter strings printed on them into words and nonwords. The youngest children in the study, who were 3 and 4 year old, accepted most of the items as words. Between nursery school and kindergarten, though, there was a significant decline in the acceptability of items like mptc and aiue. Based on these results, Pick and her colleagues suggested that kindergarteners know something about the combinations of letters that occur in words. Even though most kindergarteners cannot yet read, they are learning that words are not composed of all consonant letters or of all vowel letters.

If children have some implicit knowledge about the kinds of letter sequences that may occur in English words, as the findings just reviewed suggest, then this knowledge may be reflected in their own spellings. Children should make spelling errors that follow the orthographic patterns of English more often than spelling errors that deviate from these patterns. For example, children may misspell cake as "kack", following the pattern that ck may occur at the ends of English words. Children should be unlikely to misspell this word as "ckak", for this spelling violates the constraints of English. Looking at the classroom writings of first graders, Treiman (1993) examined the degree to which the errors honored the orthographic patterns of English. For each pattern that was investigated, the first graders usually, though not always, followed the pattern. Consider the results for ck. The children used this digraph 38 times when it was not a part of a word's correct spelling. They used the digraph at the beginning of a word only twice. The digraph occurred in the middle of a word 11 times, as in "mrckut" for market, and at the end of a word 25 times, as in "bick" for bike. Apparently, the children had begun to pick up the restriction against initial ck. This restriction, like the other orthographic patterns studied, was not formally taught at school. The children probably discovered the pattern on their own from seeing words such as sick and package but not words like ckan.

As another example, consider digraphs (or two-letter spellings) that end in y, such as ay and oy, and digraphs that end in i, such as ai and oi. As Venezky (1970) pointed out, digraphs ending in y generally occur before vowels and at the ends of words, as in mayor and boy. Digraphs

ending in i usually appear before consonants, as in maid and coin. Similar alternations occur for digraphs ending in w, such as ow, and those ending in u, such as ou. The former usually occur before vowels and at the ends of words, as in power and how; the latter usually occur before consonants, as in ouch. Treiman (1993) examined errors that contained one of the digraphs in question where the digraph did not occur in the word's conventional spelling. Errors were classified as either honoring or violating the orthographic pattern. For example, "seilf" for self honors the pattern because it has a digraph ending in i before a consonant; "plew" for play is also legal because it has a digraph ending in w at the end of a word. Errors that violate the orthographic pattern include "ai" for a, which has a digraph with final i at the end of a word, and "ewt" for it, which has a digraph with final w before a consonant. Errors which followed the graphemic pattern significantly outnumbered errors which violated it. Moreover, children's adherence to the pattern was significantly greater for i and y than for u and w. This difference may arise because the i/y alternation has fewer exceptions in conventional English than the u/w alternation. For example, the common words you and down deviate from the typical u/w alternation. That children followed the pattern more often in the case of i and y than in the case of u and w strengthens the view that exposure to print rather than explicit teaching of rules is the important factor in the learning of orthographic patterns. It is unlikely that an adult would point out a rule to a first grader but then tell the child that the rule has more exceptions in one case than another.

In Treiman's (1993) study of first graders' classroom spelling errors, compliance with the orthographic constraints tended to be greater during the second half of first grade than during the first half. Even during the first half of first grade, though, the children showed some knowledge of the patterns. Thus, children begin learning about the letter patterns within printed words from an early age. This learning may even start before children are able to read and spell words on their own. Once children begin to write, their spellings tend to honor the orthographic patterns that they have observed.

In conclusion, children learn about the kinds of letter patterns that occur in words from their experience with print. In their own spellings, they attempt to reproduce the sorts of patterns that they have seen. First graders' spellings like "bick" for bike or "seilf" for self show, at a more advanced level, a similar sensitivity to print that Jamie's linearly arranged symbols do (Figure 1). In both cases, children observe the features of the print around them and attempt to reproduce those features in their own writing. Whereas the 3 1/2-year-old Jamie mimics the superordinate features of print, such as its linear organization, the 6 year old reproduces more detailed features pertaining to the organization of letters within words.

Toward more Sophisticated Spelling

As children progress, their knowledge of the spelling system grows and deepens and they become better and better spellers. In this section, we will discuss four changes that occur with increasing spelling skill. To anticipate, one change is that children gradually internalize the classifications of sounds that are embodied in the conventional writing system. For example, children see that her is classified as having a consonant + vowel + consonant structure, like war, rather than a consonant + vowel structure, like he. Errors like "hr" for her become less common beyond the first grade. Second, children learn the range of spellings that are possible for various sounds. Rather than relying on the names of letters as a guide to spelling, children now spell sounds in conventional ways. Thus, children beyond the first grade may misspell plaid as "plad", using a rather than ai for /ā/, but are unlikely to spell when as "yn". Third, children rapidly improve in their understanding of and adherence to orthographic patterns. For example, children in first grade and above rarely produce spellings that begin with double consonants, having seen very few such spellings in English. Finally, children learn that the printed forms of English words reflect the meanings of words as well as their sounds. For example, health shares the heal of heal, even though this sequence is pronounced differently in the two words. Older children and adults gradually come to grips with the way in which meaning is represented in the English

writing system and use the spellings of words as a way of learning more about relationships among them.

Learning to Classify Sounds in accordance with the Conventional Orthography

As children learn to read, they see how sounds are classified by the conventional writing system. For example, the first sound of drag is classified as /d/, her is considered to contain a vowel, and went is considered to contain /n/. All of these classifications are embodied in the conventional spellings of the words. In each case, though, another choice might have been possible. For example, the first sound of drag has characteristics in common with /j/ as well as with /d/. Before they learn to read, some children's choices in ambiguous cases such as these do not always match those of the conventional writing system. For example, some children seem to classify the first sound of drag as a type of /j/ rather than as a type of /d/ and to spell it accordingly. As children see that this sound is always spelled with d, their classifications change. The change does not happen overnight as a result of learning to read a few dr and tr words. For example, one first grader tested by Treiman (1985c) read the word tray correctly but spelled /dr/ and /tr/ in a nonstandard manner on every possible occasion. By second grade, though, children make only a few unconventional spellings of /dr/ and /tr/ (Treiman, 1985c). The case of syllabic /r/ provides another example of how experience with conventional print changes children's ideas about sounds. As children progress from kindergarten to first grade to second grade, they are increasingly likely to include a vowel in their spellings of words such as sir and work (Treiman et al., 1993). By second grade, most children include a vowel in such words. They also use a vowel when spelling similar nonwords, showing that they have learned something beyond the conventional spellings of specific real words.

The suggestion that learning the conventional spellings of words can change the way in which children think about sounds is supported by the results of Ehri and Wilce (1980, 1986). In the first of these two studies, Ehri and Wilce (1980) had fourth graders practice reading nonwords. Some of the spellings, such as zitch, included letters that suggested the existence of

extra sounds. Other spellings, such as zich, did not include these extra letters. Although the two words were pronounced alike, the children considered zitch to contain more sounds than zich. In the second study, working with second graders, Ehri and Wilce (1986) used real words, such as notice, that the children did not yet know how to spell. Half of the children were taught how to spell the words; the other half were not. The children who were taught that notice contained a t in its spelling generally considered it to contain a /t/ in its pronunciation. The children in the control group were more likely to think that notice contained a /d/. This is a reasonable judgment given that the middle sound of notice, which is called a *flap*, is voiced like /d/ rather than voiceless like /t/.

Older children's and adults' thinking about sounds is thus colored by their knowledge of spellings. Literate people find it difficult to think about sounds as divorced from letters, as any teacher of phonetics can testify. Orthography, originally learned as a representation of speech, takes on a life of its own. Once learned, it influences our views about language itself.

The Assimilation of Spelling Conventions

When children first start to write, they may know the conventional spellings of only a few words. For example, at the time that Bobby wrote the message in Figure 2, he knew how to spell his own name, the names of other family members, and a few common words like no. Such children have a very limited stock of knowledge on which to base their spellings of sounds. If the children cannot or do not ask an adult how to spell sounds (like Bobby, who wanted to write the message of Figure 2 on his own) or if the adult will not provide such information (like the teacher in the classroom studied by Treiman, 1993), the children must come up with spellings on their own. It is not surprising that such children use their knowledge of letters' names as a guide to the spellings of sounds. For example, Bobby spelled be as "b" because the name of the letter b matches the word be.

As children learn the conventional spellings of more and more words, they acquire a broader base of knowledge from which to induce the spellings of sounds. In addition, many children are

taught the letters that are used to spell particular sounds in school. As a result, children come to spell sounds in conventional ways. Unconventional spellings that are influenced by letter names, such as y for /w/ and r for /är/, become less common (Treiman, 1994; Treiman et al., 1994).

Those letter-name spellings that occur in the conventional spellings of words seem to persist longer than those that do not. For example, even third and fourth graders occasionally misspell spike as "spick" or "spic", using i to represent its name (Beers et al., 1977). These errors may last longer than errors such as y for /w/ because the /ī/ sound is spelled with i in real words such as island and china. To children, i seems to be an excellent way to spell the /ī/ sound. It takes time for them to understand that, in some cases, an e must be added to the end of the word to "lengthen" the vowel (Henderson, 1985). Children's uncertainty about the function of final e shows up, too, in incorrect use of final e after "short" vowels, as in Jillian's "thene" for then (Figure 4).

As children move from using letter names as a basis for symbolizing sounds to using information gained from an increasingly large body of known words, their spellings become more and more conventional. Children still make errors, but these errors involve possible spellings of sounds that are used in the wrong contexts rather than nonstandard spellings. For example, the fourth grader Missy (Figure 5) used ei to spell the /ē/ of field. This is one spelling of the /ē/ sound, as witnessed by the word ceiling. What Missy did not yet know was the context in which ei spellings of /ē/ occur. As another example, Missy misspelled finally as "finnaly" and as "finaly" in the same story. She knew that n and nn are possible spellings of /n/ but she did not seem to know that double-letter spellings occur after "short" vowels whereas single letters occur after "long" vowels. Cassar's (1995) results, described earlier, confirm that knowledge of this pattern does not develop until sometime between third and sixth grade (see also Henderson, 1985).

Children do better on words in which each sound is spelled in the most common manner, or regular words, than on words for which this is not the case. For example, Waters, Bruck, and Malus-Abramowitz (1988) found that spellers in the third, fourth, fifth and sixth grade performed

more accurately on words like must, for which there are few or no alternative legal spellings, than on words like street, for which there are other possible spellings (streat, strete). In a study by Treiman (1984), third and fourth graders did significantly better on regular words such as glad than on exception words such as plaid, for which there is an obvious alternative spelling (plad).

Spelling becomes more and more correct as children sort out the contexts in which various spellings occur and as they learn the conventional spellings of more and more words. Missy (Figure 5) shows evidence of this in her correct spellings of difficult exception words such as squirrel and stomach-ache. She would have made errors like squirl and stummuck-ake had she not seen and learned the spellings of these particular words.

As we discussed earlier, even young children know a good deal about the letter patterns that may appear in printed words. For example, the first graders studied by Treiman (1993) were learning that ck is restricted in where it may occur in words. Even in their errors, they were more likely to use ck at the ends or in the middles of words than at the beginnings. Orthographic knowledge increases rapidly across the early school years (Cassar, 1995; Niles et al., 1977; Pick et al., 1978; Rosinski & Wheeler, 1972; Treiman, 1993). As children acquire a body of known words, they make generalizations about the kinds of letter sequences that do and do not occur in the language. Their spellings, even when wrong, "look right". Thus, most of Missy's spelling errors in Figure 5 -- "feild", "finaly", "finnaly", "frined", and others -- could be real English words. Although these spellings are incorrect, they contain sequences of letters that occur in real words.

Developing Awareness of Morphemes

The English writing system is typically considered to be an alphabet, albeit an irregular one. For words that contain more than one unit of meaning, however, English often deviates systematically from the alphabetic principle. The spelling of a word that contains more than one meaningful unit often reflects meaning rather than sound. For example, one would expect health to be spelled as helth based on the sounds that it contains. The conventional spelling, though,

indicates the similarity in meaning between health and heal. As another example, jumped and hemmed end with different sounds -- /t/ for jumped and /d/ for hemmed. The final sounds of the two words, although different, both represent the past tense marker. The English writing system chooses to represent the level of meaning by spelling both words with final ed.

It takes some time for children to learn about the way in which meaning is reflected in spelling (Carlisle, 1988; Ehri, 1986; Gentry, 1982; Henderson, 1985; Templeton, 1992; Waters et al., 1988). Indeed, poor adult spellers may never fully master this aspect of English spelling (Fischer, Shankweiler, & Liberman, 1985). The third through sixth graders tested by Waters, et al. (1988) had difficulty spelling words like sign. The correct spelling of this word can be predicted if one relates it to signal, which has the same root; the word is unlikely to be spelled correctly otherwise. Missy showed an apparent failure to analyze finally into its root (final) and suffix (ly) when she spelled this word as "finnaly" and "finaly". Had she divided the word into units of meaning, she would presumably have spelled it with double l. Sterling (1983) found similar errors among 12 year olds. For example, one child apparently did not divide closely into the stem close plus the suffix ly, writing the word as "closlay".

Children's spelling errors on words such as sign and finally may arise, in part, because they do not yet know that sign is related to signal or that finally is related to final. A word such as signal may not even be in a young child's vocabulary; the word, if present, may not be related to sign. In addition, children may not have mastered the often complex rules by which suffixes and prefixes are added to spoken words (Carlisle, 1988). For example, the changes that take place between magic and magician or between original and originality involve variations in pronunciation and stress.

With simple suffixes and relatively common words, young children show some ability to represent meaning relationships among words in their spelling. Evidence for this claim comes from a study by Treiman, Cassar, and Zukowski (1994). These researchers compared children's spellings of words like dirty and words like attic. Dirty is related to dirt whereas attic is not related to at. Both dirty and attic contain flaps. As discussed previously, children often misspell

flaps as d because they are voiced. However, if children use the root word dirt to aid their spelling of dirty, they should be less likely to make d errors on dirty than on attic. This result was found with children as young as kindergarten. Young children did not use their knowledge of the stem as much as they could have, in that they were not as likely to spell dirty with a t as to spell dirt with a t, but they did use it to some degree. Thus, young children appear to have some ability to represent meaning relations in spelling if these relations are clear and transparent.

Many of the meaning relations that are reflected in English spelling are more like magic and magician or heal and health than like dirt and dirty. In these cases, learning to spell may deepen and expand the learner's vocabulary and suggest new relations among words (Templeton, 1992). For example, a child may first learn to spell health as an unanalyzed unit, an exception to the general pattern that /ĕ/ is spelled with e. Having mastered the conventional spelling, the child may then realize the health is related to heal and that its spelling makes sense on this basis. Thus, learning to read and write may shape people's ideas about how words are related, just as it shapes their thinking about sounds. Orthography, once learned, is not simply a reflection of linguistic knowledge. It plays a powerful role in influencing and shaping our knowledge about language.

From Understanding to Automaticity in Reading

In all, independent writing offers a superlative medium for developing young readers' basic understanding of the sounds and spellings of words. As compellingly documented by the work on phonemic awareness, such understanding is vital for learning to read. But neither is it enough. Whereas, by its nature, writing affords reflective consideration and review of spellings, fluent reading requires that words be apprehended at a glance. In particular, skillful reading depends on acquiring deep, automatized, and detailed knowledge of spelling patterns and their mappings to the speech: In significant measure, just as this learning is specific to reading, it can only be gained through reading.

Developmental investigations of children's perceptual sensitivity to orthographic patterns show that it accrues in a gradual but systematic fashion (for a review, see Barron,1981). As discussed earlier, kindergarten and first-grade readers' sensitivity to whether the spellings of the strings they see are regular is limited. Whether reading words, pseudowords, or nonwords, they tend to process them in a simple letter-by-letter manner (Juola, Schadler, Chabot, & McCaughey, 1978; Lefton & Spragins, 1974; McCaughey, Juola, Schadler, & Ward, 1980).

Toward the end of first grade, normal readers begin to show a distinct advantage for pronounceable consonant-vowel-consonant sequences such as *rop* over irregular and unpronounceable nonwords such as *rjp* (Doehring, 1976; Gibson, Osser, & Pick, 1963; Thomas, 1968) Over the course of second grade, normal readers (but not poor readers) additionally become sensitive to the consonant pairs that frequently occur at the beginnings of words, such as *bl-* and *pr-* (Santa, 1976-77). Furthermore, even given relatively long (seven-letter) strings, the speed with which normal second graders can decide whether or not it is a real word proves sensitive to the frequency of the spelling patterns. Nonword decisions are slowed by both the likelihood of the individual consonant pairs in the strings (e.g., *shrnld* is slower to be rejected than *hgjcpl*) and the presence or absence of vowels (e.g., *turild* is slower to be rejected than *shrnld*). Moreover—and perhaps most interestingly—the mere presence of one or more vowels is enough to slow their rejection of even an otherwise unlikely string (e.g., *kugafp*, *vbejic*, and *gsecfp* are slower to be rejected than *dtscfk*, etc.) (Henderson & Chard, 1980).

By the time normal readers are in the fourth grade, the presence of a vowel slows their ability to decide that a string is not a word only if it appears in likely surroundings in the string, e.g., *clasty* and *grilts* but not *kigafp* and *vbejic* (Henderson & Chard, 1980). By that time, too, normal readers generally exhibit the adult pattern of pseudoword/nonword differences, even for long strings (Gibson et al., 1963; Lefton & Spragins, 1974). In addition, it is during the fourth grade that normal readers begin to perceive syllables more quickly and accurately than single letters (Friedrich, Schadler, & Juola, 1979) and become able, like adults, to vocalize words faster in response to print than to pictures (Marmuerek & Rinaldo, 1992).

Complementing such findings with extensive work of her own, Ehri (see 1980, 1992) has offered a "word identity amalgamation theory" to explain this remarkable growth. At the first level, according to her theory, children must acquire a working familiarity with the shapes and sounds of letters. In addition, they must acquire basic phonemic awareness and, in particular, the ability to detect systematic relationships between the sound segments of spoken words and the letters in their spellings. Working from these abilities, the children begin to build orthographic images of the words they read by matching the letters of each to its phonemic segments.

At first, children may proceed by matching just a few—usually the first and sometimes the last—of the individual graphemes of each word to its phonemic segments. As they become more and more familiar with the words and with the grapheme-phoneme relationships, their orthographic images become more and more complete and cohesive—such that, eventually, the full image of a word may be evoked at a glance. As the children's repertoires of printed words grow in number and completeness, they begin to learn about more complex spelling-sound patterns too. And as these complex patterns support more efficient mapping of spellings to sounds, it becomes easier and easier for them to read and remember newly encountered words. Meanwhile, through their reading experience, semantic and syntactic information also becomes "amalgamated" with the orthographic images of the words.

Perfetti (1992) similarly accepts that the process of skillful word recognition necessarily involves interactive connections between letters and words, letters and phonemes, and phonemes and words (where the "letter" and "phoneme" representations almost certainly include multiletter and multiphoneme units). However, he continues, the larger research on word recognition argues that these interactions are independent of, even insulated from the influence or bias of the reader's prior knowledge and expectations about linguistic flow and meaning. To be sure, such higher-order expectations are an integral part of the reading complex, but their job is to assist interpretation, not recognition. This "encapsulation" or isolation of the word recognition processes is possible for mature reader only because the mind's response to the graphic representation is fully and redundantly specified by its word, letter, and phoneme knowledge. It

is because the word is triggered by the print in a wholly deterministic way that the mind is responsive and need be responsive, only to the input features.

Thus, in its very structure and explanatory objective, Perfetti's theory directly rejects the merit and plausibility of meaning-driven notions of word learning. And, though stage theories may remain useful as gross descriptions of orthographic growth, they too are dismissed as causal explanations. That is, if the development of children's word recognition facility proceeds through increases in the number of words that are represented and the precision and redundancy of those representations, then the automaticity and autonomy of their ability to recognize a word must be a function, not of any general characteristic of their developmental level, but of their knowledge and experience with the particular word or spelling in view. On the other hand, Perfetti's theory is richly consistent with both the developmental data that Ehri sought to explain and with the burgeoning research on mature word recognition. Specifically, the ability to decode quickly and accurately while reading depends integrally and inalterably on familiarity, not just with individual letter-sound correspondences, but with the spelling patterns from which frequent words and syllables are comprised (see Adams, 1990).

Arguably, the human memory system is designed to learn quite automatically about such sequential patterns through experience—but *only* to the extent that experience has treated the patterns in that way. Children's tendency, discussed earlier, to instead view words as holistic patterns is therefore a real impediment such that, from this perspective phonics instruction, per se, takes on a very special value: The process of sounding out a new word requires attention to each and every one of its letters, in left to right order.

Even so, it is not just teaching children phonics that makes a difference but persuading them to use it. As a case in point, Juel and Roper/Schneider (1985) studied two groups children across their first-grade year. Both groups of children received the same program of phonics instruction, complete with teacher scripts and exercises. In addition, as demonstrated by accompanying tests, both groups of children learned the taught phonics, and equally well. Despite that, the first group showed consistent evidence of using their phonic knowledge while reading and, importantly, of

extending it beyond what they had been taught such that, by the end of the year, the first group was significantly better at reading new words than their peers. Why? Whereas the texts in the initial books or preprimers of the first group were built around short, decodable words, those of the second group used a text in which vocabulary was biased toward high interest words instead. (The wordings of the children's books were more or less comparable beyond the preprimer.) Evidently, a strong determinant of whether or how well children will use their phonic knowledge lies in whether or not they find it useful in their earliest efforts after print.

Contrary to such findings, prominent whole language advocates have cautioned against encouraging children to sound out new words as they read (Goodman, 1993; Smith, 1973). Doing so, they have claimed, induces children to become "word-callers"—to become so absorbed in the decoding process that they lose track of meaning. In fact, research affirms that, midway through first grade or so, many children tend toward "word-calling." As a group, that is, they measurably shift away from contextually appropriate miscues in deference to responses that maintain graphemic similarity to the print on the page (Biemiller, 1970; Juel & Roper/Schneider, 1985; Weber, 1970a,b). Yet, these same studies also demonstrate that as the children's word recognition skills improve, their sensitivity to context reblossoms.

More generally, research—as opposed to armchair musings—convergingly suggests that, at every age, the inclination to examine rather than gloss the spellings of less familiar words in text is a strong determinant of orthographic facility which, in turn, is significantly related to overall reading ability (Frith, 1980; Stanovich, West, & Cunningham, 1991). Nor, for normal readers, does it take many such efforts to conquer a new word. Recall that in Nicholson's (1991) replication of Goodman's (1967) classic study, having read the words of a text just once, days before, in a decontextualized list, was sufficient to overcome any advantage of context for the good readers, and more so with advancing grade. Indeed, Reitsma (1983) has shown that for normal second-graders, once an unfamiliar word has been decoded and reread just a few times, its recognition remains speeded significantly and quite enduringly. In contrast, he found poor readers to demonstrate relatively little savings across repeated encounters with words (Reitsma,

1989). Working with with reading-level matched children in the U.S., Ehri and Saltmarsh (1995) have replicated this contrast between good and poor readers in retention of orthographic detail

One explanation for such findings, considered by Bowers and Wolf (1993) and Stanovich (1992), is that poor readers may suffer a deficit in visual consolidation of the orthographic patterns they encounter. Another (though not necessarily exclusive) explanation, suggested by the theories of Ehri (1980, 1992) and Perfetti (1992), is that the orthographic knowledge of the poor readers in these studies was too poorly articulated or underdeveloped to absorb the spellings of the target words with useful efficiency and cohesion. Still another, slightly different, explanation is that dyslexics may characteristically adopt a reading strategy that relies more on visual than phonological information (Share, 1995); if so, the dyslexic's orthographic knowledge will be suboptimally structured for interword transfer. In support of this hypothesis, Siegel, Share, and Giva (1995; see also Stanovich & Siegel, 1994) have reported that, among children with a range of matching reading-levels, normal readers are superior at decoding nonwords while dyslexics are superior at judging their orthographic typicality.

In any case, and regardless of a child's reading ability, if too many of the words of a text are problematic, both comprehension and reading growth itself are impeded (Adams, 1990). Thus, high error rates are negatively correlated with achievement gains while low error rates are positively correlated wtih achievement gains (for review see Rosenshine & Stevens, 1984). Further, the younger or less able the readers, the stronger are these correlations until, at the extreme—for beginning readers—reading comprehension is strongly predicted by word recognition abilities but, with that factor discounted, not at all by how far they have been moved through their basal reading books (Juel, 1994).

But, of course, neither can the child grow if their texts contain no new words, which raises the question of how to arrange optimal levels of reading challenge. As rules of thumb, it has been suggested that error rates for instructional text should not exceed one in five words for older, better readers (Rosenshine & Stevens, 1984), or one in twenty for younger, poorer readers (Clay, 1979; Juel, 1994). After all, younger poorer readers are working harder even on those

words that they do read correctly. Alternatively, students can be asked to read the text several times. Not surprisingly, doing so is shown to result in increases in reading fluency and comprehension of the reread text; surprisingly, it is also shown to boost readers' performance on new texts (Samuels, 1979, 1985). Granted that nobody could become a proficient reader by reading and re-reading the same paragraph even a million times over, the reread-transfer effect begs special explanation. Its underlying source, as it turns out, depends on the subjective difficulty of the texts: Overlap in the content of the practice and transfer texts produces facilitation only for subjectively easy texts; otherwise the bulk of the reread-transfer effect is due to the readers' increasing facility with the texts' specific wording (Faulkner & Levy, 1994; Rashotte & Torgesen, 1985).

A ready inference from such findings is that, beyond the basics, gains in both the ease and productivity of reading might best be promoted by asking students to read and reread as broadly, deeply, and often as possible. Yet, even here, prominent whole language advocates have taken issue: "Literacy," wrote Frank Smith (1989, p. 354), "doesn't generate finer feelings or higher values. It doesn't even make anyone smarter."

Such pronouncements notwithstanding, the data broadly support the benefits of reading. In line with the foregoing discussion, amount of reading is strongly related to orthographic growth, as measured by both word recognition and spelling facility (Cunningham & Stanovich, 1990, 1991; Juel, 1994). Amount of reading also predicts growth in reading comprehension across the elementary school years even after controlling for entry level differences in reading comprehension (Anderson, Wilson, & Fielding, 1988; Cipielewski & Stanovich, 1992). It predicts the quantity and quality (language, vocabulary, and structure) of students' writing (Juel, 1994; Cunningham & Stanovich, 1991; Stotsky, 1984) as well as the ideational richness of their oral story-telling (Juel, 1994). In addition, it predicts receptive vocabulary, verbal fluency, content area achievement, and all manner of declarative knowledge even when other measures of school ability, general intelligence, age, education, and reading comprehension itself are partialed out of the equation (for review, see Stanovich, 1993).

In short, provided that children can read, there is arguably no more powerful lever on their overall cognitive growth than inducing them to read. Yet, even in a literate culture, the amount of reading that people do ranges dramatically (Guthrie & Greany, 1991). Among U.S. fifth graders studied by Anderson et al. (1988), the 90th percentile student reported reading about 200 times more text per year than the 10th percentile student. Anderson et al. (1988) also estimated that, all together, in school and out, the median fifth grade student encounters approximately 1,000,000 words of text per year, which includes less than than 5 minutes of out-of-school book reading per day (see also Allen, Cipielewski, & Stanovich, 1992). While setting time aside for reading in school has been shown to make a difference (Rosenshine & Stevens, 1987), classroom time is limited. Thus, activity outside the classroom—where that significantly includes summer reading—contributes very heavily to the huge performance differential in U.S. students' reading abilities (Hayes & Grether, 1983).

Other Influences on Early Literacy Development

What Else besides Phonemic Awareness and Letter Knowledge?

As our collective analyses of reading predictors and precursors have become increasingly refined and disconfounded, nearly all of our more conventional hypotheses about what makes a difference in learning to read have been discounted. Repeatedly and convergingly, the heavy majority of the variance in beginning reading success has been traced to just two factors—familiarity with the letters of the alphabet and phonemic awareness—while the measurable contributions of even our most intuitively compelling contenders appear weak, evanescent, and remote.

The issue raised in this section is not whether letter familiarity and phonemic awareness are crucial and powerful factors in beginning reading: Inarguably, they are. Yet, there remains the possibility that such analyses inadvertently discount other factors that are also key. After all, within the logic of the statistical procedures undergirding these analyses, the only means of distinguishing the contribution of one factor from any other with which it is correlated is by

entering both in the analysis. Thus, the possibility remains that there exist other potent predictors that are poorly measured by or missing from the set of independent variables in the contrast.

Fueling this concern, Clay's (1979) Concepts about Print test has been found to absorb significant variance above and beyond phonemic awareness and letter knowledge when entered into the equations. Examining this test to discover what—not counting letter knowledge, phonemic awareness, and word recognition—it taps, reveals a few very basic probes, e.g.: Which is the front of the book and which is the back? Which way should one turn the pages? Do the words come from the print (as opposed to the pictures or the page numbers)? In what direction does one follow the print (left-right and top-bottom)? And is the child aware of words and the convention of separating them by spaces in print?

So here is a puzzle: What is the nature of the variance that these items are capturing? To pose the problem in a different way, our tests of letter familiarity, phonemic awareness, and decoding are directly and unsubtly designed to measure those particular and specific abilities. We understand how letter familiarity, phonemic awareness, and decoding are involved in the reading process and that they, per se, are critical. We know that instruction that effectively instills, repairs, or strengthens abilities in any of these areas commensurately effects improvements in reading capabilities, and we know that to be effective the requirements of such instruction are nontrivial in design or delivery. In contrast, although we could sit any five-year old down for a few minutes and teach her or him how to tell the front from the back of a storybook and which way to turn the pages, it would very likely make not a whit of difference in her or his reading potential.

The suggestion, in other words, is that page-turning and so on are proxies or indirect indices of some set of factors that really do matter. By their nature, moreover, this set of factors seems closely tied to the nature or amount of children's prior experience with books.

Indeed, reading aloud to young children is broadly held to be among the most important of parenting activities (e.g., Bush, 1990; National Academy of Education, 1985; PTA, 1987)—or at least this is true in the public forum. Scouring the research forum on this topic, Scarborough and

Dobrich (1994) found that relevant studies were surprising few and collectively weak in design. Moreover, the correlations between the various outcome variables of interest and quantity or quality of parent-preschooler reading that could be gleaned from these studies suggested that the effects are quite modest, accounting for no more than 8% of the variance in concurrent or subsequent literacy-related abilities (see also Bus, van IjzenDoorn, & Pellegrini, 1995).

Given the research base from which Scarborough and Dobrich were working, reservations to this conclusion are not inappropriate: More and better research is clearly needed. Regardless of specifics, however, Scarborough and Dobrich offer a blanket caveat that warrants serious consideration: Where the nature of the relation between parent-preschooler reading and any given outcome variable is non-linear, such studies will necessarily underestimate its impact. "That is, it might matter a great deal whether a preschooler experiences little or no shared reading with a responsive partner, but beyond a certain threshold level, differences in the quantity or quality of this activity may have little bearing" (p. 285). In keeping with this, Stevenson and Fredman (1990, p. 690) found that the reading, spelling and IQ scores of a sample of 550 thirteen-year-olds were strongly predicted by the frequency with which their parents reported having read to them as preschoolers. However, they wrote, "There seemed to be a cutoff point whereby children who were read to less than four times a week achieved less well than those read to more regularly."

What is at issue here is not merely the precision, but the very appropriateness of the linear statistical models on which the field so strongly relies: In fact, the data suggest that the frequency of parent-preschooler storybook reading is strikingly bimodal. For example, across a sample of middle-class two- and three-year olds studied by Whitehurst et al. (1988), the average frequency of home book-reading was roughly eight sessions per week. Extrapolating from six months to six and one-half years, we point out that this weekly average cumulates to about 2,500 book-sharing sessions prior to school entry. In contrast, in a two-year study of home literacy activities conducted in a neighborhood with historically poor literacy success, Teale (1986) found that only three of the 24 preschoolers in the sample had been read to with any appreciable

regularity; for the majority, he found no evidence of any storybook reading whatsoever. Feitelson and Goldstein (1986) found similar differences in the home literacy support of Israeli kindergarteners from neighborhoods with records of high versus low school achievement: Whereas the homes of the kindergartners in the school-oriented neighborhoods had an average of 54 children's books in the home, 61% of those in the other neighborhood had none at all (see also McCormick & Mason, 1986); whereas 96% of the kindergartners in the school-oriented neighborhood were read to daily, 24% of those in the other neighborhood were read to "sometimes" and 61% not at all (see also Heath, 1983); further, even among those in the neighborhood with poor schooling success who did read with their children, none began before their children were four or five years old. The predictive significance of each of these variables has been independently affirmed by Payne, Whitehurst, and Angell (1994) through a study of the language development of 323 four-year-olds attending Head Start in the U.S.

Meanwhile, if ample exposure to stories and books is valuable, so too must be the linguistic, rhetorical, and conceptual exploration that such book-sharing sessions afford. Across parent-child dyads who regularly share storybooks, the sessions are nearly routinized and highly interactive, as the "reading" is sensitively tailored to the child's developing abilities and punctuated with questions and discussions of the words, concepts, and events raised by the text (Ninio & Bruner, 1978; Sulzby, 1985; Snow & Ninio, 1986; Wheeler, 1983). But again, data suggest that the instructional range of these interactions is more limited among low-SES parent-child dyads (Ninio, 1980).

Book-Sharing Interventions

The strong cultural variation in both the quantity and quality of home book-sharing urges the question of whether the behaviors can be effectively taught. Working from this perspective, Whitehurst and his colleagues (1988) gave a one-hour training session on interactive story reading to parents of fifteen children between two and three years old. Rather than just read to their children, these parents were encouraged to pause every so often and to ask open-ended (as

opposed to yes/no) questions such as "What is Eeyore doing?" They were also encouraged to expand on their children's answers, suggest alternative possibilities, and pose progressively more challenging questions. The parents were then asked to tape-record their home reading sessions with their children for one month. Meanwhile the parents of fifteen other children, matched in age and language development to the first group, were also asked to tape-record their home reading sessions. Analyses of the tapes indicated that both groups read equally often—about eight times per week. They also confirmed that the parents who had participated in the training session followed its recommendations. Analyses of the children showed that at the end of the month, those whose parents had been trained were eight and one-half months ahead of the others on a test of verbal expression and six months ahead on a vocabulary test—substantial differences for people who are only thirty months old.

The parents involved in Whitehurst et al.'s (1988) first study, were college-educated volunteers, from intact homes, who had already established solid storybook practices and rapport with their children. As a stronger test of the value of this approach, Valdez-Menchaca and Whitehurst (1992) ventured to reproduce it with two-year olds in a public daycare center for low-income families in Mexico. The daycare center did neither story-telling nor storybook reading with the children, and few of the children had ever been read to at home. For the intervention, a trained graduate student engaged each of the ten experimental subjects, one-on-one, in ten-minute sessions of interactive storybook reading daily for six weeks. Afterwards, the experimental subjects significantly outgained their matched controls both in vocabulary and on a variety of expressive language measures. The gains, though not as dramatic as in the study involving middle-class parents, were substantial and consistent across measures.

Having thus demonstrated the effectiveness of their interactive reading routines, the group turned their attention to the challenge of training children's regular caretakers to engage in effective book-sharing activities. They began by putting together an instructional videotape (Whitehurst, Arnold, and Lonigan, 1990) and verifying that its use produced solid gains among the children of well-schooled, highly motivated (reporting a pre-intervention storybook reading

rate of 12.8 times per week), middle-class volunteers (Arnold, Lonigan, Whitehurst, & Epstein, 1994). Even so, efforts to extend this experience to parents from low-SES homes have been disappointing: Enlistment of parents is difficult; the attrition rates are high; and even given compliance, the measured effects on children's language growth have been relatively meager (DeBaryshe, Rodarmel, Daly, & Huntley, 1992; Lonigan, 1993; Morisset, 1993; Needlman & Fitzgerald, 1993).

As an alternate strategy, Whitehurst, Epstein, Angell, Payne, Crone, and Fischel (1994) used their video to train Head Start teachers and parents in interactive or, in their terms, "dialogic" reading. The study involved 15 classrooms, half designated as experimental and half as controls. Because assessment was more extensive, outcomes were clustered into four factors for analysis: language development, writing, print concepts, and linguistic awareness (words, syllables, and phonemes). Post-intervention analyses showed no impact on the linguistic awareness factor, alongside a modest but significant advantage for experimental classrooms in writing and print concepts. In contrast, the responsiveness of the language factor depended strongly on to the extent that the children's parents did, as promised, read with them at home; exposure in the classroom alone had no measurable effect.

As Whitehurst et al. (1994) review, evidence of such special dependence of language growth on home language and literacy support has been found in other studies, too. The question is why. One immediate hypothesis is that the key controlling variable was the amount or frequency of shared reading which, after all, should have been doubled for the children who were also read to at home. Another possibility, however, is that the educational power (and perhaps, absent intervention, the very dynamic) of interactive reading pivots, most of all, on the reader's sensitivity to the child's own responsiveness and contributions—and that sensitivity is only afforded in a one-on-one setting. If so, then there is nothing specific that one can teach teachers or parents to do or say that will make the difference. On the other hand, to the extent that parents complied by reading at home, the effects of Whitehurst et al.'s (1994) Head Start study were strong. This raises the hopeful possibility that, in modeling the appropriate dynamic for both the

parents (as was done through the video-training session) and the children (as was done in the classroom), Whitehurst et al. (1994) have discovered a key to setting up novice parent-preschooler dyads for rewarding and self-engendering experience with books.

The importance of optimizing the child's give and take in book-sharing sessions notwithstanding, the focus of these exchanges also makes a difference. Thus, Feitelson, Goldstein, Iraqi, and Share (1993) conducted a kindergarten booksharing intervention in an Arab town in which, for reasons of the marked difference between written Arabic and the spoken language of the community, virtually no parents read to their preschoolers regardless of social background variables. In response to this situation, the emphasis of the intervention was on developing the children's appreciation of the language of the written register and of story structure. Commensurately, Feitelson et al.'s subjects evidenced strong gains in both linguistic facility with formal Arabic—as evidenced by their listening comprehension and the complexities of their expressive language—and in their tendency to impose canonical story structures and express the causal connections between events in telling stories about picture sequences. Similarly, the Whitehurst et al. (1990) program emphasizes the use of good children's literature as a platform for expanding and refining the child's vocabulary and expressive command of language. Consistent with this, the program has produced gains in both the vocabulary and the complexity of the children's descriptive speech—but not in letter or phonic knowledge. In contrast, in McCormick and Mason 's (1986) intervention, which was centered on inducing parents to share preprimer-like books with children, gains were observed in the children's letter, word, and "reading" performance, but not their vocabulary or linguistic sophistication. On the other hand, children's phonological sensitivities are found to be stubbornly indifferent to their book-sharing histories (Cunningham & Stanovich, 1993): Phonemic awareness is not easy or natural; it is rarely induced without special guidance.

Vocabulary and Syntax

The primary purpose of beginners' texts is to support basic reading processes and fluency development. By design, therefore, these texts tend to be simple and familiar in vocabulary, concept, and both inter- and intra-sentential structure. No doubt, it is largely for this very reason that, as reviewed above, the majority of the variance in beginning reading success is absorbed by measures of letter knowledge, phonemic awareness and—through them—word recognition and decoding ability.

In contrast, where the primary purpose of text becomes instead one of conveying new information and ideas, it is convenient to introduce new words and necessary to express novel relations among familiar ones. To understand a text, children must be able to understand both the meanings of the words and the intended interrelations among them. Thus, although measured vocabulary does not carry much weight in predictions of beginning reading success, it becomes a potent correlate of reading achievement in the middle grades and up (Stanovich, Cunningham, & Feeman, 1984; Chall, 1983; Thorndike, 1973).

Research suggests that the single most powerful contributor to vocabulary development is reading itself, yielding about half of the roughly 3,000 new words that adequately performing schoolchildren are expected to learn each year (Nagy, Anderson, & Herman, 1987). Yet, this raises certain educational dilemmas. First, because the likelihood of learning any given word from text is very small, the possibility of learning lots of words through reading depends on reading lots of text of the sort that contains some reasonable sampling of new words. In effect, this raises a new literacy barrier for poor readers, who have neither the capacity nor the disposition to keep up, much less catch up. Second, as implied by componential theories of meaning representation, the ease of vocabulary learning should depend on the depth, breadth, and organization of the vocabulary already learned. In keeping with this, data indicate that children with stronger vocabularies in the first place absorb new words more easily than those with weaker vocabularies (Robbins & Ehri, 1994). In all, the question of how better to support vocabulary growth for those who need it most, is urgent. Further, if a literate vocabulary is

suddenly required at grade four, then it cannot be good policy to wait until grade four to work on its development. A few promising programs have been developed (see, e.g., Beck, Perfetti, & McKeown, 1982; O'Rourke, 1974). Overall, however, and despite the rich history of work on the representation and access of word meanings by adults, work on vocabulary development and its underlying dynamics is relatively scant. We will return to this topic in the section on comprehension.

The situation is still vaguer with respect to syntactic development. The importance of syntactic awareness to reading is strongly suggested by differences in the use (Tunmer & Chapman, 1995), as well as the structure (Chafe & Danielewicz, 1987; Perera, 1986; Halliday, 1987) and processing requirements (Adams, 1980; Huggins & Adams, 1980) of written as opposed to oral syntax. Consistent with this, based on a meta-analysis of relevant literature, Bus, Van Ijzendoorn, and Pelligrini (1995) concluded that familiarization with the written register is the strongest and most important outcome of reading aloud with preschoolers. The importance of instructionally supporting early syntactic development is further indicated by longitudinal studies of children with language delay. Unless they recover by five and one-half years of age, preschoolers with with expressive and receptive language delay, whether specific or secondary (which includes environmentally induced delay), are repeatedly shown to be delayed in reading achievement across the primary school years (e.g., Bishop & Adams, 1990; Catts. 1991b; Scarborough & Dobrich, 1990; Whitehurst & Fischel, 1994). In addition, a number of studies have shown performance on syntactically specific tasks to separate good and poor readers (for a review, see Tunmer & Hoover, 1992).

Nevertheless, when measures of syntactic facility are competed against measures of phonological sensitivity, the former have been found to contribute precious little to the reading equation (Shankweiler et al., 1995; Gottardo, Stanovich, & Siegel, 1995; but see Tunmer, Herriman, & Nesdale, 1988). Where samples include beginning or disabled readers, one might argue that any effects of syntax are liable to be swamped. Alternatively, one might argue that the apparent nonsignificance of syntax may derive from poorly conceived measures thereof: Since

the 1960's when children were declared syntactically competent by age four (McNeill, 1970; Slobin, 1971), the development of syntax across the school years has been a flagrantly neglected topic of research. The other possibility, of course, is that maybe syntax really doesn't much matter. Again, however, to understand a text, children must be able to understand both the meanings of the words and the intended interrelations among them: In written text about unfamiliar constructs, syntax is the primary means of conveying such relations.

Revisiting this section at a more molar level of analysis, an inherent difficulty in studying the general impact of parent-preschooler reading is that the domain is comprised of so many different books and adults and, across them, so many different aspects of language and literacy that might or might not be explored with any given child. When concern is expanded to the more general issues of good language and literacy support, the complexities only multiply. In the interest of progress, the diffuseness of the domain is important in at least three ways. First, it challenges the informativeness of our outcome measures: For example, should we be surprised that the strongest common outcome across the various studies reviewed by Scarborough and Dobrich (1994) was an increase in children's interest in literacy-related activities? Should we expect the Peabody Picture Vocabulary Test to yield an appropriate or adequately sensitive metric of consequent linguistic growth? Do we even have a usefully refined measure of syntactic competence? Second, the prospect of bringing all children to full literacy depends on inventing practicably efficient and effective instructional strategies for ensuring that all children have the knowledge and cognitive abilities that literacy development presumes or entails. Third, resolution of these problems as well as the larger progress and productivity of the science of cognitive development will depend on discovering not just what works, but why and how it does so.

Summary

Over the last several decades, the field has established a solid research base on the critical importance of word recognition abilities and how best to support their development. For the next

several decades, the goal must be one of extending this science beyond issues of word recognition. We must turn, with the same tenacity and rigor, and with due respect for their respective social, educational, and linguistic backgrounds, to questions of what can be done to foster language and literacy most fully and effectively for all of our children.

Comprehension and Composing: Higher Level Reading and Writing

The ultimate goal of reading eduation is for students to be able to comprehend text. To this end, there have been many analyses of comprehension and comprehension instruction. Without a doubt, more attention has been given to the development of comprehension through comprehension strategies instruction than through any other approach. Thus, that is the main focus of this section on comprehension, which emphasizes connections between historically prominent work on comprehension and comprehension strategies instruction as it was studied in the 1980s and continues to be studied in the 1990s. Alternatives to strategies instruction are then considered, with the discussion concluding by emphasizing the connections between comprehension research past and present.

The Historical Foundations of Comprehension Strategies Instruction

Most of the scientific work on comprehension instruction was conducted in the past two decades. There was rapid progress during this period largely because of seven related developments in the 1970s. In this subsection, tow are reivewed: (a) The need for comprehension instruction became apparent, and (b) Serious doubts about traditional studies skills instruction arose. In subsequent subsections, five additional factors that stimulated research on comprehension instruction will be considered: (c) A number of theories of meaning representation were introduced, with many suggesting comprehension processes that might be taught; (d) The nature of conscious processing by skilled comprehenders began to be examined through verbal protocol analyses; (e) Metacognitive theory was developed; (f) Theories about the development of self-regulated cognition emerged as important; (g) Reader response emerged as an important approach to language arts.

The Need

Before there is an intervention, there must be a need for an intervention. One study (Durkin, 1978-79) more than any other made apparent the need to instruct students how to comprehend text (Hoffman, 1991; Pearson & Fielding, 1991; Shulman, 1986). In a series of studies, Durkin observed classrooms and students in grades three and six, watching for comprehension instruction during reading and social studies. She saw little of it. Instead of teaching students how to comprehend, teachers were assessing comprehension, asking students questions about material they had read. Similarly, the teachers' manuals provided little guidance about how to teach comprehension, but much material to aid assessment of reading comprehension (i.e., comprehension questions; Durkin, 1981). Although some argued that Durkin underestimated the amount of comprehension instruction occurring in schools (Heap, 1982; Hodges, 1980), her conclusions stimulated researchers to study comprehension strategies instruction, teachers to teach them, and materials producers to change their basal materials to include much more about how to teach comprehension.

The interest in reading comprehension assessment reflected the concern that reading, in the sense of accurate and fluent decoding, might occur without high levels of comprehension. For example, Wiener and Cromer (1967) proposed that some weak child readers were "difference" poor readers, who could decode but could not construct meaning capturing the overall messages in text. In addition, prominent developmental psychologists were turning attention to the difficulties young children sometimes experience in identifying main ideas (e.g., Brown & Smiley, 1977) and in drawing straightforward inferences from simple prose (e.g., Paris & Upton, 1976).

In the late 1970s, there was not an adequate response to the need for comprehension instruction. Pearson and Johnson (1977) provided a candid appraisal, flagging that much more needed to be known about teaching comprehension processes to students.

Durkin, Wiener and Cromer, Paris and Upton, Brown and Smiley, and Pearson and Johnson were all influenced in their analyses and thinking by cognitive psychology. Not surprising, most

of the research that would occur in reaction to their analyses would be conceived in cognitive psychological terms.

Doubts About Study Skill

Study skills manuals have been published throughout the twentieth century (Forrest-Pressley & Gilles, 1983). Even the earliest included comprehension strategies instruction. Thus, Sandwick (1915) instructed students to reflect before they read a passage, calling to mind what they already knew about the topic. After studying the entire passage, students were advised to return to difficult portions of it. Sandwick urged students to study aloud, drill on information that was important to remember, visualize the content of text, and summarize it. Swain's (1917) study skills manual favored self-questioning and summarizing during reading.

Robinson (1946) introduced the SQ3R approach: Students using this approach first survey (S) the text, then generate questions (Q) about the text based on bold-faced headers, followed by reading (first R), reciting (second R) of the text, and reviewing (third R) it, including attempting to recall the text. Although SQ3R continues even today to be well known in study skills circles (e.g., Nist & Diehl, 1990), it and other study skills approaches have something of a checkered history. First, there is relatively little evaluation of it, with the comparative studies that do exist not of high quality and not particularly supportive of the method—SQ3R does not produce much better learning of a text than simply reading and rereading it (Caverly & Orlando, 1991; Johns & McNamara, 1980). SQ3R is difficult for children to understand. For example, surveying means skimming, a process not well understood by students in the early elementary grades (Forrest-Pressley & Gilles, 1983; Forrest-Pressley & Waller, 1984). Elementary-level students also have difficulties constructing anything but low-level, factual questions unless they are taught how to construct questions stimulating deep reflection on text (e.g., Davey & McBride, 1986). Students who lack background knowledge related to the topic of a reading also can have difficulty with the questioning phase of SQ3R (e.g., Bean, Smith, & Searfoss, 1980). If the headers and subheaders in a text are poorly constructed and mismatched to the important ideas in text, and

they often are, using them to generate questions can direct attention away from more important ideas in favor of less important ones (Anderson & Armbruster, 1984). In addition, the method is better matched to tasks requiring recall of text content than to other tasks, for example, ones requiring application of the ideas in the text (Anderson & Armbruster, 1984). In short, many difficulties with SQ3R, the centerpiece of much of study skills, became apparent in the late 1970s and early 1980s.

Two other studies skills approaches deserve mention here, because they were precursors of reciprocal teaching, an important cognitive strategies intervention evaluated in the 1980s and taken up later in this chapter (Palincsar & Brown, 1984). The first, Manzo's (1968) ReQuest procedure, involved students and teacher reading part of text and then taking turns asking each other questions about it (i.e., engaging in reciprocal questioning). Through generation of questions, the teacher models questioning for the student. The teacher also provides feedback to students about the questions they generate. The second, Stauffer's (1969) Directed Reading-Thinking Activity approach (DRTA) focussed on three steps: predicting the content of text (based on title, subheaders, illustrations, etc.), reading, and revising predictions. After reading, revision of predictions is prompted by teacher questions: Were your predictions correct? What do think now? The teacher also solicits predictions about the content to come: What do you think will happen? That neither ReQuest nor DRTA enjoyed much empirical support became apparent with the publication of Tierney, Readence, and Dishner (1980), which detailed for reading educators the classical study skills approaches and the thin evidentiary bases for many of them. There was a need for something better than traditional study skills.

Theories of Meaning Representation

An important concern of cognitive psychologists is the determination of how meaning is represented in the mind and how mental representations of meaning determine comprehension of complex ideas, such as those represented in text. There was much new theory and debate about

representation during the 1970s. The various representational theories stimulated hypotheses about the nature of effective comprehension strategies instruction.

Many experimental studies of children's reading took the following form: One condition in the experiment would involve instruction encouraging a particular type of comprehension processing. A second condition would be a control condition, often one in which readers were left on their own to process text as they naturally would. The assumption was that children's low comprehension relative to adult comprehension was due to incomplete processing of text, so that children were creating incomplete representations of texts. We review here four of the more important representational theories of the 1970s and the types of strategies instructional experiments they spawned. In each case, the studies produced outcomes that proved replicable as the 1980s proceeded.

Kintsch and van Dijk's Theory

According to Kintsch and van Dijk (1978; also van Dijk & Kintsch, 1983), skilled readers parse text into micropropositions, the smallest units of meaning. A microproposition can be conceived as a verb or preposition and semantic roles that are related by the verb or preposition. Thus, a microproposition can contain information about an agent performing an action specified by a verb, as well as information about the object of an action specified by a verb, goals accomplished by the action, the recipient of the action (referred to as a patient in this system), time of the action, and so on. Micropropositions are equivalent to sentences in logic and are represented using a standard format that emphasizes the relationship specified by the verb or preposition. Thus, the proposition UNDER (DOG, HOUSE) specifies a relationship between a dog and a house, that the dog is under a house. TYPES (MICHAEL) conveys that Michael types. All of the micropropositions specified in a text combine to capture the full meaning of the text. Of course, no one remembers every idea specified in a text. What people remember is the gist, which is the main idea of the text, which is encoded as macropropositions according to Kintsch and van Dijk. Macropropositions are distilled from the micropropositions of the text.

Thus, macropropositions for A Christmas Carol would include that Scrooge met ghosts, who changed his life philosophy.

A number of cognitive theorists assumed that the construction of macropropositions was not as certain with children as with skilled adult readers. Thus, they hypothesized that children's understanding and memory of text would be improved if they were taught to generate summaries as they read. The result was a number of studies in which summarization was taught to students in the elementary grades (mostly in the middle and later grade-school years) in various ways (e.g., Doctorow, Wittrock, & Marks, 1978; Taylor, 1982). One of the most prominent of these studies was devised by Brown and Day (1983). They taught students a series of rules to apply as they processed text: (a) delete trivial information, (b) delete redundant information, (c) substitute superordinate terms for lists of items, (d) integrate a series of events into a superordinate action, (e) select a topic sentence from among the sentences in a passage, and (f) invent a topic sentence if one cannot be found. Students' memory and comprehension of text typically improved following their use of summarization strategies.

Paivio's Dual-Coding Theory and Imagery-Generation

Paivio (e. g., 1971, 1986; Clark & Paivio, 1991) proposed that knowledge is composed of complex associative networks of verbal and imaginal representations. The verbal system contains word-like codes for objects and events and abstract ideas, codes which are only arbitrarily related to what they represent (e. g., the word "book" has no physical resemblance to an actual book). The imagery system contains nonverbal representations that retain some resemblance to the perceptions giving rise to them (e. g., an image of a book shares features with the perception of an actual book). Elements in the imagery representational system are linked to elements in the verbal representational system. Thus, there is a connection between most people's image of a book and their verbal representation of a book, with such referential connections permitting construction of mental images given words as stimuli and generation of names when objects are seen in pictures.

A series of images can be linked according to dual-coding theory, for instance to create a nonverbal representation of the contents of a story. Thus, Levin (e.g., 1973), Pressley (e.g., 1976), and others made the case that children's imagery generation during reading was typically less extensive than it could be and thus, proposed that teaching children to construct images when reading a text might increase activation of the imagery system. In general, when children constructed mental images representing the content of texts, their memory (e.g., as tested by literal, short-answer questions) and understanding (e.g., as tested by questions tapping inferences that could be made during reading of the text) improved relative to when same-age students read as usual (see Pressley, 1977).

Story Grammar Theory and Story Grammar Analysis

Stories have a conventional structure: a beginning, including information about the time, setting, and characters in the story; an initiating event setting a goal or leading to a problem; a series of attempts to achieve the goal or overcome the problem; achievement of the goal or resolution of the problem; and character reactions to the resolution. Good readers understand this structure implicitly and use it to understand stories, with their memory of a story reflecting essential story elements (e.g, Mandler, 1984; Stein & Glenn, 1979).

In a study conducted in 1980, Short and Ryan (reported in 1984) hypothesized that not all children understand story grammar or, if they do, fail to use their story grammar knowledge to comprehend stories. To test this idea, they taught weak grade-4 readers to ask themselves a series of questions as they read, questions orienting the reader to story grammar elements of stories: (a) Who is the main character? (b) Where and when did the story take place? (c) What did the main characters do? (d) How did the story end? and (e) How did the characters feel? Use of this strategy increased the text recall of the weak readers relative to comparable ability control readers, who read as they usually read. More impressively, the strategy-instructed students recalled at the level of skilled grade-4 readers.

Schema Theory and Prior Knowledge.

Without a doubt, the most prominent representational theory among reading researchers and educators during the late 1970s and early 1980s was schema theory, as reviewed by Anderson and Pearson (1984). A schema integrates a number of concepts that commonly co-occur into an orderly systems of procedures and expectations. Events and situations are presumed to have skeleton structures that are more or less constant, although the particular ways the skeleton takes on flesh varies from instance to instance. For example, the schema for a ship christening includes its purpose—to bless the ship. It includes information about where it is done (i. e., in dry dock), by whom (i. e., a celebrity), and when it occurs (i. e., just before launching of a new ship). The christening action is also represented (i. e., breaking a bottle of champagne that is suspended from a rope). Once some small part of the ship christening schema is encountered, for example, by the mention of a bottle of champagne breaking on the bow of a ship, the entire schema is activated. Once activated, comprehension and processing of the ship christening text will be affected. Schematic processing is top-down in that activation of the higher-order idea occurs first and constrains thinking about the details of the situation. The activated schema will permit reasonable inferences to be made during reading about details of the event. For example, as the bottle is seen breaking on the bow, the viewer might infer that there was a platform beside the ship with one or more persons on it, one of them a celebrity. It will also affect the allocation of attention to information in the text, for example, to the celebrity, to the name of the ship, and memory of the event.

Schema activation can dramatically affect comprehension, inferences, attention allocation, and memory of what is read. (See Anderson & Pearson, 1984, for a review.) Thus, schema theory implies that strategic activation of prior knowledge, which is largely schematic according to this theory, will affect understanding and learning of text. It was for this reason that schema theorists encouraged students to make predictions about text before reading, relate information encountered in text to prior knowledge, and ask themselves questions about the reasons for the relations specified in text, operations which proved to affect comprehension and memory of text.

Summary

Representational theorists in the late 1970s and early 1980s believed that if children failed to understand and remember text, the fault may be that they were not constructing complete representations. That is, children were failing to generate macropropositions as completely as they could, failing to form images capturing the semantic relations in a story, failing to construct representations that adequately reflected story grammar elements or intermeshed with schematic prior knowledge. The solution was to encourage students to construct fuller representations through instruction. What resulted were strategies for enhancing mental representations of texts, ones that could be applied before, during, and after reading (Levin & Pressley, 1981).

Theory and Research on Comprehension Control

Verbal Protocols of Skilled Reading

An important analytical tool for cognitive psychologists is the verbal protocol analysis, which involves thinking aloud while performing a task. Such protocols have been collected throughout the twentieth century (e.g., Marbe, 1901; McCallister, 1930; Peikarz, 1954; Titchener, 1912a, 1912b).

The prominence of the methodology in reading research increased substantially with the publication of Olshavsky (1976-77). She studied the reading of 12 good grade-10 readers and 12 weak grade-10 readers. Each silently read a short story. The students were informed that the purpose of the study was to determine how grade-10 students read, not to test an individual participant's reading ability. The students were instructed to read silently until they encountered a read dot and then to "...talk about what happened in the story and about what you were doing and thinking as you read it. (p. 663)" Red dots were placed after each independent clause.

The verbal protocols were analyzed for cognitive strategies. Three word-level strategies were detected: using contextual cues to infer the meanings of unknown words, attempting to substitute synonyms for unknown words, and simply acknowledging when a word is not understood. Many more strategies aimed at understanding the meanings of sentences and

paragraphs were detected. These included re-reading segments of text that were not understood, attempting to infer information not explicitly stated in text, relating information in the text to personal prior knowledge, making predictions, and relating information in a just-encountered clause to the theme of the passage emerging during reading.

Five prominent verbal protocol analyses of reading appeared within five years of the Olshavsky report (Christopherson, Shultz, & Waern, 1981; Collins, Brown, & Larkin, 1980; Hare, 1981; Lytle, 1982; Olson, Mack, & Duffy, 1981), with these studies including a wide range of readers and a variety of reading genres. Although the amount of strategy use observed in these studies varied (e.g., they were not as predominant in the protocols of children as in some protocols of high school and college students), and the particular processes varied, strategies were consistently observed in these studies, with strategic processing considered as skillful processing by the protocol analysts.

Emergence of Metacognitive Theory

Metacognition is cognition about cognition, an idea first introduced into the developmental literature by Flavell (1971). Metacognition plays an important regulatory role in cognition. Thus, the long-term knowledge that intentionally creating a summary of something just read increases memory of it is important metacognitive knowledge, conditional knowledge (Paris, Lipson, & Wixson, 1983) about summarization, that can inform a student how to proceed when confronted with text containing main ideas that must be remembered. That is, conditional knowledge increases the likelihood of long-term, appropriate use of strategies (for reviews, see Pressley, Borkowski, & O'Sullivan, 1984, 1985). Other metacognitive knowledge is generated on-line, via cognitive monitoring. Thus, a reader's awareness that comprehension is not going well is metacognitive knowledge, knowledge that also can inform and motivate subsequent cognitive actions, for example, the decision to reread, read more slowly, or give up on a text.

Both Flavell's (1977) prominent book, Cognitive Development, and Flavell and Wellman (1977) offered analyses of how metacognition might regulate cognitive strategies in various