Although written English displays three types of units that make contact with readers’ knowledge of language, letters, words, and sentences, readers’ eyes come to favor words as the units that are most easily processed (Rayner & Pollatsek, 1989). The advantage of words over sentences is that words can be assimilated in one glance. The advantage of words over letters is that written words correspond more reliably to spoken words than letters correspond to phonemes. Many years ago, Cattell (1886) found that readers could recognize a whole word more readily than a single letter. More recent studies have verified the word-superiority effect (Reicher, 1969; Wheeler, 1970).

Various ways to read words can be distinguished: by sight, by decoding (also called phonological recoding), by analogizing, by processing spelling patterns, and by contextual guessing. When people read words by sight, they access information stored in their lexicons (mental dictionaries) from previous experiences reading those words. On seeing a familiar written word, readers access the word’s identities, including its pronunciation, meaning, syntactic identity (its typical grammatical role in sentences), and orthographic identity (information about its spelling) (Ehri, 1978, 1980). Words appearing frequently in text are more apt to be read by sight than words appearing infrequently because some practice is needed to form access routes into lexical memory for specific words. Several behaviors indicate sight-word reading: when words are read as whole units without any pauses between phonemes or syllables; when words are read rapidly, faster than nonsense words having comparable spelling patterns; when irregularly spelled words are pronounced correctly rather than decoded phonetically (reading recipe as /rɛ-sə-pɛ/ rather than /rɛ-sɛp/) (Adams & Huggins, 1985); when correct spellings are distinguished from homophonous spellings (rain vs. rane; sword vs. sord; pear vs. pair; write vs. right) (Olson, 1985; Stanovich & West, 1989).

Phonological recoding is a slower way to read words. It involves transforming and assembling spellings into pronunciations via the application of grapheme-phoneme correspondences and then searching the lexicon for a meaningful word that matches the pronunciation. The operations of sounding out and blending may be involved but usually are not visible, except in beginning readers who receive explicit phonics instruction (Beck, 1981; Monaghan, 1983). Because the English spelling system is not perfectly phonemic, some experimentation with varied pronunciations may be necessary to derive a recognizable word. The most common way to assess phonological recoding skill is with pseudo-words that are presumed to be unfamiliar and hence not known by sight.

There are two other ways to read unfamiliar words—by analogizing to known sight words and by detecting and pronouncing orthographic patterns. Baron (1979) distinguishes between a true analogy-based process in which readers search lexical memory for specific known words having the same parts as the word being read (reading *yave* by analogy to *gave* or *have*, for example) and a process in which readers apply spelling patterns generalized from several known words (*ave* in *gave, pave, save, brave, wave*). A conflict test has been used to distinguish analogizing from phonological recoding (Marsh et al., 1981b). Readers are given nonwords—for example, *pednesday*. Saying “ped-ness-day” indicates phonological recoding whereas saying “pens-day” (to rhyme with Wednesday) indicates analogizing.

Using generalized orthographic patterns to read words requires having the spellings of several words stored in memory and organized by pattern. Glushko’s (1979, 1981) activation-synthesis model portrays how this process works:

As letters in a word are identified, an entire neighborhood of words that share orthographic features is activated in memory, and the pronunciation emerges through the coordination and synthesis of many partially activated phonological representations. (1981, p. 62)

Glushko’s findings indicate that identical stems (rimes) are more likely to become patterns than are other parts of words. This agrees with Treiman’s (1985, 1986) finding that onsets (initial consonants) and rimes (remaining vowel stems) are more natural units within syllables than are other subdivisions.

A final way to read words is by contextual guessing. The text preceding a word enables readers to form expectations about the word’s identity (Goodman, 1976). In the analysis of miscues produced during the oral reading of text, Biemiller (1970), Goodman (1965), Weber (1970), and others observed that young readers substitute words that are semantically and syntactically consistent with the text read up to that point, indicating that expectations are operating. Contextual guessing is used mainly to read unfamiliar words (Carnine, Carnine, & Gersten, 1984); familiar words are recognized so quickly and
automatically by sight that contextual expectations do not have time to facilitate this process (Perfetti, 1985; Stanovich, 1980, 1986).

Contextual guessing cannot account for the way skilled readers read most words. Studies of the predictability of words in text reveal averages of 25 to 30 percent correct guessing, with the most important content words being the least predictable (10 percent correct) (Gough, 1984; Nicholson & Hill, 1985). To guess words effectively, the surrounding words must be known. To read surrounding words accurately, processes other than contextual guessing are required—processes that use alphabetic information. Because my focus is on how readers develop skill at reading words by alphabetic processing, studies of contextual guessing are not reviewed here.

Development extends beyond learning to read words accurately. Readers also learn to read words automatically without attention and without deliberate processing of component parts (LaBerge & Samuels, 1974), and they learn to read words at maximum speed, indicating that information about the various identities of specific words has been unitized in memory (Ehri & Wilce, 1983). The ability to read words rapidly is thought to be highly important for text comprehension because automaticity frees space in memory for the execution of higher level comprehension processes (Perfetti, 1985). Although the development of word-reading speed is highly important, it will not be considered here.

**Phases of Development in Learning to Read Words**

Following Frith (1985), the course of development is described in three phases: logographic, alphabetic, and orthographic. Logographic refers to the use of nonphonemic visual, contextual, or graphic features to read words; alphabetic refers to the use of grapheme-phoneme relations to process correspondences between the spellings of words and their pronunciations; and orthographic refers to the use of spelling patterns. I prefer the concept of phase to that of stage because it limits presumptions about developmental relationships.

**Logographic Phase**

In logographic writing systems, visual symbols represent words or morphemes, not phonemes. The first phase is called logographic because beginners select and remember nonphonemic visual characteristics rather than letter-sound correspondences to read words. Logographic-phase readers might learn to read a word by remembering the shape of one of its letters or its logo (for example, the arches in the McDonald’s logo). A visual cue that is related to a word’s meaning might be found, such as two eyes in the middle of look or the humps in the middle of camel. Semantic cues provide memorable access routes for retrieving words, but it is hard to find meaning-bearing cues in most spellings.
Logographic word reading is referred to as visual cue reading (Ehri, 1987; Ehri & Wilce, 1985, 1987a, 1987b). Paired-associate learning portrays how logographic readers learn to read words using visual cues (Gough & Hillinger, 1980; Gough, Juel, & Roper/Schneider, 1983). Readers form an association between a written word and its pronunciation or meaning in memory by selecting some visual attribute that distinguishes it from other words being learned. The next time that attribute is seen in the same or another word, the response word associated with that attribute is retrieved from memory.

Gough, Juel, and Griffith (1992) show that logographic readers select single salient visual cues rather than holistic gestalts to remember words. In one study, they taught 4- and 5-year-olds to read four words, one of which had a thumbprint next to it. Children learned to read the thumbprint word fastest. When the thumbprint was removed, children did not recognize the word, but when only the thumbprint was shown, nearly all said the word. In another study, preschoolers were shown only halves of words they could read. Consistent with the idea that logographic readers select only single cues, children who could not recognize the word from its first half were twice as likely to recognize it from its second half, and vice versa.

Visual cue reading presents several difficulties for readers. The associations formed between visual cues and words are hard to remember unless practiced frequently because they are unsystematic and arbitrary. Visually similar words are mistaken for one another because the visual cues selected are not unique to individual words. As more words are learned, it becomes harder to find attributes that distinguish words because different words contain the same visual cues. Rather than reading the exact word symbolized in print, logographic readers may produce synonyms or semantic associates because the visual cues they remember do not systematically target a particular pronunciation in memory.

Various studies reveal the difficulties of logographic word reading. In a longitudinal study with preschoolers (Mason, 1980), the least mature readers were able to read few words: their own names and environmental print such as stop, milk, and exit. When the children were shown a list of easy three-letter words, they either refused to read them or guessed wildly. This shows that logographic readers lack any means of reading unfamiliar words accurately. They may use context to guess or mistake unfamiliar for familiar words. In a word-learning task, Mason’s subjects learned to read only 3 to 4 words on a 10-item list and forgot these after 15 minutes. This indicates that logographic readers have difficulty learning words out of context. When these children were taught to read words printed in uppercase and then were shown the same words in lowercase, few remained able to read the words despite the fact that they knew many upper- and lowercase letters. This reveals that logographic readers do not use letter cues to read words.
Other studies corroborate logographic readers’ use of visual context cues rather than alphabetic cues to read labels and signs in their environment (Dewitz & Stammer, 1980; Goodman & Altwerger, 1981; Harste, Burke, & Woodward, 1982; Hiebert, 1978; Ylisto, 1967). In a study by Masonheimer, Drum, and Ehri (1984), preschoolers who were experts at reading signs were unable to read the same signs when environmental cues were removed. When letters were substituted in signs that retained their logos (Pepsi changed to Xepsi, for example) most children “read” the logo without noticing the letter change, even when they were asked about a possible mistake. One reason logographic readers do not remember letters in words is that they do not know them well. Only 62 percent of the letters were named by subjects in the study. Of course, environmental signs contain other more salient visual cues, so there is little reason to focus on letters.

Ehri and Wilce (1985) studied the kinds of cues that logographic readers find most useful in learning to read words. Children were taught to read two kinds of word spellings: those with visually distinctive letters lacking any relation to sounds (yMp for turtle, for example), and those spelled semiphonetically (JRF for giraffe). Logographic readers learned to read the visually distinctive spellings more readily than the phonetic spellings, indicating use of salient visual cues. In contrast, more mature novices learned to read the phonetic spellings more easily, indicating use of alphabetic cues. Logographic readers had more trouble learning to read all six words than did alphabetic readers, indicating that strictly visual associations are less powerful mnemonicly than letter-sound associations. Poor performance on a spelling memory task confirmed that logographic readers were not processing letter cues in words.

In other environmental print studies (Goodman & Altwerger, 1981; Harste, Burke, & Woodward, 1982), logographic readers were observed to produce variable rather than exact wordings—for example, reading CREST as brush teeth or toothpaste, and DYNAMINTS as fresh-a-mints. This lack of correspondence at the phonological level but equivalence at the semantic level indicates that the associations formed in lexical memory are between salient visual cues and meanings of words. This contrasts with later phases of word reading where the involvement of letter-sound associations restricts the word accessed in memory to a single pronunciation linked to the word’s spelling.

Byrne (1992) examined what it takes to get logographic readers to become analytic about the letter-sound structure of words. He taught preliterate preschoolers to read two words in which only initial letters distinguished the two words (fat and bat, for example). Then he showed the children new words with the same initial letters (fun, bun, fig, big, fell, bell) and asked them about the new symbols (is this fun or bun?). Children’s performance was no better than chance, indicating that they had not spontaneously deduced the relationship between letters and initial sounds during learning. Byrne found that the following procedures also did no good: teaching children letter-sound associations
along with the words, teaching four words rather than two, using geometric shapes rather than letters, making the initial sound easier to distinguish, or varying the stem and holding the initial sound constant. He found that in all cases logographic readers remained unanalytic on the forced-choice transfer task. When the units symbolized in print were changed from phonemes to words (clean chair, dirty chair), however, children were successful in processing the first symbol to distinguish between transfer items (clean plate, dirty plate), indicating that they could be analytic with meaningful units.

Byrne and Fielding-Barnsley (1989, 1990, 1991) discovered what it took to get logographic readers to deduce and transfer alphabetic information from training to transfer words: they had to be taught to perceive shared sounds in the pronunciations of words, to segment initial sounds in words, and to recognize how letters symbolized initial sounds. The three skills had to be acquired in combination to effect transfer. Byrne (1992) suggests that children possess a natural tendency to build associations between print and speech at the level of words but not at the level of phonemes. When exposed to orthography, they adopt a “default acquisition procedure” and read words logographically (nonanalytically). Experiences such as instruction in phonemic awareness, reading, and spelling are required to shift their processing to the alphabetic-phonemic level of language.

Although logographic readers lack much ability to read words by processing print cues out of context, emergent literacy researchers have shown that they may possess substantial knowledge about reading (Mason & Allen, 1986; Teale & Sulzby, 1986). If their parents have read to them, they are often able to pretend-read books they have heard many times. Sulzby (1985) proposes a tree-structure classification scheme to describe the development of emergent story reading. She uses several distinctions to assess children’s developmental level: whether pictures or print govern their reading attempts; whether a story is formed; whether their verbalizations sound like oral or written language; whether they watch the print as they read, and if print is watched, how it is used. Much of Sulzby’s scheme distinguishes levels of development within the logographic phase. The shift to alphabetic reading begins when children cease attending primarily to pictures and begin attempting to read the print. Several behaviors signal this shift: children refuse to read because they are aware that people read print rather than pictures and they know they cannot do this; they forget about reciting the story and merely pick out a few known words or letters to read; they struggle to read the story but omit unknown words, sound out words, or substitute familiar sight words excessively. Sulzby’s findings indicate that logographic readers may know a lot about reading print even though they cannot read print independently.
When readers begin to read words by processing letter-sound relations, they move into the **alphabetic phase**. However, researchers disagree about when the logographic phase ends and the alphabetic phase begins. Is the shift marked by acquisition of phonological recoding skill (Frith, 1985; Gough & Hillinger, 1980; Seymour & Elder, 1986) or by more rudimentary letter-sound processes (Ehri, 1987, 1989a; Ehri & Wilce, 1985, 1987a, 1987b; Stuart & Coltheart, 1988)? One reason for the disagreement is uncertainty about how to interpret beginners’ use of initial or boundary letters to read words by sight. Are they processing these letters as nonphonemic logographic cues or as alphabetic cues linked to sounds?

Some suggestive correlational data is provided by Huba (1984). Because the novice readers (kindergartners) in her study knew some letter-sound relations but could not phonologically recode nonwords, she expected that they would learn to read sight words logographically and be little influenced by phonemic-awareness skill. However, she found significant correlations between the two tasks, suggesting that phonological processes were involved in sight-word learning.

In her longitudinal study, Mason (1980) observed novices who were non-decoders but who were more advanced than the logographic readers described previously. They could read a few “book” words out of context, such as *dog*, *go*, *out*, and *the* and had mastered letter names and could print letters. They learned to read several words and remembered them 15 minutes later. They often correctly preserved the beginning consonant in words they misread (*key* for *kit*, *me* for *man*, *cat* for *cut*); they spelled words by analyzing sounds and picking relevant letters. These children were like logographic readers in being non-decoders, but they were more advanced in that they used letter-sound relations to process print.

A rudimentary form of alphabetic reading, **phonetic cue reading**, that contrasts with logographic or visual cue reading explains how novice beginners (non-decoders) can use alphabetic cues to read words by sight (Ehri, 1987, 1989a, 1992; Ehri & Wilce, 1985, 1987a, 1987b). To perform phonetic cue reading, beginners must know letter names or sounds and have some phonetic-segmentation skill—enough to detect some constituent sounds within pronunciations. Phonetic cue reading involves forming access routes out of partial letter-sound correspondences. Only some of the letters seen in spellings are connected to sounds detected in pronunciations. Perhaps only the initial letter or the initial and final letters form the access routes. The letters are linked to various types of phonetic units in pronunciations—sounds such as /d/ in *dog*, or letter names such as “bee” in *beak* or “jay” and “el” in *jail*. To illustrate, the first few times phonetic cue readers see and hear the word *milk*, they recognize how the initial and final letters correspond to /m/ and /k/ in the pronunciation. This creates an access route into
lexical memory that enables them to retrieve the pronunciation when they see the spelling again.

In contrast to arbitrary logographic access routes, rudimentary alphabetic access routes are systematically related to the pronunciations of words. For example, logographic readers might remember how to read *yellow* by forming a link between the two sticks in the middle and the word’s pronunciation or meaning (Seymour & Elder, 1986). In contrast, phonetic cue readers might see the two *l*’s in *yellow*, hear the name “el” in the pronunciation, and use this information to connect the spelling to the word’s pronunciation in memory. Research on paired-associate learning has shown that having a systematic mnemonic makes learning much easier.

Ehri and Wilce (1985) found that as soon as children master letters and are able to read a few words in isolation, they can use letter-sound relations to read sight words. In the JRF versus *yMp* study cited previously, novices differed from logographic readers in learning to read partial phonetic spellings more readily than visually distinctive, nonphonetic spellings. Ehri and Wilce suggest that novices use the same kinds of cues to read words in their sight vocabularies. Scott and Ehri (1990) showed that even prereaders can do phonetic cue reading if they know constituent letters and attend to them during learning.

Two of the best predictors of reading achievement after 1 year of instruction are letter knowledge and phonemic-segmentation skill measured prior to entering school (Share et al., 1984). The importance of these capabilities for word reading was found by Byrne (1992) in the fat-bat study reported previously. In a longitudinal study of first-year readers who were not receiving phonics instruction, Stuart and Coltheart (1988) analyzed students’ word-reading errors over the year and found that when students achieved phonemic-segmentation skill and letter-sound knowledge, their use of nonphonetic logographic information to read words declined and their use of phonetic information became prominent.

Ehri and Wilce (1987a, 1987b) explored phonetic cue reading experimentally. Novices who could not decode were taught either to spell words phonetically (the experimental group) or to associate isolated sounds with letters (the control group). Afterwards, in a reading task consisting of 12 similarly spelled words not studied during training, spelling-trained subjects learned to read more words than did controls. Responses indicated that subjects used partial letter-sound cues rather than nonphonetic visual cues or a decoding strategy to read the words, with spelling-trained subjects being better at phonetic cue reading than controls. Misreadings contained sounds corresponding to some letters in spellings, more so among experimentalists than controls. Words sharing more letters with other words on the list were harder to learn than words sharing fewer letters. This indicates that letter cues in words were influencing word learning. The relationship was much stronger among spelling-trained subjects than among controls, indicating heavier reliance on letter cues by experimentalists. Subjects
read words inconsistently over trials because they were using the same letter cues to read several words and got them mixed up. This illustrates one of the drawbacks of phonetic cue reading: partial cues are not completely reliable for signaling one word and excluding all others. Neither group was able to read words by phonological recoding, which is not surprising since spelling training does not teach blending but only phonemic segmentation.

The words differed in meaningfulness (for example, snake is more meaningful than soles). Meaningfulness ratings correlated significantly with the ease of learning to read the words among control subjects but not among experimentals. This, together with findings that experimentals relied on letter cues, indicates that as readers become better at phonetic cue reading, they make greater use of letter-sound associations to read words by sight and make less use of semantic associations. This is not to say that word meanings are not processed by better readers but only that meanings do not provide the access routes linking spellings to words in memory. This is not surprising since letter-sound routes provide more systematic, easily remembered links to words in memory than do semantic routes.

In a second study, Ehri and Wilce (1987b) compared the word learning of phonetic cue readers to that of readers who could phonologically recode words. The two kinds of readers were created through training either in letter-sound associations or in phonological recoding. On the transfer task, decoders learned to read 15 similarly spelled words almost perfectly, whereas cue readers had much more difficulty. Cue readers read words more inconsistently over trials, forgetting or mixing up the words. Use of partial letter-sound cues rather than non-phonetic visual cues was evident among cue readers. Most of their misreadings contained some of the letter sounds appearing in print. For example, LAP was misread as lamp, STAB as stamp. In recalling spellings of the words they practiced reading, decoders were more accurate than cue readers. Cue readers’ memory for medial letters was weak, but they did remember most initial and final consonants, indicating that boundary letters may have been the phonetic cues they used to remember how to read the words.

Seymour and Elder’s (1986) longitudinal study of first-year readers is commonly cited as evidence for logographic reading, but phonetic cue reading may better explain the results. Seymour and Elder inferred that students were reading words logographically because the reading program did not teach letter-sound relations or phonological recoding and because most students did not attempt to sound out and blend unfamiliar words. However, students did receive spelling instruction that introduced letter-sound associations early in the year, so they were not unfamiliar with phonics concepts. Students began school as nonreaders. On isolated word-reading tests given during the year, they read many words they had been taught but very few words not taught, indicating acquisition of a sight vocabulary but no decoding skill. The words produced when students misread
were from their sight vocabularies rather than untaught words or nonsense words, indicating use of lexical retrieval rather than phonological recoding. Misreadings usually were words that were similar in length to the printed words and that shared salient letters, indicating use of partial letter and length cues to remember sight words. Longer words were not read more slowly than shorter words, indicating that readers were not analyzing letters serially but were processing cues in parallel. Subjects were able to read visually distorted words correctly, indicating that letters rather than word-shape cues were critical. This contrasts with logographic reading where letters in words are not well remembered. Although semantic misreadings occurred (misreading room as house, for example), these were infrequent, indicating that access routes into memory were not primarily semantic. On a spelling task consisting of unfamiliar nonwords given three-quarters into the school year, most children spelled one or more sounds correctly, indicating sensitivity to phoneme-grapheme relations.

Seymour and Elder (1986) conclude that their beginners learned to read 100 or so sight words logographically by a process of feature discrimination involving length, shape of salient letters, and salient feature position. However, the above analysis suggests that the readers bore a greater resemblance to novice alphabetic readers than to logographic readers. It may be that students combined phonetic cues with logographic cues such as word length. Arbitrary cues might be easier to store in memory when scaffolded on systematic letter-sound cues that provide the access route into memory. This possibility awaits study.

What factors influence the selection of partial cues when novice alphabetic readers learn to read words? According to Gough and Hillinger (1980), readers select the minimum cues needed to distinguish among words in the set they are learning. The more similar the words, the more cues they need to remember and the longer it takes to learn to read the words. Several studies show that children take longer to learn to read similarly spelled words (pots, post, spot, stop) than dissimilar words (play, fire, bugs, honk). On transfer tasks those who learned similar words mistook fewer new words for old words than those who learned dissimilar words. The explanation is that learning similar words requires attention to more letter cues, better preparing learners to distinguish new words from old (Gilbert, Spring, & Sassenrath, 1977; McCutcheon & McDowell, 1969; Otto & Pizillo, 1970; Samuels & Jeffrey, 1966; Spring, Gilbert, & Sassenrath, 1979). One problem in these studies was that the subjects learning to read dissimilar words took fewer trials to reach criterion. Spring, Gilbert, and Sassenrath found that equating the number of learning trials for dissimilar and similar groups eliminated differences on the transfer task, indicating that the amount of practice was more important than word similarity. One explanation is that practice facilitates phonetic cue reading. Visual-phonetic connections into lexical memory may be formed spontaneously rather than selectively. The more times learners
reread words, the more connections they may detect and retain in memory. This may happen regardless of how similar or dissimilar the spellings of words are.

Wimmer and Hummer (1990) challenged the necessity of logographic and novice alphabetic phases in learning to read. They examined word reading in German-speaking students who had received 4 months of reading instruction. Because German spellings are more phonetically regular than English spellings and because German students are taught systematically from the outset how to phonologically recode words, beginning readers were not expected to exhibit signs of logographic or phonetic cue reading. On a reading test with pseudowords patterned after known real words, even the weakest readers decoded most of the nonwords correctly. Misreadings were mainly nonwords with the same first letter. Only a few misreadings involved substituting similarly spelled real words for nonwords, indicating use of logographic or phonetic cues (Auto for Aufo, for example). Results appear to suggest that beginning German readers bypass the logographic and novice alphabetic phases. However, if students had been tested before receiving instruction, these phases might have been detected. The rapid movement into mature alphabetic reading evidenced here may have resulted from highly effective phonics instruction applied to a more regular orthography (Feitelson, 1988). Perhaps even in English phonetic cue reading might be minimized by teaching decoding systematically at the beginning of instruction.

**Alphabetic Phase**

Although there is disagreement about when the alphabetic phase begins, it is definitely underway when readers can phonologically recode written words into pronunciations. Gough and Hillinger (1980) call this cipher reading, which requires mastery of the system of rules (known implicitly) by which letters and letter sequences map onto phonological forms. One advantage of phonological recoding over logographic reading and phonetic cue reading is that readers have a means of reading unfamiliar words accurately. Another advantage is that readers are enabled to learn to read sight words with greatly increased reliability.

**Phonological Recoding.** Tunmer, Herriman, and Nesdale (1988) studied the emergence of phonological-recoding skill longitudinally from prereading to 2nd grade reading. Results suggested that Piagetian concrete operativity influenced children’s acquisition of low-level phonemic and syntactic awareness skills, which in turn helped children discover grapheme-phoneme correspondences and cryptanalytic intent—that print maps onto specific structural features of spoken language. Some minimal level of phonological awareness was necessary for children to use their letter-name knowledge to acquire phonological recoding skill.

Marsh et al. (1981b) distinguish two types of decoding skill: sequential decoding, followed developmentally by hierarchical decoding. Whereas
sequential decoders apply one-to-one correspondence rules, hierarchical decoders use conditional rules in which one letter marks the phoneme symbolized by another letter. For example, the final e in college and peace marks the preceding g and c as /j/ and /s/, respectively; i in city and e in cell mark the c as /s/; final e in make marks the a as long. Venezky (1970) describes the morphophonemic rule system thought to be used for both types of decoding.

Venezky and Johnson (1973) studied 1st, 2nd, and 3rd graders’ knowledge of sequential and conditional rules in a nonsense word decoding task. By the end of 1st grade, most sequential rules were known—for example, pronouncing c as /k/. Hierarchical rules emerged later. By the end of 3rd grade, final e was known to mark long vowels. By the end of 2nd grade, final -ce was pronounced as /s/. However, even in 3rd grade, initial c was rarely pronounced as /s/ (as in cipe), possibly because few words in beginning level texts exhibit this pattern.

Results of a study with 1st and 2nd graders (Taylor & Ehri, 1984) indicate that when long-vowel decoding rules are being acquired, they may temporarily disrupt short-vowel decoding while application of the various rules is sorted out. In a nonword reading task, readers who knew short- but not long-vowel rules (the least advanced readers) overgeneralized short-vowel rules to long-vowel forms—for example, misreading rife as /ɾɪf/ or /ɾɪ-ɾɛf/. Moderately advanced readers who were learning long vowels sometimes overgeneralized long-vowel pronunciations to short-vowel spellings. In fact, this tendency depressed their short-vowel reading accuracy below that of less and more advanced readers. Mason (1976) also observed long-vowel overgeneralization errors in beginners. The phenomenon of overgeneralization is especially interesting because errors replace correct performance yet they are a good sign indicating that new structural knowledge is emerging.

Monaghan (1983) identified several stages in the emergence of recoding skill in 1st graders trained in a synthetic phonics program. In reading nonwords, the least mature readers could sound out, but were unable to blend sounds into words. At the next stage, children could quite slowly sound out and blend. The slowest decoders sounded out and blended overtly, whereas faster decoders were soundless and moved their lips rapidly before pronouncing words aloud. At the next stage, students read more rapidly and pronounced words as units without sounding out aloud or subvocally. These observations suggest that during development, phonological recoding progresses from a slow, overt process to a covert process that is executed rapidly and automatically.

Jeffrey and Samuels (1967) and Carnine (1977) showed that beginners who can phonologically recode print have a big advantage in reading unfamiliar words. In Carnine’s study, prereading preschoolers received either phonics training or whole-word training. The phonics group learned 8 letter-sound correspondences, then was taught to sound out and blend 18 CVC words, and then practiced reading the 18 words to criterion. The whole-word group was simply
taught to read the 18 words to criterion. On a transfer task with new regularly spelled words, phonics subjects read 92 percent of the words correctly, whereas word-practice subjects read only 28 percent. These results verify the advantage of decoding skill and show that readers do not pick up decoding skill simply by learning to read words exhibiting systematic letter-sound relations—at least not in a short-term experiment.

Fox and Routh (1984) assessed the contribution of three components of decoding to transfer. One control group received letter-sound training. Another control group received letter-sound training plus phonemic-segmentation training. The experimental group was taught all of this as well as blending. On the transfer task only the experimental group learned to read the words to criterion. Controls did not learn the list even after 40 trials. In two other studies, Yopp (1985) and Fox and Routh (1976) found that blending instruction did not benefit reading unfamiliar words if the readers were not also strong at phonemic segmentation. These results indicate that acquisition of phonological recoding skill entails learning to blend as well as learning letter-sound relations and phonemic segmentation.

The kinds of oral word reading errors that phonics-instructed 1st graders produce as they read text have been observed to change over the year, reflecting the acquisition of phonological recoding skill. Cohen (1975) found that no-response errors were common at first. Children halted on a word because they were unable to recode it and unable to guess a word with those letters. Subsequently nonword errors and word substitutions became as frequent as no-response errors. Nonwords resulted when recoding failed to yield recognizable words. By midyear, at least half of the nonwords and word substitutions resembled the printed words closely, sharing at least half of their letters, showing that subjects were attempting to recode the letters. Among the good readers, no-response errors peaked in November and then declined. Nonword errors peaked in January and then declined. Word substitutions continued to rise gradually throughout the year, with a high proportion sharing at least half of the letters with the words in print.

Barr (1972) compared the word-reading errors of two groups of beginners. Students who received whole-word training produced mainly word substitutions from the same list being learned, whereas phonics-trained readers produced previously taught words, untaught words, and nonwords. Others have reported similar findings (Biemiller, 1970; Delawter, 1970; Elder, 1971). Because the readings of decoders are not constrained by previously learned words, their responses bear a greater resemblance to the letters in print, even though responses may be nonwords. However, nonwords are temporary and decline as readers’ decoding skill improves (Cohen, 1975).

Although phonics instruction promotes acquisition of phonological recoding skill, phonics rules “bear only a superficial resemblance to the rules which the
fluent reader has internalized” (Gough & Hillinger, 1980, p. 187). Rules of phonics are taught as conscious, explicit statements, whereas the rules that readers use are unconscious and implicit. To illustrate, many readers can decode *cibe* and *cabe* correctly as /siːb/ and /kaːb/, respectively, but cannot state the rules. The important capability for recoding is pronouncing unfamiliar spellings correctly, not vocalizing rules (Beck, 1981). One problem with rules is that they are partly inaccurate (Adams, 1990). For example, children may be taught that “P” stands for *puh* whereas it really stands for the phoneme /p/ that cannot be vocalized accurately by itself. Another problem is that many rules have only limited utility (Clymer, 1963). For example, the rule “When two vowels go walking, the first does the talking” accounts for only 45 percent of relevant spellings. One further problem is that decoding is executed much too rapidly to be mediated by the application of letter-sound rules.

Gough and Hillinger (1980) suggest that the alphabetic knowledge taught in phonics programs is not the same as that used by skilled decoders. A disparity between operations taught to learners and operations used by experts, however, is not unique to reading instruction and may, in fact, be important. In discussing the acquisition of mathematical competence, Resnick (1980) distinguishes between ways novices organize information for learning and ways experts do. Glaser (1984) proposes the value of temporary models of knowledge structures created by teachers (he calls these *pedagogical theories*). These models resemble but differ from the knowledge structures actually acquired by learners and are taught in order to provoke learners to restructure and further develop their own knowledge. It may be advantageous and perhaps even essential for learners to deviate from expert performance during the course of acquiring knowledge in order to attain expertise. The use of artificial devices that get processes underway but are abandoned as those processes develop may portray what happens in learning to sound out and blend. Although learners are told that *puh* is the sound made by the letter “P,” as soon as they practice blending, they figure out that it is not the syllable *puh* but rather the phoneme /p/ that is critical. Learning that *uh* is irrelevant is made easier by its recurrence in other letter-sounds.

One reason that implicit analytic phonics is less effective for teaching decoding skill than is explicit synthetic phonics (Johnson & Baumann, 1984) may be that implanting decoding processes in students is harder without an artificial teaching device. In fact, Durkin (1984) observed that teachers using implicit phonics programs often deviated from their manuals and produced isolated sounds for students because they believed this was necessary to help students hear the separate sounds in words. Studies examining beginning readers’ phonemic-segmentation skill verify that dividing words into constituent sounds is difficult and that teaching students to do this helps them learn to read (Ball & Blachman, 1991; Bradley & Bryant, 1985; Cunningham, 1990; Ehri, 1979; Juel, Griffith, & Gough, 1986; Lie, 1991; Lundberg, Frost, & Petersen, 1988; Perfetti
et al., 1987; Stanovich, 1988; Treiman & Baron, 1983; Wagner & Torgesen, 1987; Williams, 1980). Thus, there appears to be little harm and much value in explicit phonics instruction (Anderson et al., 1985).

Gough and Hillinger (1980) and Marsh et al. (1981b) draw a distinction between the strategies used by beginners to read words (by sight, by decoding) and the method of instruction they receive (whole word versus phonics). Barr (1975) studied whether instructional method determines strategy use. In a word-reading task, use of a sight-word strategy was indicated by word substitutions drawn from students’ reading vocabularies. Use of a decoding strategy was indicated by word substitutions coming from outside students’ reading vocabularies and nonword errors. Barr found that midway through the year many phonics students (63 percent) exhibited a decoding strategy while the remainder used a sight-word strategy. By the end of the year, most had shifted to a decoding strategy. In contrast, most whole-word students stuck to a sight-word strategy throughout the year. These results indicate that instructional method influences the use of decoding but not sight-word reading, which emerges earlier in readers regardless of method and is easier than reading words by decoding, even for phonics-instructed students.

One limitation of Barr’s (1972) study is that children were not observed beyond 1st grade. Whole-word students may not acquire sufficient knowledge of the spelling system to develop a decoding strategy until after they have acquired an extensive sight vocabulary. Thompson (1986) observed phonological recoding skill in students who had received at least 12 months of whole-word instruction. He analyzed their word reading errors: 13 percent were nonwords, indicating use of a decoding strategy; 34 percent were real-word substitutions. Nonword errors were highly correlated with word reading success ($r = .63$) while lexical substitutions were negatively correlated ($r = -.12$), indicating that better readers were the ones producing the nonwords and hence learning to decode. Nonwords were mainly recoding flaws (/be¯-lı ¯f/ for belief, /tı ˘n-je ¯/ for tongue). Recoding skill in whole-word students may result from implicit learning of letter-sound relations and blending, or it may be facilitated by spelling instruction.

Another limitation of Barr’s study is that use of a sight-word reading strategy was inferred when students produced real-word substitutions drawn from their reading vocabularies. These criteria may not be appropriate for assessing sight-word reading in phonics-trained readers. Skilled decoders make very few errors when they read words by sight. Moreover, it becomes difficult to keep track of their “reading vocabularies” because of rapid growth (Reitsma, 1983).

The possibility that phonics instruction in the form of spelling might benefit word-reading skill has been studied. Ehri and Wilce (1987a) found that beginners who were taught to generate phonetic spellings learned to read a set of similarly spelled words more easily than beginners who were taught letter-sound correspondences. Spelling appeared to benefit word reading by strengthening
phonetic cue reading. Uhry (1989) provided beginners with spelling instruction that supplemented classroom reading instruction over a longer period and observed benefits to phonological recoding. Other studies also have shown that early spelling benefits reading (Ball & Blachman, 1991; Bradley & Bryant, 1985; Clarke, 1988; Cunningham, 1990; Ellis & Cataldo, 1990). In a longitudinal study, Foorman et al. (1991) found that beginning readers who received their letter-sound training mainly from spelling instruction and their reading instruction from a meaning-emphasis program made progress in learning to read and spell words during 1st grade, but their progress was not as great as that of students who received more explicit letter-sound training as part of their reading instruction. Supporters of whole language instruction argue that students acquire working knowledge of the alphabetic system from the writing practice they receive. However, this instruction is usually neither principled nor systematic. More research is needed to explore this claim.

The development of decoding skill in English is influenced not only by instruction but also by the words that beginners practice reading as a result of the variability and irregularity of English spellings. Surber and Mason (1977) drilled preschoolers for 4 days on the “silent E” rule. Then subjects practiced reading either words that conformed to the rule or words that did not (for example, was, large). On a transfer task a week later, rule-conforming subjects were the only ones who applied the rule in reading nonwords. Thus, for rules to become operational, beginners must practice reading words that conform to the rules. Juel and Roper/Schneider (1985) report similar findings in a classroom study.

**Sight-Word Reading.** Studies of beginning readers reveal that phonological-recoding skill is a key ingredient for learning to read words. However, studies of mature readers show that they do not read most words by phonological recoding (Gough, 1984). Why is phonological recoding thought to be so necessary for mature reading? Jorm and Share (1983) suggest one possibility—that phonological recoding equips learners with a self-teaching mechanism so they can read unfamiliar words on their own, thereby insuring many “positive learning trials” that establish the words as sight words in memory. Ehri (1980, 1987, 1992) suggests another possibility—that phonological recoding provides the mnemonic equipment for storing sight words in memory.

There is disagreement about how sight words are stored in memory. According to the traditional dual-route view, sight words are learned by creating access routes between visual forms of words and their meanings, much like logographic word learning in readers of Chinese. The access routes are arbitrary, nonphonological, and learned by rote (Baron, 1977, 1979; Coltheart et al., 1977; Frith, 1980). Phonological recoding is not involved. Poor decoders are believed to form the same kind of access routes as good decoders. Poor decoders’ only
handicap is that they must depend on external aids for identifying new words: someone to tell them the words or an informative context to enable accurate guessing (Barron, 1986; Share, 1992).

The evidence does not support this view. Dual-route theorists reasoned that because irregular spellings such as “island” cannot be decoded accurately, these words must be read logographically by sight. Aiming to support this claim, Baron (1977) and Treiman (1984) showed that correlations between reading irregularly spelled words (presumed to be read logographically) and reading nonsense words (a measure of recoding skill) were significantly lower than correlations between reading nonsense words and reading regularly spelled words (both presumed to be decoded). This was interpreted as support for the distinction between the two routes. However, although the correlations between irregular word reading and nonsense word reading were lower, they were far above zero ($r = .55$ in Treiman; $r = .71$ in Freebody & Byrne, 1988; $r = .56$ in Gough & Walsh, 1991), indicating that the two word-reading processes are far from being independent. Although irregular words cannot be decoded accurately, most of their letters correspond to sounds in pronunciations (all but the $w$ in sword, all but the $s$ in island). Thus, it is strongly possible that phonological recoding plays a central role in reading irregular words by sight.

There is further evidence against the idea that sight words are read logographically without any phonology by skilled readers. Children who cannot phonologically recode do not become skilled readers (Gough & Tunmer, 1986). Dyslexics are uniformly deficient in phonological-recoding skill (Firth, 1972; Vellutino, 1979) and also in spelling skill, which requires phonological knowledge (Ehri, 1986, 1989b). Phonological awareness and letter knowledge are the strongest predictors of beginning reading achievement ($r = .58$ to .68), stronger even than intelligence ($r = .39$ to .41) (Share et al., 1984). This suggests that phonological recoding skill is essential for reading words by sight.

An alternative conception of sight-word learning, referred to as amalgamation theory, makes phonological-recoding skill essential (Ehri, 1980, 1984, 1987, 1992). According to this view, when mature alphabetic readers practice reading specific words by phonologically recoding the words, they form access routes for those words into memory. Readers build these access routes by using their knowledge of grapheme-phoneme correspondences to amalgamate letters in spellings to phonemes in pronunciations of the words. The letters are processed as visual symbols for the phonemes and the sequence of letters is retained in memory as an alphabetic, phonological representation of the word. Perfetti (1992) conceptualizes the amalgamation process similarly in his lexical theory when he proposes that “a fully specified orthographic representation [is] ‘bonded’ to the phonemic representation”—much as in chemical bonding.

Reading words by sight in this way is different from phonologically recoding the words because once a word-specific access route is established in
memory, phonological rules are no longer applied to convert the word to a pronunciation before accessing its meaning. The middle steps drop out. Seeing the spelling activates connections that lead directly to the pronunciation of that word in memory, where its meaning is found.

Studies reveal that this alphabetic way of reading words by sight differs from phonologically recoding words. Reitsma (1983) and Ehri and Saltmarsh (1992) found that beginning readers were able to read words they had practiced faster than phonologically equivalent words they had not seen before, despite the two sets being phonologically identical (kradl versus cradl, for example). Reitsma found that only a few practice trials—four in one experiment—with the spellings were necessary to make a difference.

Ehri and Wilce (1983) examined 1st, 2nd, and 4th graders’ speed in reading familiar primer-level words, unfamiliar CVC nonwords, and single digits. They reasoned that if familiar words are read by sight rather than by recoding, words should be read faster than equally decodable nonwords. If familiar words are read as single holistic units, they should be read as fast as single digits. Amalgamation or unitization is thought to occur when spellings of sight words are fully connected phonemically to pronunciations in memory. Results revealed that familiar words were read much faster than nonwords, indicating use of the sight route. Skilled readers read the words as fast as digits, indicating unitization. Poor readers with weak decoding skill did not exhibit unitization, suggesting the involvement of decoding in skilled sight-word reading.

Ehri (1980) showed that when beginners read words, they store the spellings they see in memory. Second graders read several nonwords in one of two forms—for example, either bistion or bischun, both pronounced identically—and then they wrote the words from memory. Every subject who saw bistion and misspelled it included st but never ch in her misspelling, whereas every subject who saw bischun and misspelled it included ch but never st. The fact that subjects remembered particular letters rather than phonologically equivalent letters indicates that they were not simply recoding the words when they read them but were storing letter-sound connections in memory.

Another type of evidence that phonological recoding enables readers to store sight words in memory comes from studies showing that acquisition of sight words influences readers’ conception of phonemes in the words when the phonemes are ambiguous (Ehri, 1984, 1985, 1987; Ehri & Wilce, 1980, 1986; Ehri, Wilce, & Taylor, 1987). For example, letters in the spelling of pitch identify four sounds, /p/-/ı/-/t/-/ch/, each of which can be found in the word’s pronunciation, whereas letters in the spelling of rich distinguish only three sounds, /r/-/ı/-/ch/, with no /t/. Spellings taught as sight words were found to influence how children segmented the words into sounds when no spellings were present (Ehri & Wilce, 1980). Subjects were not simply marking remembered letters rather than sounds (Tunmer & Nesdale, 1982) since subjects pronounced each
sound segment as they marked it and did not create separate segments for silent letters and digraphs.

What capabilities and experiences account for individual differences in sight-word reading skill? According to the above view, phonological-recoding skill should explain a large portion of the variance because it enables readers to form visual-phonological access routes in lexical memory and also helps them learn new words by themselves. In addition, because English spellings of words are variable and not fully determined by the system (/rɪt/ might be write or right or rite), readers must be exposed to words to acquire information about specific spellings.

Stanovich and West (1989) and Cunningham and Stanovich (1990) examined whether three capabilities accounted for unique variance in the word reading ability of 3rd and 4th graders and adults: (1) phonological recoding of nonwords, (2) orthographic memory for specific word spellings (which is correct—rume or room?), and (3) familiarity with the titles or authors of books, yielding an index of readers’ exposure to print. They found that all three capabilities accounted for separate aspects of word reading. Moreover, they found that unique variance in orthographic memory for specific words was explained by phonological recoding, print exposure, and another measure of orthographic memory. These results support the idea that sight-word reading involves using phonological recoding skill to store specific forms of words in memory through exposure to those words in text.

**Orthographic Phase**

At the orthographic phase, readers have use of grapheme-phoneme correspondences and orthographic knowledge to read words. This phase replaces the alphabetic phase as readers consolidate grapheme-phoneme patterns that recur across words they have learned to read. Consolidation allows readers to operate with multiletter units symbolizing blends of phonemes that may be morphemes, syllables, or subsyllabic units. Orthographic knowledge may accumulate as readers phonologically recode different words with the same patterns, as their phonological recoding of letter sequences becomes automatic, as they store similarly spelled sight words in memory, and perhaps as they learn to spell words with recurring patterns. Letter patterns may become part of readers’ generalized knowledge of the spelling system or work their influence through the activation and synthesis of specific word spellings stored in the lexicon (Glushko, 1979). Share (1992) refers to the “progressive lexicalization” of phonological recoding as reading skill develops. Larger letter units for word reading are valuable because (1) they facilitate the decoding of unfamiliar words, particularly multisyllabic words with too many letters to sound out and blend easily; (2) they reduce the memory load involved in storing sight words in memory; and (3) they speed
up the process of accessing words by facilitating letter identification (Juel, 1983; Venezky & Massaro, 1979).

Various kinds of spelling patterns may be detected by readers. Becker, Dixon, and Anderson-Inman (1980) analyzed 26,000 high-frequency English words into root words and morphographs, defined as irreducible units of meaning in written English. They detected 8100 different root words and 800 different morphographs (-ed, -ing, -ible, -ate, -ment, for example) that occurred in at least 10 different words. Nagy et al. (1989) showed that morphological relations between words are represented in the lexicon.

Glushko (1979, 1981) proposed the concept of orthographic neighborhoods to depict sets of words that share beginning or ending letter sequences. Words in the same neighborhood may symbolize consistent pronunciations (made/wade) or inconsistent pronunciations (steak/creak). He found that consistent words were read faster than inconsistent words even when both contained regular grapheme-phoneme correspondences.

Treiman, Goswami, and Bruck (1990) had subjects read two types of nonwords containing the same grapheme-phoneme correspondences. Some nonwords, like tain and goach, shared their VC (rime) units with several real words, while others, like goan and taich, shared their VC units with few or no real words. Nonwords with common spelling patterns were read more accurately than nonwords without such patterns. Partial correlations revealed that grapheme-phoneme knowledge and VC spelling pattern frequencies predicted nonword reading, but frequency of CV letter units did not. These findings show that both alphabetic and orthographic knowledge make separate contributions to nonword reading skill and that spelling patterns that symbolize rime units in speech are more likely to become functional orthographic units, perhaps because the onset-rime division of syllables is more natural (Treiman, 1985, 1986).

English word spellings have been analyzed to determine letter position frequencies and co-occurrence patterns. In a study with adults, Massaro et al. (1979, 1980, 1981) examined the psychological reality of two kinds of orthographic structure: statistical redundancy, which takes account of the frequency of occurrence of letters and letter sequences within words in written text, and rule-governed regularity, which takes account of phonological constraints in English and scribal conventions for sequencing letters in words. Adults performed forced-choice and rating tasks on nonsense words (rodipe, dripoe, prdioe, dperio, for example) to judge which letter sequences bore greater resemblance to English words. Subjects revealed more sensitivity to rule-governed regularity than to statistical redundancy, supporting the idea that knowledge of orthographic structure emerges from competence in alphabetic-phase reading.

Several studies have shown that readers are able to detect orthographic structure in nonwords after 1 year of reading instruction (Allington, 1978; Leslie & Thimke, 1986; Massaro & Hestand, 1983). In Golinkoff’s study (in Gibson
end-of-the-year 1st graders performed at chance level whereas 2nd graders performed significantly better than chance in deciding whether legal or illegal nonwords (such as nar versus rna) bore a greater resemblance to real words. Orthographic judgments were found to be more highly correlated with reading ability than with grade level, suggesting that orthographic patterns are acquired as readers become more practiced at phonological recoding and as their lexicons of printed words grow larger.

One way to assess use of orthographic knowledge is to have readers search for target words through three types of lists: illegally spelled nonwords, legally spelled nonwords, and familiar sight words. Searching through illegal faster than legal nonwords indicates sensitivity to orthographic structure, because illegal nonwords are less similar to target words than legal nonwords. Searching through illegal and legal nonwords equally fast and faster than through familiar words indicates sensitivity only to the difference between unfamiliar and familiar words. Leslie and Thimke (1986) found that students reading at a 2nd grade level were sensitive to orthographic structure whereas 1st grade level readers were sensitive only to the familiar/unfamiliar word distinction. These findings and others (Juola et al., 1978; Leslie & Shannon, 1981) indicate that 2nd grade is when children build up sufficient experience reading words to recognize standard English spelling patterns.

Juel (1983) measured 2nd and 5th graders’ reaction times in reading target words that varied in frequency, decodability, and two types of orthographic regularity (frequency of two-letter patterns in running text versus across different words). She found that only the latter type of regularity involving different words proved important. It affected 5th graders’ reaction times but not 2nd graders’, who were influenced primarily by decodability. These findings indicate that orthographic structure facilitates word-reading speed sometime after 2nd grade. Findings also support the idea that readers derive their knowledge of orthographic regularity from their knowledge of different words—perhaps those stored in lexical memory—rather than from exposure rates to words.

It is interesting to note that letter overlap among words has the opposite effect on novice alphabetic readers, who have a harder time reading words that share letters with other words. This is because they use partial letter cues to read words, and these cues do not make similarly spelled words unique. In contrast, orthographic readers have an easier time reading words with similar patterns when the patterns are familiar.

In reading unfamiliar words, orthographic-phase readers are thought to divide letter strings into root words and affixes or syllables, convert these to pronunciations, and then blend them to derive a recognizable word. However, Johnson and Baumann (1984) found few studies showing that students trained in syllabification were able to read unfamiliar words better than control groups. The problem, they assert, is that in order to know how to apply traditional
syllabification rules, one needs to know how to pronounce the word, which is the goal of syllabification.

An approach studied by Henry (1988, 1989) appears to hold more promise. Henry taught upper grade elementary students the letter-sound correspondences, syllable patterns, and morpheme patterns for different origins of words—Anglo-Saxon, Romance, and Greek (Calfee & Drum, 1986)—and the technical vocabulary for discussing decoding concepts. She observed significant pre- to posttest gains on word reading as well as on spelling measures and superior performance compared to control subjects. Henry’s (1988) instructional program included many components, so it is not clear what made the difference. However, she attributes its success to the fact that students knew which regularities to apply to which words.

Reading Words by Analogy: Alphabetic or Orthographic Phase?

There is disagreement among researchers about the size of the units that beginning readers use when they first become able to read new words: do they use grapheme-phoneme correspondences, or do they process larger chunks? In other words, are beginners able to read new words by analogy to known words before or after they are able to read words by phonological recording? The advantage of larger chunks is that subsyllabic (onset-rime) units are easier for beginners to distinguish in speech than are phonemes (Liberman et al., 1974; Treiman, 1985). The difficulty comes in matching these phonological chunks with letters in the spellings of words and recombining units to form new words.

In their developmental theory, Marsh et al. (1981b) regard reading by analogy as more advanced than reading by sequential decoding. The shift from decoding to analogizing occurs as readers internalize and remember the visual alphabetic forms of words, learn to process hierarchical regularities spanning entire spellings, and learn recurring lexically based patterns that are not phonemically regular (could, should; night, sight). Employing a conflict test (is the non-word faugh decoded as faw or read as faff by analogy to laugh?), Marsh et al. observed less analogy reading in 2nd graders than in 5th graders. Other studies have reported similar findings (Manis et al., 1986; Zinna, Liberman & Shankweiler, 1986). However, Goswami (1986) criticized these studies for failing to use spelling patterns that were sufficiently familiar to the younger readers and for failing to verify that younger subjects could read the analogs. When Marsh et al. (1981a) did this, they found that younger readers were capable of reading words by analogy.

Goswami (1986, 1988, 1990) performed several experiments indicating that reading words by analogy develops earlier than reading words by sequential decoding. She presented beginning readers with a clue word (beak, for example) and had them read several analogs and nonanalogs (bean, beal, peak,
neak, lake, pake). Clue words were printed above test words and were pronounced before the child read each test word. Goswami found that 1st grade level readers read more analogs than control words correctly. Analogs sharing the same rime were correct more often than analogs sharing other parts, indicating the greater phonological cohesiveness of onsets and rimes (Treiman, 1985, 1986, 1992). Even nonreaders were observed to produce some rime analogies (Goswami, 1986, 1988). Children’s ability to detect rhyming words in a sequence of words was more strongly predictive of their analogical reading performance than were other phonological skills (Goswami, 1990; Goswami & Mead, 1992). This suggests that dividing words into onset and rime subunits is important for being able to read words by analogy (Goswami & Bryant, 1990, 1992).

Goswami (1986, 1988, 1990) ruled out alternative explanations for the superior reading of analogous words. Whether clue words and analogs contained letters printed in the same or different case made little difference to performance. Words were less apt to be read by analogy when the words rhymed but the spellings were different (such as most/toast) and when the spellings were the same but pronunciations differed (most/cost). These results indicate that letter identities rather than visual word configuration or sound similarities between words provide the basis for analogizing.

Goswami interprets her findings to show that analogizing appears very early—at the beginning of the alphabetic phase, before readers learn sequential decoding. However, a task analysis of what is required to read monosyllabic words by analogy raises doubt that analogizing is possible without some decoding skill. Reading by analogy requires not only that readers segment words into onsets and rimes but also that they match these spoken units to letters in their spellings. This requires knowledge of grapheme-phoneme correspondences, one component of decoding skill. Once readers recognize that the new word shares the same rime letters with the known word, they must be able to blend the onset letters of the new word with the rime letters of the known word to generate the new word’s pronunciation. Blending is another component of decoding skill.

In the developmental scheme adopted here, readers this advanced would be at the mature alphabetic phase, beyond phonetic cue reading. Phonetic cue readers should be unable to analyze letters fully enough in words to recognize analogous relations between spellings. If they encounter a new word spelled similarly to a known word (peak and beak, for instance), they might cue on the identical letters and mistake the new word for the known word.

Ehri and Robbins (1992) examined whether limited decoding skill was required to read words by analogy. They tested kindergartners’ and 1st graders’ reading skills, taught them to read a set of words, and then gave a transfer task. They found that only subjects with some decoding skill read any transfer words by analogy to training words. Nondecoders exhibited no analogizing but rather
misread transfer words as training words, indicating phonetic cue reading. Nondecoders had difficulty segmenting and blending onsets and rimes. For example, one nondecoder first read the transfer word save as its training analog cave and then modified it to scave. These results indicate that phonetic cue readers are too immature to read words by analogy. Analogizing requires that readers have some phonological-recoding skill to detect analogous relations between the spellings of known and new words and to blend onsets with rimes to read the new words.

In this study, the decoders included novices who read only a few nonwords. They were observed to read more words by analogy than by phonological recoding. One possible reason is that analogizing helped novices compensate for weak blending skills. Reading CVC words by analogy requires blending two units (an onset with a rime) whereas reading CVC words by decoding requires blending three units. Perhaps analogizing is a temporary strategy that is supplanted by phonemic recoding when blending is perfected. Laxon, Coltheart, and Keating (1988) found that better readers showed less reliance on reading words by analogy and more use of phonological recoding than less mature readers (see also Bruck & Treiman, 1992).

Effective instructional programs have been developed to teach students to read unfamiliar words by detecting known words and word parts. In studies by Cunningham (1976, 1979) and Gaskins et al. (1988), students with weak decoding skills benefited from learning how to use known key words to read new words. However, as indicated above, some decoding skill is very likely needed to succeed in such programs.

Regarding the disagreement over whether analogy reading emerges early during the alphabetic phase or later during the orthographic phase, it becomes evident that both are true. Reading unfamiliar words by analogy can happen in multiple ways: by analogy to a single known word, by analogy to several known words sharing a spelling pattern, and by application of a generalized spelling pattern. Analogizing that requires single-word knowledge would be expected to emerge in the alphabetic phase, whereas analogizing that involves knowledge of spelling patterns characterizing multiple words should emerge in the orthographic phase.

Alternative Developmental Theories

In this chapter, a phase theory of the development of word-reading skill has been constructed to organize the results of many studies. The theory and its components are summarized in Figure 1. Four phases of word-reading development are distinguished. The alphabetic period is separated into two phases—a novice phase in which phonetic cue reading is common, and a mature phase characterized by phonological-recoding skill and sight-word amalgamation.
## FIGURE 1
Ways to Read Words Classified by Developmental Phase

<table>
<thead>
<tr>
<th>Ways to Read Words</th>
<th>Logographic</th>
<th>Novice Alphabetic</th>
<th>Mature Alphabetic</th>
<th>Orthographic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ways to Read Words Familiar in Print</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>By sight</td>
<td>Visual cue reading</td>
<td>Phonetic cue reading</td>
<td>Amalgamated cipher reading</td>
<td>Amalgamated cipher reading (advanced)</td>
</tr>
<tr>
<td>Lexical access routes</td>
<td>Salient visual cues connected to meanings by rote learning; connections do not involve letter identities, sounds</td>
<td>Salient letters connected to easily detected sounds in pronunciation by letter-name or sound knowledge; spellings partially connected</td>
<td>Letters amalgamated to phonemes in pronunciation by grapheme-phoneme knowledge; spellings fully connected</td>
<td>Single- and multi-letter units amalgamated to phonemes and syllabic units in pronunciations by grapheme-phoneme, morphographic knowledge; spellings fully connected</td>
</tr>
<tr>
<td>Characteristics of sight-word lexicon</td>
<td>Context dependent; environmental print; variable pronunciations; isolated written words (few recognized, hard to remember, unstable); does not support text reading</td>
<td>Isolated written words can be recognized, remembered; partial letter-based representations; similarly spelled words mistaken; text reading supported</td>
<td>Rapid, unitized word reading possible; complete letter based representations; spellings may influence phonemic analysis; word reading in text made effortless</td>
<td>Easier to store multisyllabic words; representation of word morphology; organized by orthographic neighborhoods; similarly spelled words read easily</td>
</tr>
<tr>
<td><strong>Ways to Read Words Unfamiliar in Print</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>By guessing</td>
<td>Wild; constrained by context; constrained by memory for text (pretend-reading)</td>
<td>Constrained by context; constrained by initial letter</td>
<td>Constrained by context; constrained by spelling</td>
<td>Constrained by context; constrained by spelling</td>
</tr>
<tr>
<td>By mistaken lexical access</td>
<td>New word misread as sight word having same visual cues</td>
<td>New word misread as sight word having same letter cues</td>
<td>(Less likely to occur)</td>
<td>(Less likely to occur)</td>
</tr>
<tr>
<td>By phonological recoding</td>
<td>(Not possible)</td>
<td>(Not possible)</td>
<td>Sequential decoding</td>
<td>Sequential and hierarchical decoding</td>
</tr>
<tr>
<td>By orthographic recoding</td>
<td>(Not possible)</td>
<td>(Not possible)</td>
<td>Analogizing to specific words</td>
<td>Analogizing to specific words, word families, orthographic neighborhoods</td>
</tr>
</tbody>
</table>
Word reading is divided into two kinds of processes—those used to read words that have been read before and are familiar, and those used to read words seen for the first time. The various ways to read words at each phase are briefly portrayed to capture the essence of the foregoing discussion.

The phases differ in the type of sight-word reading used: visual cue reading, phonetic cue reading, and amalgamated cipher reading. The latter term reflects the claim that mature alphabetic readers possess sufficient knowledge of the alphabetic system, or cipher, to amalgamate spellings of specific words to their pronunciations in lexical memory. At the orthographic phase, the same sight-word amalgamation process continues to operate except that multiletter units as well as graphemes are available for use, so readers can learn longer words and words with more complex spellings. In sight-word learning, the access routes into the lexicon change in various ways across phases. These differences are summarized in the figure, together with distinguishing characteristics of readers’ lexicons.

One characteristic needing comment is the relationship between readers’ sight-word lexicons and their ability to read text. Although logographic readers may be able to pretend-read text they have memorized (Sulzby, 1985), they cannot use their lexicons to read unfamiliar text, mainly because their ability to read sight words from print cues alone is impoverished and unstable. In contrast, sight vocabularies support text reading in the other phases. For texts to be readable to novice alphabetic readers most of the words must be known by sight because decoding skill is absent and guessing is of limited value. In more advanced readers, sight-word reading is qualitatively different. Words are read rapidly with great accuracy. As a result, texts can be read efficiently with little attention and effort devoted to word processing (Perfetti, 1985, 1992).

As evident in the figure, several ways may be used to read words never before seen. The process of making guesses about words is usually constrained by factors such as syntactic and semantic expectations arising from prior text, pictured information accompanying print, or the reader’s memory for a story that has been heard or read before. Lexical-access mistakes may arise when the information remembered about sight words does not uniquely specify those words and distinguish them from other words. This is a problem for phonetic cue readers who may mistake words having the same initial and final letters. Such mistakes occur much less frequently among readers who possess full representations of sight words in memory.

Regarding the reading of unfamiliar words, from the figure it is clear that unless logographic and novice alphabetic readers can correctly guess these words, they have little hope of reading them accurately. In contrast, mature alphabetic and orthographic readers have recoding and analogizing skills to read new words.
An approximate timeline for the phases in normally developing readers who are receiving adequate reading instruction is as follows: logographic reading occurs during the preschool years before children have received any reading instruction; novice alphabetic reading emerges prior to or at the start of formal instruction, once children learn letter shapes and names or sounds; mature alphabetic reading appears during the first or second year of instruction when students acquire substantial knowledge of the alphabetic system and decoding skill; the orthographic phase takes over during the second or third year as readers begin operating with spelling patterns. This view of word-reading development is compatible with other views. In Chall’s (1983) theory, the logographic phase corresponds to her Stage 0. Both alphabetic phases fit into Stage 1 (decoding). The orthographic phase emerges during Stage 2 when readers attain greater fluency in their reading. Readers are thought to master the mechanics of word reading during the fluency stage. Hence, the orthographic is the final phase. Although readers’ knowledge of specific orthographic patterns continues to grow as new words are added to their lexicons, no new word-reading processes are thought to emerge.

Mason (1980) identifies three developmental levels of word knowledge to distinguish among beginning readers. These closely match the phases proposed here. Mason’s level of context dependency depicting readers who can read only environmental signs and labels corresponds to the logographic phase. Her visual-recognition level depicting children who have mastered letters, pay attention to initial consonants in words, and can read a few “book” words corresponds to the novice alphabetic phase. Her level of letter-sound analysis depicting readers who can sound out words, read multisyllabic words, and have rapidly expanding lexicons combines the mature alphabetic phase and orthographic phase.

Claiming that “the major essential development in learning to read is the acquisition of individual word representations,” Perfetti (1992, p. 154) proposes a theory of lexical development in which the representations of sight words stored in lexical memory change along several dimensions: from being partially specified to completely specified alphabetically; from being imprecise in containing unstable letters that change from time to time to being precise with fixed letters; and from being weakly attached to pronunciations of words to being bonded to phonemic representations of words. The reader’s knowledge of the phonemic values of letters determines whether they are included in the representation. Bonding increases as redundancy in knowledge about the “belongingness” of parts improves (that is, letter-phoneme relations, experience with letter sequences in other words). These concepts are very close to the amalgamation theory of sight-word learning proposed here. In that scheme, Perfetti’s immature representations characterize phonetic cue reading. Fully specified, fully bonded, redundant representations characterize sight words at the orthographic phase. Perfetti’s descriptions appear to support and enrich the present
view of sight-word development and invite further research to verify and work out development in greater detail.

Adams (1990) also presents a view of word-reading development that characterizes how alphabetic and orthographic knowledge grows as a consequence of several kinds of experiences (extensive exposure and practice reading words, instruction in how the alphabetic system symbolizes speech, and so forth). However, although the processes Adams describes as characterizing development are quite similar to those presented in this chapter (much of her evidence is drawn from studies reviewed here), her model of word reading is not. She adopts the parallel-distributed processing model, also referred to as connectionist theory, developed by Seidenberg and McClelland (1989). According to this view, the concept of a lexicon is eliminated and replaced by separate processors—orthographic, phonological, and semantic—that are activated in combination when words are read. In my view, it is unclear that Adams’s (1990) model offers a superior account of the acquisition of word-reading skill. By eliminating the lexicon, focusing on separate orthographic, phonological, and semantic codes, and obscuring how the integration or unitization process among these codes works in learning to process words, connectionist theorists have not captured the key constructs and mechanisms necessary to account for acquisition.

Although I have portrayed sight-word learning during the mature alphabetic and orthographic phases as involving the formation of connections between spellings and pronunciations of specific words, no functional separation persists once the connections are formed. This is indicated in the concept of amalgamation. Spellings function as symbols for pronunciations, as “visual phonology.” Several studies indicate that pronounceable letter sequences are not functionally separate from phonology in readers who possess mature knowledge of the alphabetic system. Perfetti (1985), Perfetti, Bell, and Delaney (1988), VanOrden (1987), and VanOrden, Johnston, and Hale (1988) have shown that phonetic codes are activated at a very early point during the word-recognition process. My research has shown that spellings influence readers’ conception of sounds in words (Ehri, 1984; Ehri & Wilce, 1980, 1986) and that spellings function as mnemonics to help readers remember pronunciations (Ehri & Wilce, 1979). It remains for future research to clarify which theoretical perspective, lexical or connectionist, has more explanatory power (Stanovich, 1991).

Notes

1 The word decoding is ambiguous. To some researchers, it refers to the process of phonological recoding of words, while to others it simply means word identification and covers sight-word reading as well as phonological recoding. In this article, I will use decoding interchangeably with phonological recoding in the specific sense.

2 Symbols marking phonetic/phonemic transcriptions are placed between slashes. Dictionary symbols are used to represent short and long vowels. Short vowels are marked as follows: /bʌt/, /bɛt/, /bɪt/, /bɔp/, /bʊt/. Long vowels are marked with a horizontal bar: /bʌk/ for bake, /bʊt/ for beet,
/bɪ/ for bite, /pɔk/ for poke, /dʊk/ for duke. The symbol for schwa, the vowel in unstressed syllables is ∂. Although linguists distinguish between the terms phonetic and phonemic, they are used synonymously here.

3 Dual-route theory is so labeled because it specifies two routes to access words in the lexicon—by phonological recoding and by logographic sight-word reading.

4 I conceptualize the orthographic phase differently from Frith (1985), who adopts the traditional dual-route view that direct nonphonological access routes are established for sight words in the lexicon. She believes that readers at the orthographic stage instantly analyze words into orthographic units without phonological conversion. In contrast, I regard orthographic phase readers as operating phonologically as well as orthographically.

5 Statistical orthographic redundancy involves counts of how often letters occur within words in running text. Spelling patterns of frequently occurring words such as the contribute much more to these counts than less frequently occurring words. As a result, letters such as th in initial position are regarded as common patterns, even though relatively few words begin with th.

6 It is unclear whether superior performance with legal patterns in these tasks reflects readers’ knowledge of orthographic structure or phonological-recoding processes since the two variables are unavoidably confounded, with orthographic structure deriving from phonological regularities (Massaro et al., 1979, 1980, 1981).

7 Ask linguistics instructors about the hardships they suffer when they attempt to rid students of orthographic misconceptions about phones and phonemes in their phonetics and phonology courses. According to my colleagues Bruce Derwing and Robert Scholes, using spellings to analyze phonological representations is a hard habit to break in students. This supports the idea that, in learning to read, orthography becomes amalgamated or bonded to phonological representations (Ehri, 1984). In my view, this process is very important in accounting for the acquisition of word-reading skill in English and is minimized if not missed in connectionist theory.

References


learning to read (pp. 119–147). New York: Springer-Verlag.


Ehri, L.C., & Saltmarsh, J. (1992). Do beginning and disabled readers remember the letters in words they have learned to read? Unpublished manuscript.


